European
Semiconductor Application Markets
Volume II—Newsletters

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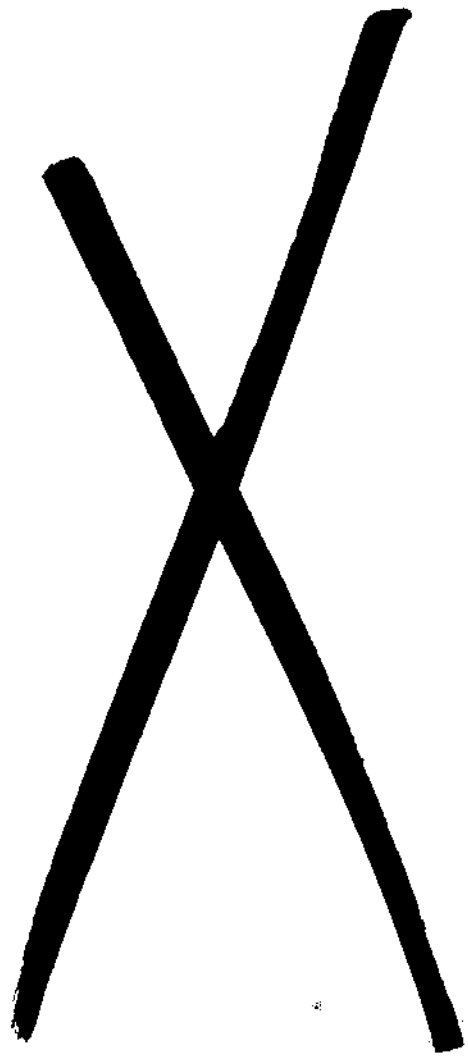

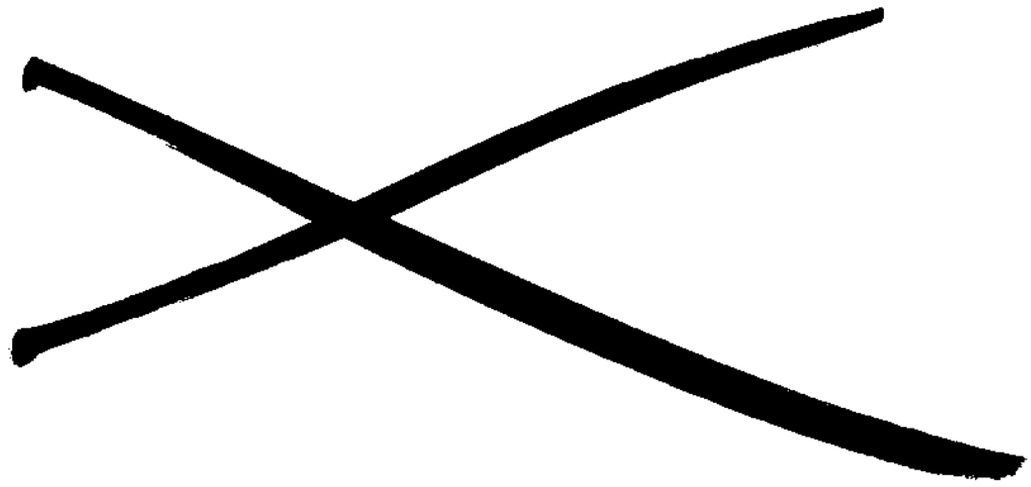

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Research Newsletter

EUROPEAN SEMICONDUCTOR PROCUREMENT SURVEY

SUMMARY

Dataquest periodically conducts procurement surveys of the leading semiconductor purchasing locations in Europe. The information from these surveys is then analyzed to provide key industry indicators such as regional, product, and application forecasts and trends. This newsletter covers a number of important procurement trends within different market sectors and highlights major issues currently facing procurement executives and semiconductor marketing managers. Table 1 summarizes the results obtained in Dataquest's most recent survey.

THE MARKET SEGMENTS

Data Processing Segment

When asked to specify, in local currency terms, the percentage of increase in their semiconductor purchases from 1988 to 1989, the majority of respondents indicated a range between 25 and 60 percent. For 1989 to 1990, the growth expectation varies from 0 to 5 percent. The decline in growth rate stems first from a decline in the average selling price of MOS memory products and second from an increase in inventory levels within the PC sector. Most of the large users, especially those concentrating on PC production, indicated that their actual inventory levels were five to six weeks higher than their targeted inventory levels. The major culprit causing this excess inventory level is memory, which represents more than 50 percent of these companies' semiconductor purchases in dollar terms. No new large orders have been placed for DRAMs over the last few months, and our analysis indicates that many buyers are hedging for the best prices before they place more DRAM orders. Very little double ordering is occurring because most buyers are not rescheduling their delivery dates. The market for PCs grew by more

TABLE 1
European Procurement Survey Key Results

Segment	Target Inventory Levels	Semiconductor Spending 1989-1988	Semiconductor Spending 1990-1989	Key Concerns
Data Processing	5-6 weeks over	+25%-60%	0%-5%	Memory inventories and prices
Communications	2 weeks over	+10%-15%	5%-10%	Increased complexity of ASICs memory prices
Transportation	2-3 weeks under	+5%-10%	+10%	Discrete, opto
Industrial	3 weeks over	5%-10%	Flat	On-time delivery, distribution shakeup
Military	OK	20%	5%	Reduction of military memory suppliers
Consumer	High	10%	Negative	Slowdown in consumer spending

Source: Dataquest
October 1989

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than 50 percent in the first half of 1989. The inventory build-up is due to suppliers catching up on long-term agreed contract delivery dates and prices. We expect inventories to be used up by the fourth quarter of 1989.

One sign of major concern facing this sector is that most Japanese vendors are cutting back on 1Mb DRAM capacity in favor of 256K SRAMs and 4Mb DRAMs. This situation could cause some hiccups in supply of 1Mb DRAMs, especially when 4Mb DRAMs become widely available in 1990.

Communications Segment

The major central office equipment manufacturers indicated a growth of 10 to 15 percent in semiconductor purchases in 1989 over 1988. However, this growth is expected to decline to 5 to 10 percent in 1990. This segment is also a very large user of ASIC devices. Dataquest believes that full-custom ASICs will still dominate over standard cell and gate array devices in terms of purchasing dollars spent in 1990.

The next biggest expenditure should be for memories, followed by microcontrollers. Inventory levels in these products are two weeks over targeted levels and are expected to remain the same in the near future. The datacommunication sector showed some signs of weakness, with some buyers indicating very little growth in 1989 over 1988 and a minimal increase of 5 percent in 1990.

Issues that caused procurement managers in the telecommunications sector most concern were pricing, on-time delivery, and quality of incoming goods—ranked in that order.

Transportation Segment

Most survey respondents indicated that they are two to three weeks below their targeted inventory levels of three to four weeks holdings. The majority of them participate in just-in-time programs with their key vendors. Comparatively speaking, they spend a large portion of their purchasing dollars on discrete and optoelectronics products, followed by linear devices and microcontrollers. Exceptionally, most buyers indicated that they were budgeting for a 10 percent growth in 1990 in contrast to other segments that indicated a gradual slowdown in semiconductor purchase dollars. This growth is being driven specifically by the greater use of electronic systems and components in the mass market range of automobiles.

Major issues ranked by transportation buyers were on-time delivery, pricing, quality, and accurate forecasting of demand. Interestingly, a number of buyers intimated that they relied upon making up to 5 percent of their purchases via distributors in order to make up for shortfalls in delivered quantities from major vendors.

Industrial Segment

As in the transportation segment, discrete and optoelectronic devices enjoy a relatively high proportion of the total semiconductor expenditure in the industrial segment. These devices make up more than 50 percent of the purchased devices in dollars, followed by linear, memory, and standard logic. Most respondents indicated that between 20 and 35 percent of their purchases were via franchised distributors. Despite this fact, most of the microcontrollers and ASICs are purchased directly from semiconductor vendors.

Inventory levels in this segment are three weeks over targeted levels. Overall, industrial segment buyers anticipate that their 1990 spending will be flat compared with 1989 despite buoyant market conditions in the test, instrumentation, and medical markets.

Military Segment

Most military buyers indicated a slowdown in their purchasing power in 1990, with some stating a positive 20 percent growth in 1989 over 1988. Inventory levels do not seem to be a major problem because of the availability of standard parts from distributor shelves and the long lead times required for some military parts.

Major concerns are the shrinking base of military high-density memory suppliers and the switch from bipolar to CMOS devices. A large percentage of dollars is spent on memory products, followed by ASICs, linear, microcomponents, and standard logic. A number of respondents intimated that a high proportion of their memory spending is taken up by specialized hybrid configurations. Among their ASIC expenditures, 80 percent were in the PLD segment, with standard cells becoming more popular.

Consumer Segment

Within the consumer segment, procurement executives indicated concern about the overall economic situation. Most economists are forecasting a reduction in GNP during the first half of 1990. In the United Kingdom in particular, high interest rates have affected the amount of disposable income in circulation, leading to a reduction in order intake. Inventory levels at present are high, and total spending in 1990 could be reduced by up to 10 percent over 1989. Key concerns in this sector were just-in-time, quality, and pricing.

DATAQUEST CONCLUSIONS

Dataquest's overall analysis shows that it will take time for excess inventory to be used up, resulting in slow growth in 1990. We believe that the brightest sectors will be transportation, telecommunications, and industrial; the data processing, military, and consumer segments will show some decline.

Bipin Parmar

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Research *Newsletter*

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PRINTER MANUFACTURING SCENE TRANSFORMED IN EUROPE

SUMMARY

The European printer industry is experiencing a period of rapid change caused by the increase of Japanese plants in Europe. This newsletter examines the European printer industry changes in three parts. The first part explores the reasons behind the Japanese influx, studies the European printer industry's recent history, and shows the results of a Dataquest survey of Japanese printer plants. The second part looks at the European printer market in detail and analyzes the potential impact on the semiconductor market of the increase in local production. Finally, the third part lists the major printer manufacturing locations in Europe by the types of printers manufactured at each site.

RECENT PRINTER INDUSTRY HISTORY

Until 1970, the European printer market was dominated by Centronics. In 1984, as the potential demand for printers for the oncoming PC boom was recognized, European and North American companies started to invest in new printer production sites in Europe. European printer production focused mainly on high–quality, heavy–duty printer products for multiuser systems. Brother was the first company to prepare for volume dot matrix printer production in Japan.

With the boom in PC markets, there was a clear demand for low–priced, high–quality printers. Although Centronics was the first company to provide a dot matrix printer costing less than $1,000, the product had too many technical problems to survive in the market. North American and European companies noted this problem and many gave up their products in this market.

Meanwhile, two Japanese manufacturers (namely, Epson and Oki) responded with high–quality, low–cost products that were produced in high–volume factories. With a well–established distribution network in Europe, the Japanese producers managed to gain a 60 percent market share; virtually all of this was in products that cost less than $1,000. In 1987, Japanese market share had risen to 75 percent of the European market.

Europe-based manufacturers were concerned, which resulted in a large-scale investigation by the European Community (EC) that was instigated by the Europrint Group. In March 1987, the EC Antidumping Committee initiated an information-gathering process for analyzing the intricacies of the complex path from manufacturers to end users. The EC's objective was to raise the prices of Japanese dot matrix printers and to allow European manufacturers breathing room so that they could become more competitive, but the EC did not anticipate the 13 new Japanese printer production plants in Europe. These plants were set up to avoid the high tariff on imported printers.

In 1988, the EC imposed import tariffs on the majority of imported printers from Japan. The companies that received maximum tariff penalties of 33.4 percent accounted for more than 50 percent of the printer market share in 1987. This resulted in more than $500 million in import tariffs from sales of more than $1.6 billion. To make sure that end-user prices reflected the import tariffs, the EC produced a new regulation, 2423/88, which compelled Japanese manufacturers to apply the tariff on imports sold at the first European point of sale. The idea behind the rule was to prevent manufacturers from spreading import tariffs over a wider range of products or to recover tariffs from the more expensive models. The EC, after finalizing an investigation into local content for photocopiers, started a similar investigation into the printer industry in 1988.

DATAQUEST SURVEY OF JAPANESE PRINTER MANUFACTURERS

In 1987, there was only one Japanese printer manufacturing plant in Europe—that of Canon in France. By 1988, there were 14. More than 70 percent of total investment was situated in the United Kingdom. Table 1 lists the most important factors cited by manufacturers in deciding where to locate.

Table 1

Factors in Choosing Locations

Most Important	Less Important
Local government grants	Wage cost
Communication	Skilled labor
Language	Overall cost
Component sourcing	

Source: Dataquest
October 1989

As indicated in Table 1, sourcing of components is considered very important. The major problems currently encountered in local sourcing are that of quality, price, and delivery. The companies surveyed estimated that it would take them 12 months to reach 40 percent local content, 18 months to reach 50 percent, and 24 months to reach 60 percent. What is apparent is that most companies are determined to source more than the required minimum of 40 percent local content.

As the printer manufacturing industry in Europe begins to mature, we expect an infrastructure comparable to that of Japan to emerge. Until then, most of these semiconductor components probably will be sourced from Japan. Fujitsu's announcement that it will locate its semiconductor fab in the United Kingdom is just the beginning of a potential wave of investment by Japanese component suppliers and printed circuit board (PCB) assembly subcontractors in Europe.

Major Printer Components

The main components of a printer are the printheads, PCB with electronic components, and specialized mechanical subassemblies. Dataquest believes that although the 40 percent content rule can easily be met without PCB, some Japanese plants have started inclusion of subcontract to local PCB assembly houses. These PCB boards can then be counted as local content as they are invoiced in local currencies. The majority of semiconductor components on the PCB still are sourced from Japanese vendors because most of the value is added via ASICs that are designed in Japan and sourced from either an in-house semiconductor supplier or an appropriate merchant supplier. Table 2 shows the major semiconductor components used in three types of printers.

Table 2

Major Semiconductor Printer Components

Serial Dot Matrix Printer

Quantity	Components
1	Serial EEPROM and small RAM buffer
1	128-Kbit EPROM
1	8155 8-bit parallel port
1	8-bit controller with 128-Kbit EPROM and four 8-bit A/D converters
1	Printhead electronics with 9 Darlington pairs delivering up to 2 amps and 24 pulsed volts
10	Standard TTL

Estimated total semiconductor value = $18.10

(Continued)

Table 2 (Continued)

Major Semiconductor Printer Components

Ink Jet Printer

Quantity	Components
2	ASIC nozzle-control 8-bit input and 4 x 8-bit output
2	ASIC parallel ports
2	ASIC bus controllers
1	16-bit MPU
2	Diode arrays
3	Discrete power supply regulator chips
7	Custom nozzle drives
1	LSI decoder
12	Standard TTL logic

Estimated total semiconductor value = $58.10

Page Printer (Laser Printer)

Quantity	Components
1	16/32-bit image processor
1	8-bit MCU
3	ASIC control logic, bus controllers, clock chip
30	Standard TTL logic
16	256-Kbit DRAMs
1	Hybrid laser driver, with controllers for lens, motors, mirrors, scanners

Estimated total semiconductor value = $214.10

Source: Dataquest
October 1989

OPPORTUNITIES FOR EUROPE-BASED SEMICONDUCTOR VENDORS

An analysis of the semiconductor content of a printer shows that most of the technology, and therefore value, is packed into ASICs. Considerable use is made of gate arrays and full-custom ICs, particularly in the printer head controlling the pin drivers. Most of this technology is proprietary, and in the case of Japanese printer companies, the design is done in Japan. This makes it very hard for European semiconductor companies to design in their products. The fundamental requirement must be to have a design center in Japan.

Other than ASICs, printers incorporate standard logic, EEPROM, EPROM, DRAM, MCUs, and power transistors. Further integration of standard logic into ASICs is difficult, since this mainly comprises octal bus functions.

The Printer Market's Potential Impact on the Semiconductor Market

The printer market can be broken down into the following three major categories:

- Serial printers
- Line printers
- Page printers

Each category has several types of printers; for a full breakdown, please refer to the "Definition Section" of your ESAM binder or turn to the glossary at the end of this newsletter.

Serial Printers

The total serial printer market in 1988 was estimated to be 4.5 million units in Europe. Of these, Dataquest estimates that 1.6 million units were produced in Europe. This many units would represent a potential semiconductor market of $29 million if semiconductors were sourced locally. The market is expected to grow at a compound annual growth rate (CAGR) of 5.5 percent, reaching 5.9 million units by 1993. We estimate that 4.5 million units will be produced in Europe by 1993. Assuming that the majority of semiconductors will be purchased locally, this represents a potential market of $82 million.

The market is led by Epson, Star Micronics, and NEC, which together control 40 percent of the market. Citizen, Oki, and Amstrad follow; together they control 19 percent of the market.

Line Printers

The line printer market is aimed at professional users (i.e., mainframes, microcomputers, and workstation installations). The total line printer market for 1988 was estimated to be 46,500 units and is expected to grow to 61,800 units by 1993. The largest growth would be in line, impact, thermal transfer printers; we expect this market to grow at a CAGR of 33.8 percent to reach 28,600 units.

Dataquest estimates that 14,000 line printers were produced in Europe in 1988. Of these, 9,000 were in the line, impact, fully formed category. The leading companies in this category are: Dataproducts, Gemicron, Fujitsu, IBM, and Nixdorf.

Page Printers

Page printers are commonly known as laser printers. Dataquest estimates that the 1988 market was 445,000 units, and we expect it to grow at a CAGR of 27.9 percent to reach 1.5 million units in 1993. We estimate that 45,000 laser printers were produced in Europe in 1988. The largest category in unit shipment terms will be in the 1- to 10-ppm (page per minute) category representing 1.3 million units; of this, we estimate that 540,000 will be produced locally. Although laser printer unit shipments are relatively low compared with serial printers (see Table 2), their semiconductor content in 1988 was estimated at $214.10. This amount represents a semiconductor market of $9.6 million in 1988 for semiconductors that were sourced locally and should rise to $113 million for the 1- to 10-ppm category by 1993.

The leaders in the 1- to 10-ppm printer category are Hewlett-Packard, Canon, and Kyocera, which together control a 50 percent market share. Apple, NEC, and Qume follow, together controlling 14 percent of the market.

Printer Production in Europe

During 1988, 13 additional plants relocated to Europe, the result of the EC Antidumping duties on imported printers. Currently, 42 printer manufacturing plants are located in Europe—12 in the United Kingdom and Ireland, 11 in West Germany, 5 in France, 4 in the Benelux countries, 3 in both Scandinavia and Italy, and 2 each in Spain and Switzerland. Table 3 shows plant locations and types of printers manufactured.

Table 3

Western European Printer Manufacturing Sites

Company	City(ies)	Country	Technology
Agfa-Gevaert	Mortsel	Belgium	PNPP
Daisy Systems	Wijchen	Netherlands	SIFF
IBM	Amsterdam	Netherlands	SIDM
Printronix	Wijchen	Netherlands	LIDM
Bull Peripherals	Belfort	France	LIFF, PNPP
Canon	Liffre, Brittany	France	PNPP
Epson	Paris	France	SIDM
IER	Besancon	France	SIDM
TIV	Lognes	France	SIDM
Canon/Olivetti*	Aglie	Italy	PNPP
Honeywell Bull	Milan	Italy	SIDM
Olivetti	Ivrea	Italy	SIDM, SIFF, SNTT
Facit	Atvidaberg	Sweden	SIFF, SIDM
IBM	Stockholm	Sweden	LIFF, PNPP
Mercante	Copenhagen	Denmark	PNPP

(Continued)

Table 3 (Continued)

Western European Printer Manufacturing Sites

Company	City(ies)	Country	Technology
Fujitsu	Malaga	Spain	SIDM
Rank Xerox	Madrid	Spain	PNPP
Hermes	Yverdon les Bains	Switzerland	SIDM, SNTT
Wenger	Reinach	Switzerland	SIDM
Dataproducts	Dublin	Ireland	SIFF, LIFF, PNPP
Brother	Wrexham	United Kingdom	SIDM
Citizen	Scunthorpe	United Kingdom	SIDM
Epson	Telford	United Kingdom	SIDM
Newbury Data	Staines	United Kingdom	SIDM
NEC	Telford	United Kingdom	SIDM
Okidata*	Glasgow	United Kingdom	SIDM
Panasonic	Newport, Gwent	United Kingdom	SIDM
Rank Xerox	Gloucester	United Kingdom	PNPP
Star*	Tredegar, Wales	United Kingdom	SIDM
Technitron	Slough	United Kingdom	PNPP
Walters	High Wycombe	United Kingdom	SIDM
Binder	Villingen	West Germany	SIDM
Kienzle	Villingen	West Germany	SIDM
Mannesmann Tally	Elchingen	West Germany	SIDM
Nixdorf	Paderborn	West Germany	SIDM
Olympia	Wilhelmshaven	West Germany	SIFF
Philips	Siegen	West Germany	SIDM,PNPP
Siemens	Muenchen	West Germany	PNPP
Siemens	Berlin	West Germany	SIDM,SNIJ,SNTT
TEC	Braunschweig	West Germany	SIDM
Triumph-Adler	Nuremburg	West Germany	SIFF
Walther	Gerstetten	West Germany	SIDM

*Production plans announced, but not yet finalized

Source: Dataquest
October 1989

DATAQUEST CONCLUSIONS

The European PC market has created a strong demand for low-cost printers; the demand was originally satisfied by low-cost imports from Japan. The EC investigation and subsequent imposing of dumping duties and local content rules have resulted in an invasion of Japanese printer plant locations in Europe. The market demand for printers remains high, and pressure for higher local content has resulted in the use of local subcontractors for PCB assembly and a gradual rise in locally purchased semiconductors. Dataquest estimates that a potential $200 million semiconductor market will be created by these new printer production plants in Europe by 1993. We believe that long-term opportunities exist for locally based semiconductor vendors making the right investments and planning the right penetration strategies now.

Bipin Parmar

APPENDIX

PRINTER INDUSTRY DEFINITIONS

The following categories comprise all electronic printers:

- Serial printers
- Line printers
- Page printers

Serial Printers

Serial printers are printers that use a single printhead or striking mechanism to print characters sequentially across the page. They include the following:

- Serial, impact, fully formed (SIFF) printers
- Serial, impact, dot matrix (SIDM) printers
- Serial, nonimpact, direct thermal (SNDT) printers
- Serial, nonimpact, thermal transfer (SNTT) printers
- Serial, nonimpact, ink jet (SNIJ) printers

Line Printers

These are printers with a printhead that covers a full line of the printed page and a striking mechanism that prints one full line at a time. They include the following:

- Line, impact, fully formed (LIFF) printers
- Line, impact, dot matrix (LIDM) printers
- Line, nonimpact, direct thermal (LNDT) printers
- Line, nonimpact, thermal transfer (LNTT) printers

Page Printers

Page printers can buffer, in part or whole, a page of images received from an electronic source and then transmit these images to a receiving substrate. They include:

Page, nonimpact, plain paper printers (PNPP) using laser, LED, ionography, magnetography, or ink jet technology.

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Research Newsletter

DOMESTIC METERING: THE MARKET IN EUROPE

SUMMARY

This newsletter examines the prospects for semiconductor consumption in electronic domestic meters used for measuring electricity, gas, and water in Europe. In it, we will discuss the main factors that will affect the rate of substitution of these meters over mechanical rivals and forecast the demand for semiconductors during the next five years. Dataquest forecasts that the total market will increase from an estimated $18 million in 1989 to $83 million by 1994, showing an overall 35 percent compound annual growth rate (CAGR).

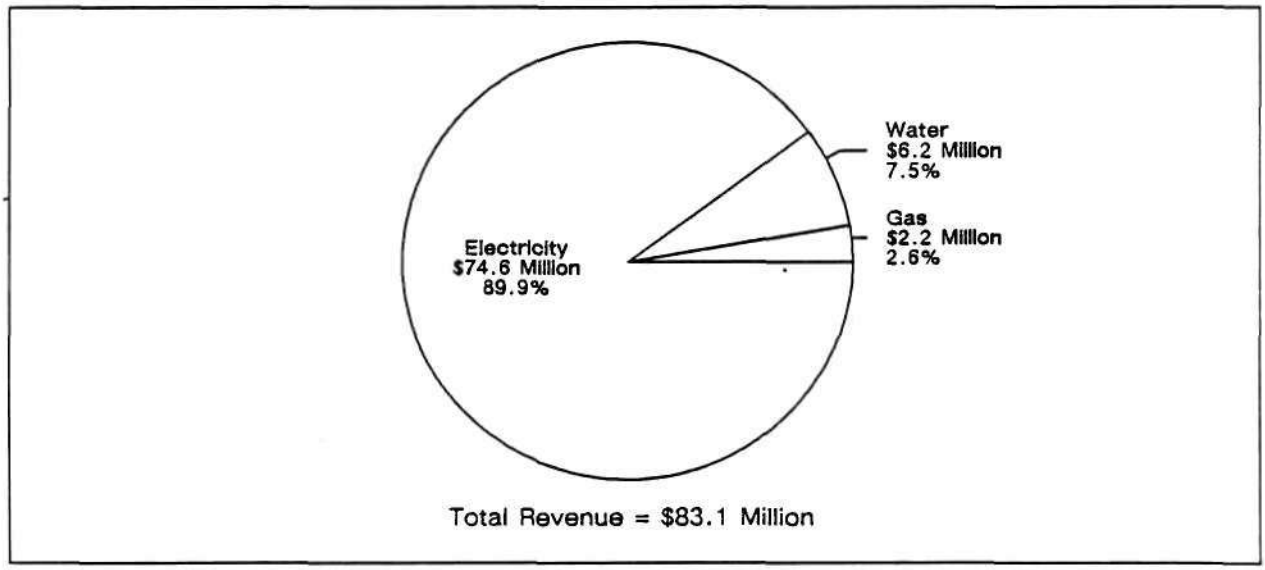
Figure 1 shows our estimation of the demand among electricity, water, and gas applications for 1994. Electricity meters and teleswitches should account for the lion's share—90 percent—of this market, with consumption for meter applications forecast to grow at a heady 54 percent CAGR between 1989 and 1994.

ELECTRONIC METERS BRING NEW FEATURES

Although electronic meters cannot exactly match mechanical products point for point on cost, they do offer features that traditional meters cannot provide. Table 1 summarizes these features, which are the "back doors" to the meter market.

Electronic meters allow multiple rate tariffs to be administered according to the season, day of the

FIGURE 1
European Semiconductor Revenue Forecast by Domestic Metering Application (1994)



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Source: Dataquest
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TABLE 1
Benefits from Electronic Functionality for Electricity, Gas, and Water Meters

Function	Electricity	Gas	Water
Multiple Tariffs	1	N/M	3
Supply Management	2	N/M	3
Data Capture	3	3	3

Note: 1 = Most Important; 2 = Important; 3 = Least Important N/M = Not Meaningful

Source: Dataquest October 1989

week, or time of day. The benefits are most pronounced for electricity metering where considerable power savings may be made to encourage or shape demand.

Supply management functions allow the utility companies to switch off certain home appliances during periods of peak demand. As for multiple rate tariffs, the greatest benefit is in electricity management. Trials have been conducted in the United Kingdom using the public telephone network, radio, and mains signaling to control household appliances. Savings are as much as $50 per annum per domestic consumer; however, this is not sufficient to justify equipment and installation costs.

Data capture features can either shorten the manual measurement process or remove the need for meter-reading personnel to visit each home. Although automated measurement is common in the United States where the utility companies have a statutory obligation to read and bill monthly, this is not the case in Europe. Combined with the lower cost of labor in Europe, the prospects for remote measurement systems are weak.

ELECTRICITY—COGS AND DISKS RULE ... FOR NOW

Dataquest expects the greatest demand for semiconductors to occur in the electricity segment, where extra features offered by electronic meters bring the greatest utility.

However, traditional mechanical, nonelectronic meters still dominate the market in Europe years after many predicted a switch to electronic meters. With few exceptions, this is true worldwide. Whether used for measurement of electricity, gas, or water, the crucial selling points for both products are price, reliability, and durability.

Electricity meters using the spinning Ferraris disk cost $35 and have a proven useful life of up to 30 years. They are approximately $10 less expensive than electronic versions, which have lifetimes that can only be estimated.

Semiconductor Content

Many solutions have been developed for domestic power measurement. The most common solution is to feed current signal from a laser-trimmed shunt and voltage signal into an analog multiplier to derive a power signal (see the semiconductor breakdown in Table 2). This power signal is, in turn, passed to a voltage-frequency converter and frequency counter to enable reading by a standard microcontroller (MCU). Excluding the MCU, all these functions are integrated onto a single, low-noise CMOS or bipolar ASIC. An EEPROM provides a nonvolatile store in case of power failure. We estimate the semiconductor cost for this approach to be $8.95, 21 percent of an average selling price of $42.00.

Another approach dispenses with the analog multiplier circuit and resistive shunt by combining current-voltage measurement and power multiplication functions onto a single Hall probe attached to a slow 12-bit A/D converter and MCU.

Electronic teleswitches are common adjuncts to either electronic or electromechanical meters. There are two basic types that differ in terms of the transmission medium the utility companies use to control them. First, radio teleswitches using the 198-kHz radio band are employed widely in the United Kingdom. Second, ripple teleswitches, or "ripple controllers," are used widely in Austria, France, and West Germany; they use the electricity supply grid as the transmission medium.

Except for the front-end receiving circuitry, the semiconductor contents for radio and ripple teleswitches are similar. Dataquest's estimation for the semiconductor content of a radio teleswitch is shown in Table 2. The major components are a radio-frequency preamplifier IC, a switch capacitor filter/data decoder ASIC, and an 8-bit MCU. We

TABLE 2
Estimated Semiconductor Content for an Electronic Meter and Teleswitch

Electronic Meter (With LCD Display)		
Function	**Technology**	**Cost**
8-Bit Microcontroller with LCD Controller	Standard CMOS	$ 4.00
1-Kbit EEPROM	Standard NMOS	0.65
Analog Power Multiplier and Frequency Conversion	Linear CMOS ASIC	3.50
Discretes	Bipolar	0.80
Total Semiconductor Content		$ 8.95
Average Selling Price		$42.00
I/O Ratio		21.3%
Tariff Teleswitch*		
Function	**Technology**	**Cost**
8-Bit Microcontroller	Standard CMOS	$ 4.00
RF Front-End/Preamplifier	Analog ASIC bipolar	3.00
Receiver/Filter/Decoder	Analog/digital ASIC CMOS	5.50
Discretes (Relay Drivers & LED)	Mixed	0.90
Total Semiconductor Content		$13.40
Average Selling Price		$60.00
I/O Ratio		22.3%

*Content estimated for U.K. 198-kHz radio teleswitch

Source: Dataquest October 1989

estimate the semiconductor content of these units to be $13.40, which is 22 percent of an average selling price of $60.00.

At present, most teleswitches are designed to complement double-rate Ferraris disk meters, which are less expensive to supply than electronic versions. As Table 2 indicates, there is a significant scope for the combination of meters and teleswitches into one unit, allowing sharing of the same MCU and integration of the ASIC functions onto one IC.

Market Analysis

Table 3 shows the major companies that have commenced domestic electronic metering equipment manufacture in Europe. In addition, many smaller national suppliers of conventional meters are developing electronic versions too.

By region, France and the United Kingdom currently lead Europe in domestic electronic meter implementation. The public utility Electricite de France (EDF) is the most ambitious, with plans to build its initial trial of 90,000 electronic meters (supplied by Sauter and Schlumberger) to full electronic metering across all of France by 1995.

In 1989, Dataquest estimates that only 330,000 electronic meters will be sold out of 7.4 million meters shipped to Europe each year. Most of these units are electronic budget meters that replace vulnerable coin meters in the United Kingdom. By 1994, we expect electronic meters to account for 40 percent of all meters shipped.

This year, we estimate that 1.1 million teleswitch units will be fitted in Europe. Of these, 430,000 are radio versions for use in the United Kingdom and the rest are ripple controllers going mainly to France, West Germany, and Austria. We predict that this volume of teleswitch shipments will have risen to 4.1 million units within five years; one-half of these units will be integrated with an electronic electricity measurement function.

TABLE 3
Key Electronic Electricity Meter Suppliers

Company	Town	Country
AEG	Hameln	West Germany
GEC Meters	Stone	England
Landis & Gyr	Acton	England
	Telford	England
	Frankfurt	West Germany
	Zug	Switzerland
Sauter	Mulhouse	France
Schlumberger	Felixstowe	England
	Poitiers	France
	Chasseneuil	France
Siemens	Vienna	Austria
	Oldham	England
	Nuremburg	West Germany

Source: Dataquest
October 1989

Figure 2 shows Dataquest's estimate for semiconductors consumed in domestic electronic electricity meters and teleswitches in Europe. We estimate this market to be worth $18 million in 1989, rising to $75 million by 1994, a 32 percent CAGR.

MIXED PROSPECTS FOR WATER METERS

Although no electronics are used in water meters, electronic encoders can be connected to them to allow fast transmission of water usage data to meter reading personnel. The major suppliers of these encoders in Europe are Kent (ASEA Brown Boveri) and Neptune (Schlumberger).

Except for the United Kingdom, where very few domestic water meters currently are used, meters are installed in each of Europe's 120 million households. Dataquest estimates that 7.6 million new meters will be fitted in Europe this year, rising to 8.9 million units by 1994. The increasing demand is due largely to the privatization of the water industry in the United Kingdom, where rapid demand is expected. We estimate that only 0.13 percent of these shipments will be fitted with encoders this year, resulting in semiconductor consumption of only $60,000. Of the several water authorities we contacted in Europe, none will be prepared to fit electronic meters for a few years, for the following reasons:

- Cost—With a selling price of $60, encoders presently cost many times more than the $20 for the meters themselves, thus making manual reading more attractive.
- Power availability-Batteries are a common solution, but their lifetimes (10 to 12 years) and reliability are unacceptably low.
- Industry standards—Industry standards for encoder transmission techniques are lacking.

As encoder prices fall compared with the cost of labor, this situation will change. Assuming that one in five water meters will have encoders in 1994, we estimate the European semiconductor market to be $6.2 million in 1994. This market is small compared with the demand for semiconductors in domestic electricity metering.

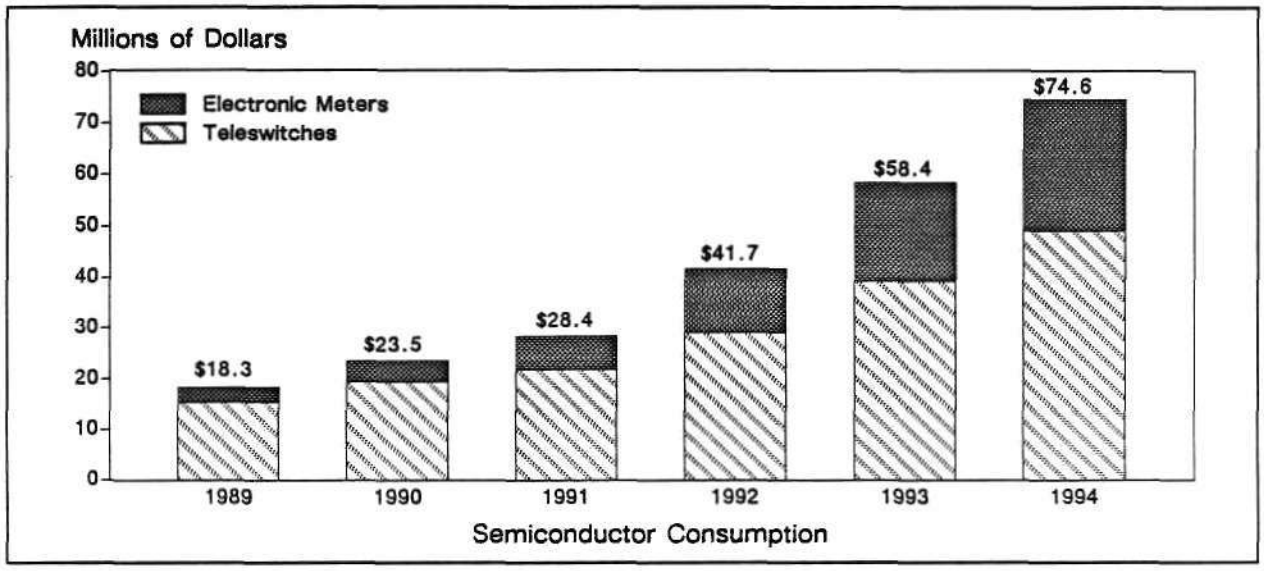
ELECTRIFIED GAS?

Conventional mechanical bellows gas meters are bulky and inaccurate. At $60 each, they also are far more expensive than their electricity or water counterparts.

Limited electronic meter trials are under way in West Germany. However, inexpensive electronic versions are not currently available. Research and development is under way, some of it funded by the utility companies themselves. The major companies involved are Ferranti Meters Limited (Siemens), Sauter, and Schlumberger.

Of the utility companies we contacted, none expect electronic gas meters to be widely used for

FIGURE 2
Semiconductor Consumption Forecast for Electronic Electricity Meters in Europe (1989-1994)



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Source: Dataquest October 1989

at least another five years. The reason is cost. Today, electronic versions cost $110 to build—twice what is acceptable. Furthermore, without access to an electricity supply they must use lithium batteries, which are both expensive and labor intensive for the gas companies to replace.

The consequent demand for semiconductors in Europe is uncertain. Assuming a semiconductor content of $20 and that electronic versions are forecast to account for 1 in 20 of Europe's annual shipments by 1994, this European semiconductor market could be worth $2.2 million.

DATAQUEST CONCLUSIONS

Clear evidence exists that electronic meters are positioned to fully replace their mechanical rivals, particularly in electricity metering. All the key manufacturers contacted by Dataquest have electronic designs on their drawing boards. Schlumberger Industries already has ceased production of Ferraris meters in Europe in favor of electronic meters. A similar situation appears imminent at Landis & Gyr following its announced construction of an all-electronic meter factory in Telford, England.

Environmental issues such as the potential greenhouse effect have come to the public's attention. European governments presently are looking at ways in which energy waste can be minimized to avert environmental damage. Sophisticated electronic domestic and industrial energy management systems will make a major contribution and further drive the demand for features that only electronic products can satisfy.

The factors that have kept the electronic metering markets in check now are disappearing. Mechanical technologies have reached the bottom of their experience curves, with prices for these products expected to increase, not decrease, with time. In contrast, the quest toward inexpensive mass-produced electronic meters has only just begun.

Jonathan Drazin

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Research Newsletter

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THE EUROPEAN PC HOME MARKET: AN UNKNOWN POTENTIAL

SUMMARY

The home market for microcomputers is often associated with fringe activities such as family entertainment and hobbyist usage. But with growth rates in the business market expected to flatten out over the next few years, an increasing number of PC vendors, including IBM, are taking the home market seriously. Throughout Europe, shipments to the home market currently account for one quarter of all PCs shipped. However, a more significant statistic is that current household penetration rates are low, attaining less than 5 percent in even the most developed home markets. This means that the potential of the equivalent home market is still far from being fully exploited when compared with the European business markets. In this respect, it is interesting to look at the penetration of PCs into U.S. households; Dataquest estimates that, in 1988, the U.S. penetration was around 15 percent.

In this newsletter, the home market is defined as the sum total of PCs purchased by individuals rather than by corporate or other legal entities. The basic distinctive criterion for the home market is therefore "who pays for the PC." This implies that the distinction is not at all related to product characteristics of the hardware acquired. In defining a PC, Dataquest only considers fully functional PC models sold with a central processing unit, keyboard, display monitor and with at least one internal floppy disk drive, costing US$600 or more, exclusive of value-added tax. This definition excludes the dedicated word processors, low-performance 8-bit PCs and games consoles currently sold to home users by vendors such as Amstrad, Atari, Commodore and Nintendo.

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CHARACTERISTICS OF THE HOME MARKET

Price-Driven with Special Requirements

Home users traditionally have more limited budgets and tend to be far more price sensitive than business users when it comes to buying personal computers. However, price is not the only deciding factor. In certain respects, such as a machine's graphical and musical capabilities, home users are very demanding and have very specific requirements. Vendors such as Atari and Commodore were quick to recognize the fact, and developed PCs that provided fairly sophisticated graphics and sound capabilities at a modest price. Amstrad's PCs are successful because they provided IBM compatibility at a low price. But the PC1512's integral design and the bundling of inexpensive, cut-down versions of professional software were also important factors.

Figure 1 shows the business/home breakdown of the European market and Figure 2 shows the percentage penetration of PCs into European households.

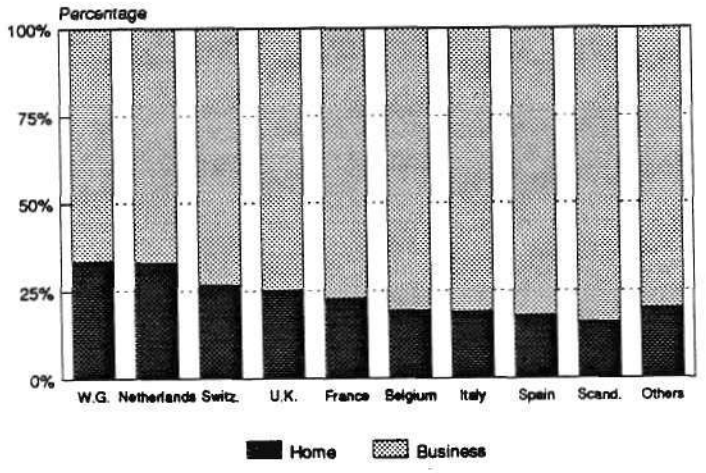
Increasingly Sophisticated Applications

Home users have always differed from business users in terms of their needs and their motivation for buying a PC. Businesses purchase PCs to increase their competitive edge, either by computerizing individual tasks or by installing more encompassing management tools. Home users typically buy for yet another set of reasons, which now stretches well beyond the traditional leisure and hobbyist activities. Currently, the basic application for PCs within households is still the home/hobbyist application. However, educational or instructional usages, as well as "household productivity or commercial" applications, are gaining in importance.

Educational applications include both the more sedentary education activities usually associated with parents and their children, and the more specialized activities of students. Of these, the student "home campus" market is currently the most developed and sophisticated. Students are also the most mobile members of the educational population. As laptops become smaller and lighter, and as more vendors introduce IBM-compatible notepad-size PCs and "palmtops," students are likely to become a major driving force in the development of this lightweight PC market. However, a major price/performance issue still needs to be solved by the laptop vendors before laptops become really successful in the student market.

Figure 1

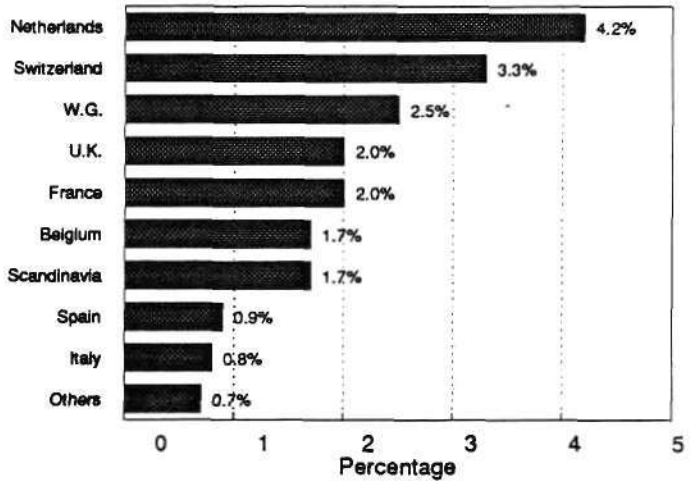
European 1988 PC Market
Estimated Breakdown by Market Sector



Source: Dataquest
September 1989

Figure 2

European 1988 PC Market
Estimated Penetration of Households by Country



Source: Dataquest
September 1989

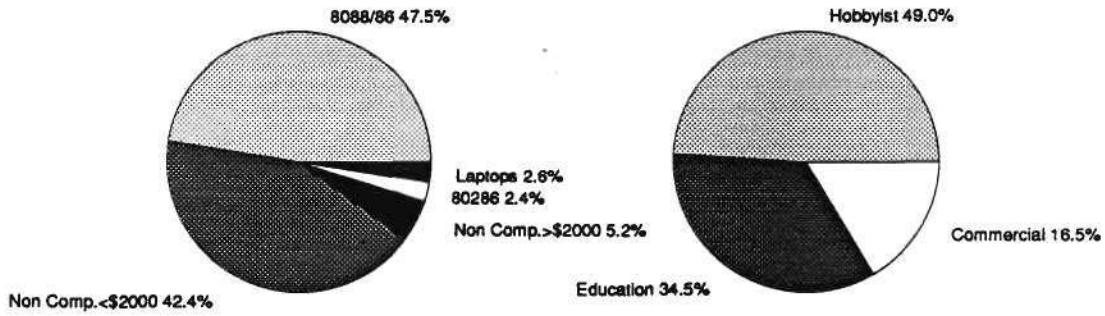
In the past, using computers to work at home was limited to executives and the professions, but more and more employees are now taking work home, and a small but growing number of employees actually work at home. Links between the office and the "home office" are thus likely to become much more widespread with the development of networking and communications in workplaces, and as these home-to-work links become effective and affordable. With job mobility also tending to increase and employees having to learn new work skills, home-based computerized adult education is also likely to experience renewed growth. This formal instruction dimension also seems a prerequisite for the success of joint employer–employee financed schemes such as the Private Computer Projects which, although they have become a major driving force of the Dutch PC market, are increasingly criticized for their lack of effectiveness. Without appropriate software and a high level of formalized training, many of these PCs are collecting dust in cupboards.

The commercial applications in the home market are likely to assume significant proportions in the coming years. The scope of this market ranges from traditional uses, such as word processing, accounting and filing, to the integrated computerization of homes. The French have termed this latter concept "Domotique." It entails cabling houses and apartment blocks during their construction to allow for the computerized control of heating, lighting, security systems, and audio/visual and kitchen appliances. No reference point exists at present and the market is wide open.

Figure 3 shows 1988 shipments in the European market by both product type and application.

Figure 3

European 1988 PC Home Market
Total Shipments by Product Type and Application



Source: Dataquest
September 1989

Which Computer?

The computers purchased by home users are strongly influenced by their previous experience with computers, either in the classroom, at their workplace or at their home with a game/hobbyist machine. Thus, IBM compatibility is almost a prerequisite for most employees wishing to work at home, while non-compatible machines tend to predominate where PCs are used in a strictly family environment.

PCs bought by home users are also becoming more high powered. Already, certain long-established vendors of home computers, such as the British vendor Acorn, have introduced highly sophisticated models equipped with RISC processors. Low-cost UNIX workstations are also on the horizon. As in the business market, the availability of increasingly powerful hardware, including hardware based on the Intel family, is one of the driving forces of the home market. If the percentage for PC penetration in the home market is really to increase, the hardware needs to become considerably more user-friendly, and with better performance, than at present. Both requirements—user-friendliness and pure performance—can only be met by more powerful processors, allowing really sophisticated applications to be run, such as the previously mentioned Domotique applications. Current pricing will initially limit the market for such models to the more elitist and affluent "power users," but prices are expected to drop and highly user-friendly and powerful PCs will become available for even the most computer-illiterate households.

Expensive Entry Tickets in Promotion and Distribution

The home market is characterized by its high barriers for entry, which make it difficult for any newcomer to this market to acquire a market share that really challenges the current market leaders. The sheer investment in marketing and promotion in order to build up a market presence, and the resources involved in the development of services and other complementary activities around the PC hardware, are all factors adding to the high barriers for entry in the home market. Most established home vendors are deeply involved in the area of software, and support user clubs, dedicated brand-oriented magazines, and so on. Additionally, the research and development (R&D) costs involved in the supply of a challenging and complete product line are high and prohibitive for many potential newcomers.

Another significant entry barrier is the structure of the distribution channels for the home market. The home segment is typically supplied by non-dedicated PC dealers, such as the various kinds of mass merchandisers—department stores, hypermarkets and cash and carry stores—hi-fi and video shops, and stationery stores. These home market dealers tend to have a highly concentrated structure, and are mainly controlled by large chains or a purchasing group. It is therefore critical to get shelf space among the relatively few companies that control a large proportion of the home market at the retail level. At the same time, mass merchandisers that sell PCs are very selective and are willing to sell only a restricted number of strong and potentially best-selling brands. Examples of these mass merchandisers are Auchan, FNAC and NASA in France; Dixons in the United Kingdom;

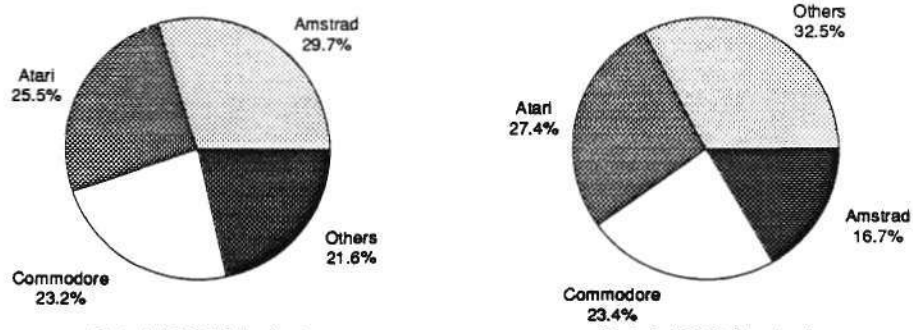
El Corte Inglés in Spain; Vroom & Dreesmann in the Netherlands; Bilka in Denmark; and Kaufhof in West Germany.

Specialist Vendors Dominate the Market

Largely as a result of the importance of these entry barriers, the competitive situation on the home market is one of extreme concentration. In 1988 three vendors, Atari, Commodore and Amstrad, had a combined market share of close to 70 percent. This almost oligopolistic nature of the home market contrasts sharply with the structure of the 1988 business market, where 11 vendors accounted for not more than 60 percent of total sales. Figure 4 shows the percentage market shares in terms of shipments of the main vendors in both 1987 and 1988.

Figure 4

European PC Home Market
1987 and 1988 Shipments by Vendor



Source: Dataquest
September 1989

The three leading vendors in the home market are companies that are highly specialized toward, and with a background in, consumer-electronics products. Currently, their specialization is also reflected in the fact that a high proportion of their business is done on the home market, with sales to the business market accounting for a relatively low proportion of their total sales.

Atari, which became the number one supplier to the home market in 1988, is the best example of this. In 1988, 83 percent of all Atari sales went into the home market. As far as sales to the business market are concerned, Atari follows an approach very much oriented to niche markets, where it specializes in the MIDI (musical instrument digital interface) and multimedia markets (such as desktop video, CD-ROM and animation).

Interestingly, several of the home-market vendors have currently embarked on a strategy to move upmarket, and are planning to take a greater share of the business market; the best examples are Amstrad, with a new strategy based on its P200 range, and Commodore, which has recruited several top executives from Apple, Hewlett-Packard, Olivetti and Compaq in the past year. However, it remains to be seen whether a highly developed home image jeopardizes sales to the business market, or whether the home-market vendors can remain competitive through the high-margin professional dealer outlets.

Despite the structural difficulties in challenging the position of the leading vendors on the home market, it is possible that several high-end vendors will take a share of the home market, and that companies with strong R&D and mass-merchandising muscle, such as Philips and Olivetti, will increase their stake in this market.

DATAQUEST ANALYSIS

In view of the many uncertainties about product development, applications and market entrants affecting the development of the home market, it is difficult to predict how far this market will increase. However, the sheer number of households in Europe (124 million), combined with the still very low penetration figures, shows that there is probably a large potential market waiting to be developed.

(This document was first published in *European Monitor*, August, 1989.)

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PART III
DIGITAL CELLULAR RADIO—THE MARKET FORCES

INTRODUCTION

This is the third newsletter in an initial series of three examining various aspects of the European cellular radio industry. These newsletters are entitled:

- Part I: Cellular Radio—Its History and Principles
- Part II: Cellular Radio in Europe—Growing into the Future
- Part III: Digital Cellular Radio—The Market Forces

The first newsletter outlined the history and the principles of cellular radio, and the second examined the growth of the European market. This newsletter examines the potential dynamic market forces that could affect the initial launch of digital cellular radio in the early 1990s.

BACKGROUND

Pan-European digital cellular technology represents the most cooperative development project ever experienced within the European Telecommunications industry. In just a few years the idea has been conceived, standards agreed upon, collaborative ventures established (shown as follows), and product development initiated as the race began to start implementing the networks by 1991.

- Ericsson—Siemens
- Philips Kommunikation Industrie—ANT—Bosch
- Alcatel NV; Nokia—AEG
- Racal—Plessey (Orbitel)
- Orbitel—Ericsson

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However, although there can be little doubt that digital networks will be successful in the longer term, there are some factors which, in the short term, could slow the initial adoption of the new technology.

Current Networks

Cellular networks in Europe currently conform to many standards, but this has not prevented a substantial growth in the subscriber base over the last four years. Indeed, in many of the continental European countries where initial growth was rather slow, more recent statistics show that growth rates are accelerating.

At present growth rates, the installed base of analog system subscribers could approach 5 million by 1992. Historically, estimates of cellular growth have tended to be conservative, so it is clear that, by 1992, there will be a significant number of users employing analog technology.

IMPLEMENTATION OF DIGITAL NETWORKS

One of the major factors that has governed the growth of cellular radio is believed to have been the large latent demand for widespread, economic mobile communications. Some may regard current cellular technology as far from economic. However, it is significantly less expensive—and more widespread—than the systems that preceded it. Much of this latent demand has been satisfied by the analog networks and therefore will not be present to provide an impetus to the digital system, except in those countries where networks are very small.

Additionally, the growth rate experienced by the analog systems was in an environment of no competing technologies. A digital cellular system will not have this luxury and will have to compete in the marketplace on its own merits as would any other product or service. Consequently, it must be perceived by the customer to offer an advantage in price and performance over existing systems; specifically, improved performance at a lower price.

This particular requirement presents the network operators with something of a dilemma; that between earning a good return on investment in the now-mature analog system and at the same time promoting a technologically superior product that initially will show a lower return.

Similarly, the customer has also made an investment in purchasing and subscribing to the analog network. Only in a few cases will this equipment be discarded prior to its normal life expectancy simply to change network technology. In cases where mobile equipment is leased, the lessor could have significant funds invested in equipment that possibly relies on one- to three-year leasing contracts to recover that investment. There is no financial incentive to change that installed base until such time as those leasing agreements expire. There is a real possibility that as the introduction of digital networks approaches, the resale value of leased mobile equipment could tend toward zero.

Moreover, in the early days of a digital cellular system, its coverage will not be as widespread as the existing analog system. This could be a major delaying factor for those users wishing to adopt digital technology.

Another factor in the dynamics equation is the appearance of new operators building and operating a competing network infrastructure. A new operator would have to install a digital network from scratch. Initially, there would be no disadvantage in this respect as other licensed digital operators would also have to install their networks. However, there would still be competition from the existing analog system operators (some or all of whom might also be digital operators).

As yet, there has been no significant downward pressure on air-time charges on the analog networks. Faced with attempts from the new digital operators to establish their place in the market, there could well be room for analog operators to cut tariffs on their networks to a level at which the digital operators, with their heavy investment costs and initially smaller subscriber base, would find it extremely difficult to compete. It could be possible, therefore, without some form of regulation, for current operators (which will themselves move to digital) to inhibit competition in new networks at an early stage.

Digital cellular radio could also experience competition from other emerging technologies—a problem that analog systems did not experience. In particular, the emergence of CT2 cordless telephones, together with the deployment of "phone-point" or "zone-phone" public cordless services, could impinge on users who are unsure as to whether they really need the level of flexibility that cellular radio offers. It is too early in the development of CT2 to analyze its impact. At present, Dataquest believes that CT2 and cellular technologies will be initially largely complementary rather than competitive.

Although all of the foregoing factors will affect the development of digital cellular networks, probably the most significant will be the quality of service provided by the analog networks in three years' time. Already during peak hours in the densely populated (in cellular terms) Southeast England, there are signs that the networks cannot cope and users are complaining of poor transmission quality, dropped calls, and interference from other calls in progress.

With an increasing number of users subscribing to the service and the frequency spectrum becoming fully utilized, network operators will find it increasingly difficult to overcome these problems. If this scenario does occur when digital systems become available, it is possible that discontented users will switch to the new system. However, this mechanism could be self-limiting, because as the number of subscribers on the analog network decreases, the quality of service will begin to improve, removing the need to switch networks.

DATAQUEST CONCLUSIONS

The assertion that digital cellular technology will be successful still holds true for the longer term. However, this newsletter has aimed to demonstrate that the mechanics of the marketplace are not as simple and straightforward as when analog systems were launched. As a result, the available choice could well confuse both existing and potential customers. This could cause them to defer making a decision until the new networks have proven themselves capable of offering an improved solution.

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Research *Newsletter*

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PART II
CELLULAR RADIO IN EUROPE—GROWING INTO THE FUTURE

INTRODUCTION

This is the second newsletter in an initial series of three about cellular radio. These newsletters are entitled:

- Part I: Cellular Radio—Its History and Principles
- Part II: Cellular Radio in Europe—Growing into the Future
- Part III: Digital Cellular Radio—The Market Forces

The first in the series deals with the principles of operation of this exciting communications medium. This newsletter reviews the growth in the European market for cellular radio, and the reasons and factors for its success and forthcoming development. The third newsletter reviews the possible market dynamics that could interact when digital networks are deployed in the early 1990s.

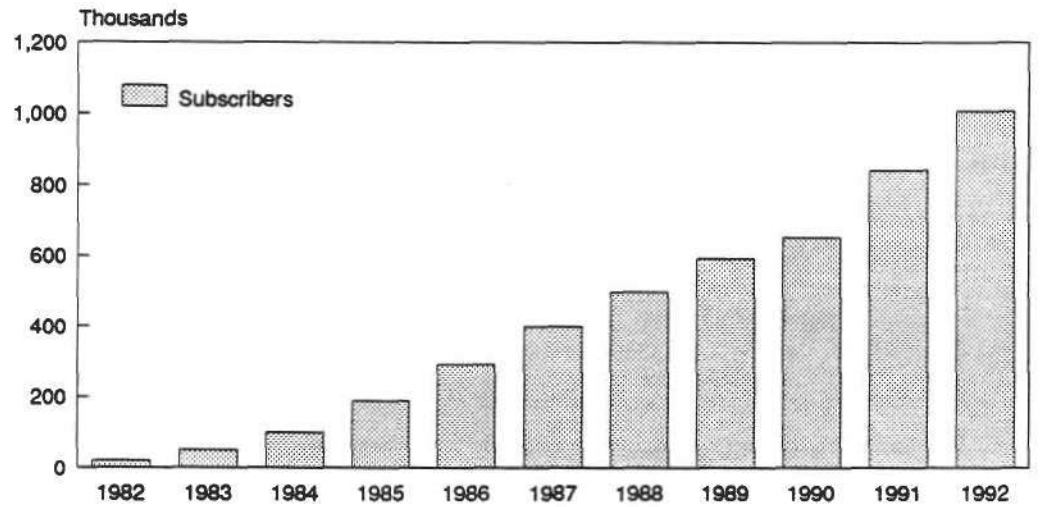
BACKGROUND

Cellular radio began in earnest in Europe as recently as October 1981, when Sweden launched its NMT-450 system. By the following March, the system was available throughout Scandinavia. The new medium experienced spectacular growth, reaching a level of 100,000 subscribers in just three years (see Figure 1: Scandinavian Cellular Market).

In January 1985, the United Kingdom launched its two networks (three months ahead of schedule). Demand for the service was huge, exceeding even the operators' optimistic forecasts (see Figure 2: United Kingdom Cellular Market). Since then, many European countries have launched cellular radio networks. However, due to proprietary system designs and available spectrum in each of the individual countries, most of the systems are incompatible and do not permit country-to-country mobile roaming. The exceptions are the Nordic countries (Denmark, Finland, Norway and Sweden) who all adopted the same system, thereby allowing a mobile to be used in each of the four countries. Table 1 shows the systems operated in some of the major European countries.

Figure 1

Scandinavian Cellular Market 1982–1992



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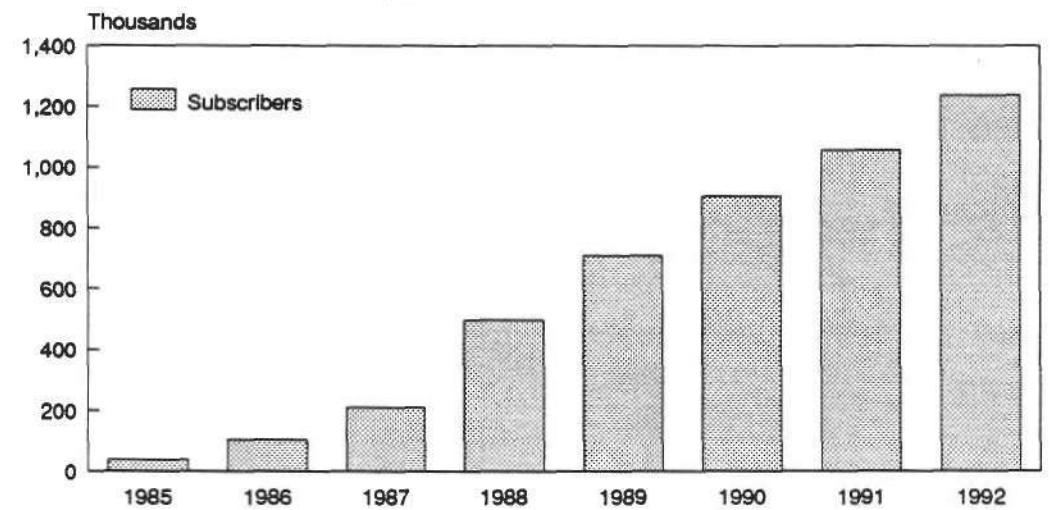
Source: Dataquest
July 1989

Figure 2

United Kingdom Cellular Market 1985–1992



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Source: Dataquest
July 1989

Table 1

Systems in Operations Across Europe

Austria	NMT-450
Denmark	NMT-450/900
Finland	NMT-450/900
France	RC2000 (quasi-cellular)
Ireland	TACS
Italy	RTMS (quasi-cellular)
Netherlands	NMT-450
Norway	NMT-450/900
Spain	NMT-450
Sweden	NMT-450/900
West Germany	C-450
United Kingdom	TACS (and ETACS)

Source: Dataquest
July 1989

Market Structure

In common with traditional telecommunications networks, cellular radio in most European countries is run by the Post, Telegraph and Telephone organizations (PTTs) on a monopoly basis. The main exception is the United Kingdom, where two network operators compete for market penetration. There is also limited competition in Sweden. France has licensed a second cellular radio operator whose NMT–450 network was scheduled to begin service in March 1989.

COMPETITIVE ENVIRONMENT IN THE UNITED KINGDOM

It is significant that the U.K. market has shown the most prolific growth in its subscriber base as well as the greatest price erosion of mobile telephone handsets. Rapid growth has been experienced for several reasons:

- There was an immense latent demand for an accessible mobile service.
- The economic climate was fostering economic growth, mindful of ever-improving efficiency.
- Two network operators were able to cope with high demand whereas one may have been overwhelmed, with resultant waiting lists (which in turn may have stifled demand).
- Competition was growing.

The provision of cellular services in the United Kingdom is based on a hierarchical structure. Under the terms of their licenses, Racal Vodaphone and Cellnet are not permitted to sell equipment directly to the end user. This has caused the growth of a competitive infrastructure of retailers and dealers, who also sell the air-time on the network and provide the necessary billing services.

These dealers and retailers have been operating in an environment that has become increasingly fierce, to the benefit of customers but to the detriment of some retailers. The first move came when some retailers started to discount mobile telephone sets in an attempt to establish and increase their market share. Over the last two years, this has continued to such an extent that it is believed that some retailers are earning no revenue from the sale of equipment, but are instead relying on the sale of air-time for their revenue. This discounting has been partly offset by bonuses that network operators pay to the retailers for each new subscriber they connect to the network.

Air-time to retailers is sold at a discounted rate compared to that which the end user pays, so that a margin is present from which the retailer can earn revenue. The greater the number of subscribers a retailer has, the larger is the discount received from the network provider. Clearly, this system benefits the larger retailers, who thus have a greater overall margin than their smaller competitors. This in turn exerts pressure on the smaller retailers to supply the mobile equipment itself at competitive prices.

Consequently, we believe only retailers with a sufficiently large subscriber base are likely to survive in the longer term. Approximately 65 retailers operate in the United Kingdom today; it is possible that as few as 15 will survive in their present form over the next two years.

The Market in Mainland Europe

With the exception of Scandinavia, initial growth on most of the national cellular networks in Europe was relatively slow. However, more interest has been aroused recently, and the growth in the subscriber base has increased.

We believe that this previous lack of interest was due to the high cost of subscribing to the system, the shortage of suppliers of the service, slow growth in the area covered by the system, and the absence of competition.

THE FUTURE

Currently all operating networks use analog transmission technology and each type of system is incompatible with others. Consequently, subscribers are limited to using their mobile only in their own country.

This shortcoming should be overcome with the introduction of second-generation digital cellular technology in 1991, implementing a common standard throughout Europe. The drive behind the "pan-European digital cellular system" is motivated by several reasons:

- To permit Europe-wide cellular usage.
- Common standards enable a single technology, and therefore economies of scale, to be achieved.
- To provide the first real example of Europe-wide telecommunications cooperation.
- To provide European industry with a technological lead in mobile systems over the rest of the world.
- Digital technology permits greater utilization of available bandwidth (by a factor of between 2.5 and 5).
- Enhancements providing new features/services would be easier with a digital system.
- To provide higher-quality service.

Certainly, this international co-operation in largely agreeing standards in just under two years fulfills the promise that the pan-European digital system can become a successful reality.

However, having overcome the technical and logistical problems of a digital system, the next hurdle for the network operators will be a commercial one. They will be in the position of operating two networks with different characteristics:

- An analog network with wide coverage and a large subscriber base
- A digital network with low coverage and few subscribers.

The challenge for the operators is to manage successfully the transition from analog to digital system.

DATAQUEST ANALYSIS

Cellular radio has become firmly established across Europe as an indispensable communications medium. Dataquest believes that current trends indicate continued strong growth in the subscriber base well into the 1990s.

Although the United Kingdom has experienced severe price erosion of radio telephone handsets, the prices throughout the rest of Europe are still relatively high. Increased growth in the subscriber base should enable manufacturers to improve manufacturing efficiency, and reduce the prices of mobile equipment. Dataquest also believes that there is room for suppliers of end-user equipment to reduce margins per unit, and increase revenues from the larger volumes that should result.

The introduction of digital networks in 1991 will produce additional challenges for equipment suppliers and network operators. Dataquest believes the advent of competition in network operation will be of benefit to all parties, since prices will fall and demand will rise. The additional features offered by a digital system should greatly enhance its utility to current and future users of mobile technology.

However, we do envisage some transient problems during the introductory period. This topic is discussed in the third newsletter in the series about cellular radio.

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Research *Newsletter*

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PART I
CELLULAR RADIO—ITS HISTORY AND PRINCIPLES

INTRODUCTION

Cellular radio has been operating for just seven years in Europe and in that time has experienced tremendous growth which at present shows no sign of slowing down. This newsletter is the first in a series of three newsletters about cellular radio. These newsletters are entitled:

- Part I: Cellular Radio—Its History and Principles
- Part II: Cellular Radio in Europe—Growing into the Future
- Part III: Digital Cellular Radio—The Market Forces

This newsletter reviews the history and principles of this communication medium. The second newsletter reviews the current European market and its short-term prospects, while the third newsletter takes a longer-term view and discusses the prospects for the pan-European digital cellular network.

PRINCIPLES OF CELLULAR RADIO

Although the main idea for a "cellular" radio system originated in the Bell Telephone Laboratories in 1947, it was not until the early 1980s that technology made the first systems practicable. The main advantage of a cellular system over conventional mobile radio systems is its ability to handle a wider range of traffic loading through a more efficient reuse of available frequency spectrum. Ultimately cellular systems cater for considerably more customers than the earlier, traditional mobile radio systems.

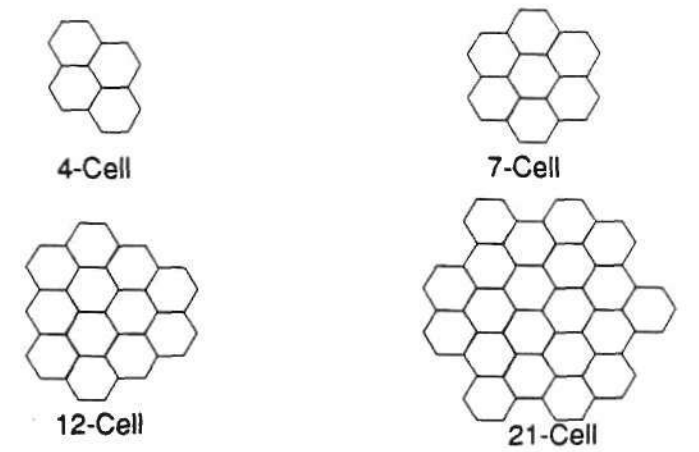
Cell Structure

The area required to be covered is split into a number of smaller areas (cells). Each cell is equipped with its own radio base station. The cells are arranged together into clusters, the available number of radio channels being allocated to the clusters in a regular pattern that repeats over the entire coverage area. This technique enables radio channels to be reused several times throughout the coverage area.

The number of cells in a cluster has to be chosen such that the clusters fit together into a continuous area. Only certain configurations do this. Typical cluster arrangements are based on 4, 7, 12, or 21 cells (see Figure 1).

Figure 1

Cell–Repeat Patterns



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Source: Dataquest July 1989

The number of cells in each cluster has a significant impact on the overall capacity of the system. The smaller the number of cells per cluster, the larger the number of channels per cell, and consequently the traffic carried per cell is higher. However, there is a trade–off. Since more channels are being used per cell and the cluster size is smaller (fewer cells), then the distance between cells using the same channels reduces, with the consequence that interference from adjacent clusters increases (co–channel interference).

The total number of channels per cell (and therefore, the traffic) is governed by the total number of channels available and the cell–repeat pattern that is:

$$\text{Total number of channels per cell} = \frac{\text{Total number available channels}}{\text{Cell–repeat pattern (4, 7, 12, 21)}}$$

However, traffic in a particular area can be increased (bearing in mind interference constraints) by reducing the cell size, thereby increasing the number of available radio channels in that area.

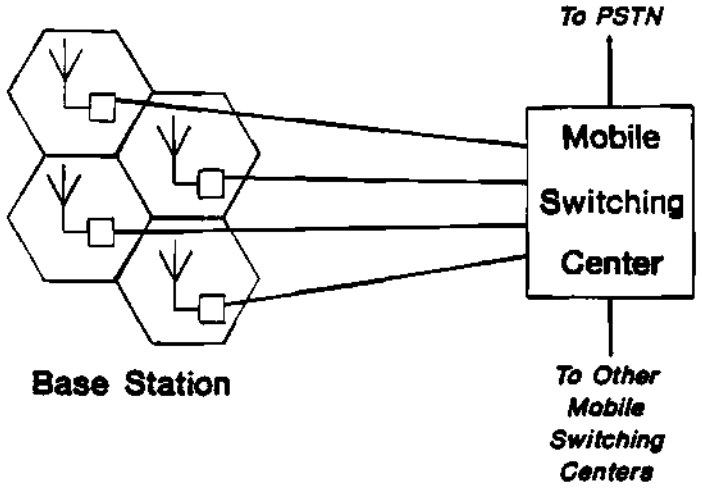
System Structure

Each cell's base station is connected to a switching center, which is a modified central office switch. In practice, a cellular network will consist of several interconnected switching centers, which are themselves also connected to the public telephone network (see Figure 2). This configuration enables the full permutation of call types to be initiated and completed, that is, PSTN to mobile, mobile to mobile, etc.

Two main features within a cellular system enable efficient communication with a mobile subscriber to be maintained. The first of these is the process of "registration", which is the ability of the system to maintain a knowledge of an individual mobile's whereabouts. This is described below.

Figure 2

Cellular Radio Network



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Source: Dataquest July 1989

Registration

Within the system, a number of radio channels are reserved as common signaling channels. Additionally the network is divided up into a number of traffic areas, each area consisting of a group of cells. The base station generates a code identifying the traffic area to which it belongs, as part of the information transmitted on the signaling channels. A mobile subscriber travels through the network, monitoring the strongest common signaling channel. As the mobile moves from one cell and/or traffic area to the next, it will detect a deterioration in the received quality (usability) of the existing common signaling channel and, therefore, will begin a search for a stronger, more usable signal.

After the mobile has tuned to the new signal, two options for action are possible. The first option is that having crossed a cell boundary, the mobile is still in the same traffic area, in which case (in respect of registration) no further action is taken.

The second option is that the mobile has crossed not only a cell boundary but also a traffic area boundary. In this instance, the mobile transmits its identity to the new base station, which passes the information onto the switching center. Thus the mobile has registered its location with that of the system so that the network is able to route an incoming call to the mobile efficiently and quickly.

In–Call Hand–Off

The second process in the cellular system is that of "in–call hand–off". As a mobile moves throughout the coverage area it may cross a cell boundary while a call is in progress. So that the call is not dropped as it moves from one cell to another, the current base station monitors the received signal from the mobile and will detect any deterioration of the signal in the region of the cell boundary. At this point the base station informs the switching center that a "hand–off" may be necessary. The switching center then commands the base stations in the adjacent cells to monitor the mobile's signal and chooses the best cell to which to transfer the call. A radio channel allocation in the new cell is made and the mobile, via the original base station, is instructed (over the signaling channel) to tune to that selected channel. The final part of the hand–off takes slightly less than 500 ms typically and is barely noticeable to the user. This small break in transmission hardly affects a voice call but, of course, could be disastrous for a data call. Consequently, modems with specific error–correcting protocols are necessary if a user wishes to use a cellular network for the reception/transmission of data.

ADJACENT AND CO–CHANNEL INTERFERENCE

Voice communication is carried on the speech channels. In addition, at certain times, some signaling is also carried on the speech channels.

Speech is carried on the speech channel as an analog frequency–modulated (FM) signal with a frequency deviation of 9.5 kHz. (More traditional radio telephone systems using the same 25 kHz channel spacing generally have a maximum frequency deviation of 5 kHz. This approach was taken to minimize interference problems in adjacent channels.)

The use of higher deviation in cellular radio greatly improves the rejection of unwanted signals on the same frequency (co–channel interference). Co–channel interference is the most significant limiting factor determining the cell–repeat pattern used. However, there has to be a compromise. Increasing the deviation increases the interference to adjacent channels, and if this effect becomes too large it will negate the effect of using higher deviations. This can be controlled by careful channel allocation, for example ensuring that adjacent channels are never allocated in the same cell.

CONCLUSIONS

This newsletter has given a brief overview of the general principles of cellular radio. While cellular radio is not a recent idea, the practicalities of planning and operating such high–capacity systems have been rapidly learnt. Further advances in antenna design, for example, have enabled capacity to be increased by further dividing urban cells (sectorization).

The rapid move towards an all–digital technology will again increase the utilization of the available frequency spectrum. Further techniques still to be honed into practical solutions lie in the areas of modulation techniques and reduced channel spacing.

The number of cellular subscribers has grown considerably over the past seven years, and is still growing—proof that there is a considerable future market to exploit this technology further.

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Jim Eastlake
Ted Richardson

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DATAQUEST'S EUROPEAN SEMICONDUCTOR INDUSTRY CONFERENCE: "THE EUROPEAN RENAISSANCE"

SUMMARY

Dataquest's eighth annual European Semiconductor Industry Conference was held recently at the Park Hilton, Munich, West Germany. The theme of the conference, "The European Renaissance," provided an excellent opportunity to discuss how Europe's consolidation of twelve economic entities into one will affect the ways that both Europeans and non-Europeans do business.

Many key issues were discussed, including the following:

- Application markets
- International trade
- Distribution
- Deregulation
- Mergers and acquisitions
- New technology

This newsletter summarizes the information presented, by topic and speaker, at the conference.

SPEAKER HIGHLIGHTS

The following extracts are highlights from the conference presentations.

Dataquest Incorporated, 1290 Ridder Park Drive, San Jose, CA 95131-2398 / (408) 437-8000 / Telex 171973 / Fax (408) 437-0292

"World Economic Overview"
Joseph W. Duncan, Corporate Economist and Chief Statistician
Dun & Bradstreet Corporation

The U.S. trade deficit has been the world's engine of growth, but President George Bush's economic policy will have to tread a careful path between Draconian deficit reduction, which could lead to recession, and reduction measures that are too lax, which could lead to higher inflation. Mr. Duncan believes that President Bush can find the right balance and predicts high growth for the U.S. economy in the first half of 1989 and slow growth in the second half.

However, five factors could affect that prediction as follows:

- A bail-out for the savings and loans will occur this year and will cost each U.S. citizen $1,000.
- The U.S fiscal deficit can only be reduced by higher taxes, and it is expected that corporation taxes will be increased.
- New Soviet links offer the United States the chance to reduce its obligations to NATO and give economic credits to Russia, which would help reduce the budget and trade deficits.
- Action will have to be taken on the debt burden of the less developed countries.
- Action will have to be taken on the growth of leveraged buyout debt.

"New Frontiers in Technology"
Hans Geyer, Assistant General Manager
Intel Europe

Intel has spent $250 million in the last five years on CAD, and every Intel design engineer has a Sun hooked to VAXes and IBM mainframes for simulation. Thus, Intel's 'Megaprocessor' strategy for 1-million-plus transistor chips like the 486, i860, and the new version of its 80960 is well supported. These chips require close cooperation in the early stages of the design cycle between design technologists, process technologists, and manufacturing personnel. The result is that Intel's chips will be made on processes so complicated and unique to Intel that no other company will be capable of manufacturing them. Processor technology is evolving fast toward the microprocessor of the future, which, by 2000, will have 100 million transistors, 250-MHz operation, 2,000 mips and 1-billion-flops performance.

"Manufacturing Globally"
Joel Monnier, Worldwide Corporate Manufacturing Manager
SGS-Thomson Microelectronics

The Japanese strength is in manufacturing science. SGS-Thomson has targeted the manufacturing standards it wants to attain within the next six years to match Japanese capability. The key is equipment uptime: SGS-Thomson's target is to increase the average length of time for which equipment works without stopping from today's

30 minutes to 600 minutes by 1995. In 1995, SGS-Thomson expects to have peopleless fabs that will be six times more productive than present fabs. SGS-Thomson has targeted 1990 for its 4-Mbit EPROM on a 0.8-micron process, 1993 for a 16-Mbit EPROM on a 0.5-micron process, and 1996 for a 64-Mbit EPROM at 0.3 micron.

"The New Cordless Community"
Barry Moxley, Managing Director
Phonepoint

Research indicates that a cheap, light, cordless telephone that is usable anywhere would have a large market. Semiconductor technology now allows digital cordless systems to replace analog systems, thus allowing for a high density of users—3,000 per square kilometer—for which interference problems have ruled out analog systems. When combined with the lower power, which means smaller, lighter batteries are required for the modern telephone chip sets, this allows for the rapid evolution of cheaper, lighter, and smaller phones. Prices will follow a similar course, as was seen with calculators, and in the future, it will be common for people to own several cordless telephones.

"RISC versus CISC"
Bob Miller, President, Chairman and CEO
MIPS Computer Systems Inc.

With MIPS' performance capabilities on 260,000 transistors, there is no need to design 1-million-plus transistor microprocessors like Intel's. Also, MIPS has five competing sources (instead of one for Intel microprocessors) and a rapidly increasing level of performance—60 to 70 mips in CMOS this year, 120 mips in ECL in 1991, and 180 to 220 mips in GaAs in 3 to 4 years' time. In 1993, 7 million of the estimated 16 million processors sold will be RISC based. The RISC performance levels are achieved primarily through software (particularly the compilers), rather than from pushing the technological limits of silicon hardware. If Microsoft succeeds in making OS/2 portable, and an "informed rumor" says it is working on it, then RISC must win over CISC.

"Electronics in the Automotive Environment"
Enrico Ferrati, Research and Development Manager
Marelli Autronica SpA

The value of electronics in a car is now about 5 percent of the value of the car, but this percentage will rise to 20 percent by the year 2000. Electronics will be used in power steering, digital displays, information control, active suspension, electronic transmission, shock damping, antilock systems, and engine management. Electronics features will amalgamate into electronics subsystems, which will be integrated together on ASIC chips. Such subsystems will be in the areas of power management, chassis control, information management, and various convenience features. ASICs and smart power will account for 50 percent of the automotive semiconductor's total available market (TAM) in 2000, whereas the current TAM is 50 percent discretes, 35 percent standard ICs, 10 percent microcontrollers, and 5 percent ASICs.

"Positioning Internationally"
Robert Freischlag, President
Fujitsu Mikroelektronik

The European semiconductor market is expected to grow from $8.5 billion in 1988 to $12 billion by 1992. European companies that rely on state support and protectionist legislation will lose out, while the most efficient companies will survive. Cars and semiconductors, however, will receive national protection from their governments. Non-European companies that merely export to Europe will be in trouble. Those who want to win will need a European headquarters sales office, assembly, packaging and test facilities and diffusion plants. To support the future market they will also need increased R&D. Companies will need to pursue global strategies, while retaining their sensitivities to local needs.

"Integrating into Europe"
Barry Waite, Vice President and General Manager Europe
Motorola Semiconductor

Europe has 360 million consumers, of whom 320 million are in the European Economic Communities (EEC) compared with 250 million in the United States. Europe's GNP is $4.7 billion—10 percent more than the U.S.'s GNP. Europe's semiconductor requirements are supplied 43 percent by U.S. producers, 38 percent by European producers and 19 percent by Japanese producers. New markets for semiconductors will account for 40 percent of the 1994 semiconductor TAM. These markets will be in car safety, emission controls, intelligent credit cards, ISDN, HDTV, CD-I, pan-European digital cellular phones, and satellite TV. As Europe grows in self-sufficiency, it will increasingly manage free trade to the point where capital and information will be the only freely traded worldwide commodities.

"Global Distribution in the 1990s"
Stephen Segal, Executive Vice President
Future Electronics Inc.

The world is becoming a global marketplace characterized by huge TAMs (e.g., a 1993 distributor TAM of $5.7 billion); world trade liberalization (e.g., the push to open up the Japanese market); consolidations, acquisitions, and mergers (e.g., Harris/GE/RCA); technology alliances (e.g., Motorola/Toshiba, Texas/Hitachi, and new fabs (e.g., Amphenol and Fujitsu in Scotland). The strategy for non-European distributors in Europe is fourfold, as follows:

- Have deep pockets to prepare for a nonprofit period of up to two years
- Enter Europe through start-ups or takeovers
- Be structurally efficient—ship-from-stock and credit, single price globally, MIS systems, regional warehousing
- Form quality partnerships with a few global customers on a global supply basis

"Think Global—Act Global"
Jose Menendez, General Manager and President of the Executive Committee
Sonepar Group

Think global and act local. Europe is a more difficult place to do business in than outsiders expect: the many different currencies, local customs, languages, and credit practices all contribute to outsiders' confusion. Sonepar deals with nine different nationalities and believes that there is a long way to go before the European market can be addressed in a single, logical manner using standardized methods. Sonepar's personalized contacts, market data, and ability to provide local assistance and service can help manufacturers to penetrate Europe by providing manufacturers with early anticipation of demand (without manufacturers losing control of their marketing and distribution networks).

"A Vendor's Viewpoint on Distribution"
Marco Landi, Vice President, Semiconductor Marketing and Sales
Texas Instruments

A shake-up is coming in European distribution. One reason for the shake-up is the declining profitability of the industry (e.g., a major distributor has closed in Italy, and Unitech has made a major disinvestment). The year 1992 will accelerate this shakeout because there are new European distributors (BMW bought Kontron). Also, new non-European companies want to enter the market. Who will survive? The following characteristics point to success:

- Pay attention to cost of sales
- Differentiate in selected market segments
- Commit to close relationships with manufacturers
- Invest in EDP for inventory management
- Look for profit before sales growth
- Broadline
- Generate demand as well as serve it

"Pan-European Distribution"
Edward D Burgess, General Manager
ITT Distribution Worldwide

Pan-European distribution must satisfy 80,000 customers in 15 countries which collectively purchase $2 billion worth of semiconductors annually. Furthermore, it needs to help its major customers reach customers that they cannot serve directly, which represent 15 to 35 percent of the TAM. It would be attractive for a supplier to sign one agreement that contains the same contractual conditions for all 15 countries with one distributor and have that distributor service 15 national markets. But pan-European franchises are rare, and not all distributors have Europewide management or warehousing. The year 1992 should see an increase in the share of the TAM that goes

through distribution, but the large investments required to be pan-European and the declining profitability of the industry may turn out to be insurmountable hurdles for some companies.

"Introductory Remarks on the European Renaissance"
Jean-Marie Cadiou, Director of ESPRIT
Commission of the European Communities

The European IT industry has some weaknesses—it is dependent on non-European microprocessors and foreign chips—but it is looking better. ESPRIT 2 will produce 0.5-micron CMOS ASIC and 0.5-micron SOI processes. Europe still needs an engineering culture to bring leading-edge chips to market. ESPRIT 1's successes included a state-of-the-art BiCMOS process; spectacular results in the silicon compiler project; and the Supernode project, which produced parallel processing machines that beat Intel. Opportunities for Europe lie in HDTV, ISDN, and broadband communications networks.

"Procuring in the 1990s"
Dan Byrne, Director of European Operations
Apple Computer

Apple wants to be a truly European computer company. Since 1986, it has been doubling the annual amount of its European-sourced components. Recently that process has accelerated and in 1989, the company will source the same number of components from Europe in one quarter as it sourced in the whole of 1988. Apple's procurement requirements are as follows:

- Shipment on an as-needed basis to fit with the Cork manufacturing plant's flexible production schedules
- Apple works to 0.5 percent defects today and is moving to 0.05 percent in the early 1990s as part of its commitment to high quality
- Competitive prices that are key to Apple, because 90 percent of its product cost is materials cost
- New products/technology, because Apple has a total bias toward innovation and needs suppliers that can keep it ahead of the technology curve

"A European in the International Scene"
Heinz W. Hagmeister, Managing Director and CEO, Business Unit ICs
Philips Components

Fewer companies are buying more and more of the world IC output. These companies are multinationals that operate with local profit centers, but which demand worldwide pricing and high standards of service and quality. Currently, 15 companies buy 15 percent of the output of the semiconductor industry. These major customers are reducing the numbers of vendors that they deal with and thus require global servicing. Philips Components is responding by strengthening its presence in the Asia/Pacific region.

"Telecommunications Technologies for the 1990s"
Horst Ohnsorge, Director, Research and Technology
Alcatel

Already the 29 biggest cities in Germany have been linked with 500,000 kilometers of fiber-optic cable for a broadband communications system. Fiber-optic technology is also prevalent in other countries: Fiber-to-the-home is the goal in the United States, with trials in 11 cities; France has the Biarritz network; the United Kingdom has the Milton Keynes network; Canada has the Elie Manitoba net; and Japan has the Hi Ovis network. Technical advances that are required to service broadband communications equipment include the following:

- 1-million-plus transistor ASICs with less than 50ps gate delays
- 32-Mbit memories with 1 ns access time costing 10 ECUs
- 500-mips, 32-bit microprocessors with 100-MHz clock rates costing 50 ECU

"Eastern Europe and Perestroika"
Yuri Levine, Senior Research Fellow
Institute of World Economy and International Relations, USSR Academy of Sciences

Having a nonconvertible currency, an inefficient bureaucracy, and a state monopoly on foreign trade have contributed to slow economic growth in Russia. However, since December 1988, every Russian company has had the right to trade abroad and find partners. By the end of 1988, 200 joint ventures—representing Western investment of $441 million—had been registered. So far, in 1989, 300 more have been added. There is no limit on the percentage share that foreign companies can hold. Nonconvertibility of the ruble poses problems for foreign companies that want to repatriate profits. Either the Commerce Ministry could find ways around that problem, or Western companies could either purchase Russian goods and export them or export the products of the joint venture.

"Consumer Europe"
Jacques Noels, President and CEO
Nokia Consumer Electronics

A revolution is taking place in Europe on several fronts. First, a revival of interest in consumer electronics with big investments in HDTV, in satellite broadcasting, and DSP is taking place. Second, the technical revolution that has changed the computer world has not yet affected consumer electronics, but it will—TVs in the 1990s will have 50 Mbytes of RAM. Third, personal electronics will become big business, especially with home-integrated systems. Fourth, what effect will 1992 have? And, last but not least, are the effects of deregulation. European governments should support the industry that is fighting not only the Japanese but the developing countries as well.

"The European Renaissance"
Jurgen Knorr, Senior Vice President, Components Division
Siemens

If a renaissance in Europe's electronics industry is to occur, the industry will need to catch up in microelectronics technology. Siemens believes that it is only six months behind the Japanese with the 4-Mbit generation of DRAMs and will catch up with 16 Mbit technology. It will cost $3.7 billion to reach the stage of producing 10 million 16-Mbit DRAMs a month. The R&D cost for the 16-Mbit DRAMs will be $500 million. It is an expensive and risky business, but dependency could result if only one member of the triad has DRAM manufacturing capability. JESSI, funded 50 percent by participating companies and 25 percent by the EEC, will ensure that Europe maintains its position in DRAMs. "So we see a green light for the European semiconductor industry."

Byron Harding

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INTERNATIONAL SEMICONDUCTOR TRADE ISSUES— DOMINANCE, DEPENDENCE, AND FUTURE STRATEGIES

OVERVIEW

Trade issues have been a major concern throughout the world thus far in 1989. The Japanese semiconductor manufacturers have achieved dominance of the worldwide DRAM market, while U.S. manufacturers still hold a comfortable lead in high-end microprocessors. The European semiconductor producers, particularly in view of the forthcoming 1992 combined-market scenario, have pledged that they will be in a position to supply Europe's semiconductor needs. Finally, substantial growth is being seen throughout the Asia/Pacific region as Taiwan, Korea, and Singapore rapidly expand their semiconductor production base.

Dataquest forecasts a global semiconductor industry taking shape by the mid-1990s, with a more balanced distribution of products and technologies than we witnessed in the 1970s and 1980s. However, with the trade press burgeoning with weekly—if not daily—statistics regarding export balances, threats of protectionism, and national agendas for critical electronic components, it is difficult to sort out the true current situation in the worldwide market. Dataquest has taken an alternate perspective on current worldwide production/consumption of semiconductor components and has classified each region as to whether it consumes more ICs than it produces or has a sufficiency for export after satisfying domestic needs. This net difference for each region, presented by major product category, is a measure of the self-sufficiency profile for each region. By understanding the net consumer or net producer profile of each region, we can anticipate strategic moves that the IC producers in these regions may make in the international marketplace.

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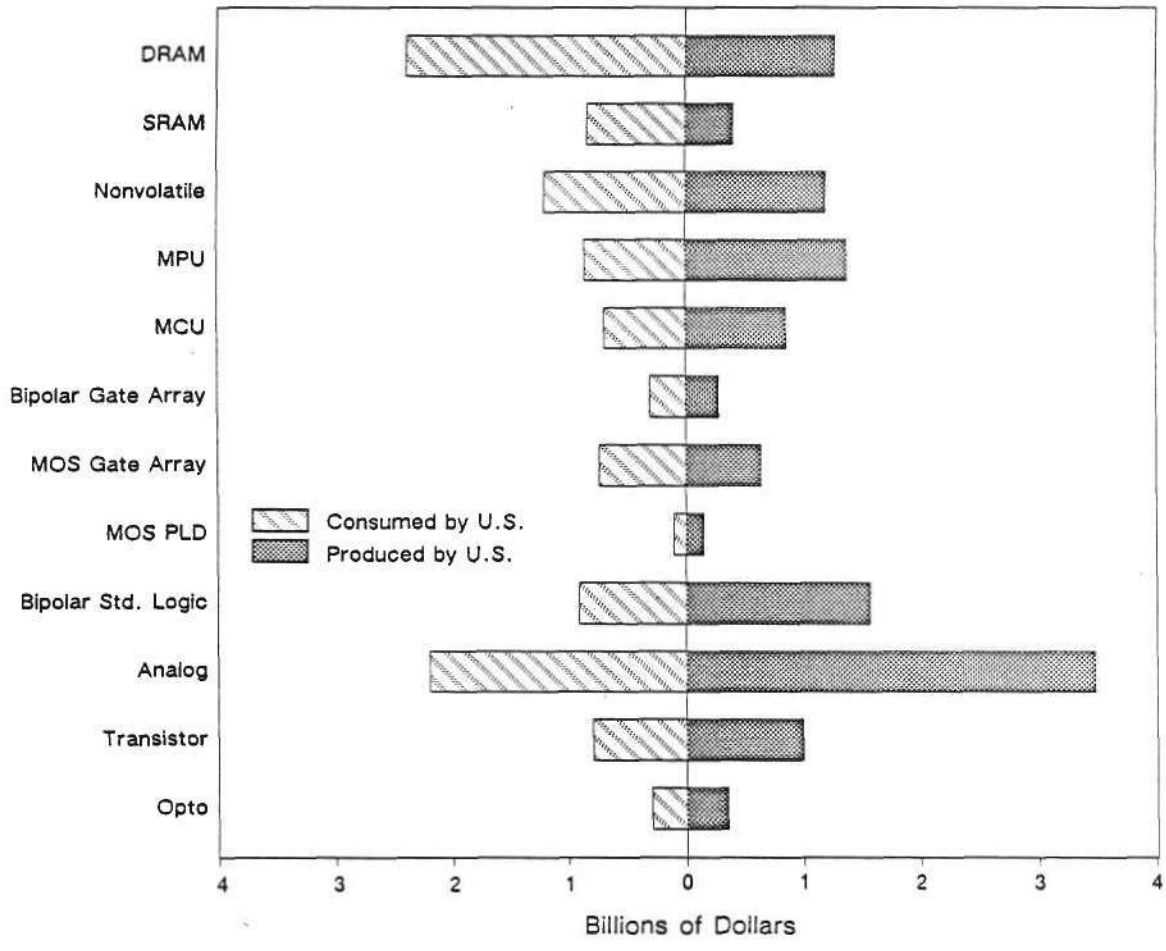
PROFILES BY REGION

U.S. Companies

We begin our analysis of worldwide production and consumption of ICs with a look at the U.S. semiconductor consumption/production profile. Figure 1 illustrates that the United States has a relatively symmetrical consumption/production profile, except for DRAMs and analog ICs. Figure 2 presents a better picture of the United States' position as a net consumer or net producer of ICs. From it, we can see that the United States is a net producer of both microprocessors and microcontrollers of bipolar standard logic, analog ICs, and discrete transistors. However, as expected, the United States also is a net consumer of DRAMs, a net consumer of SRAMs, and, surprisingly, a net consumer of both bipolar and MOS gate arrays.

Figure 1

Semiconductor Consumption/Production Profile
United States



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Source: Dataquest
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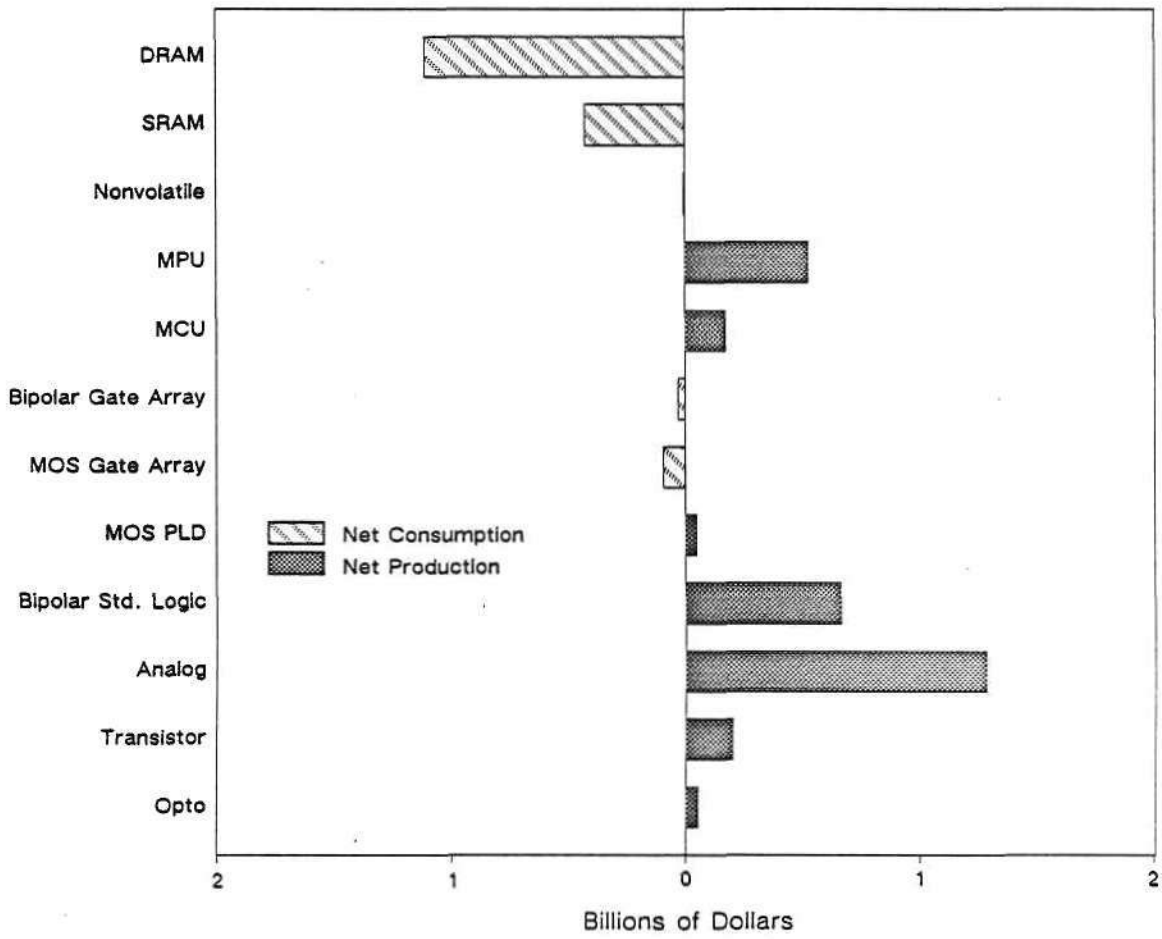
Figure 2

Difference between Semiconductor Consumption and Production United States



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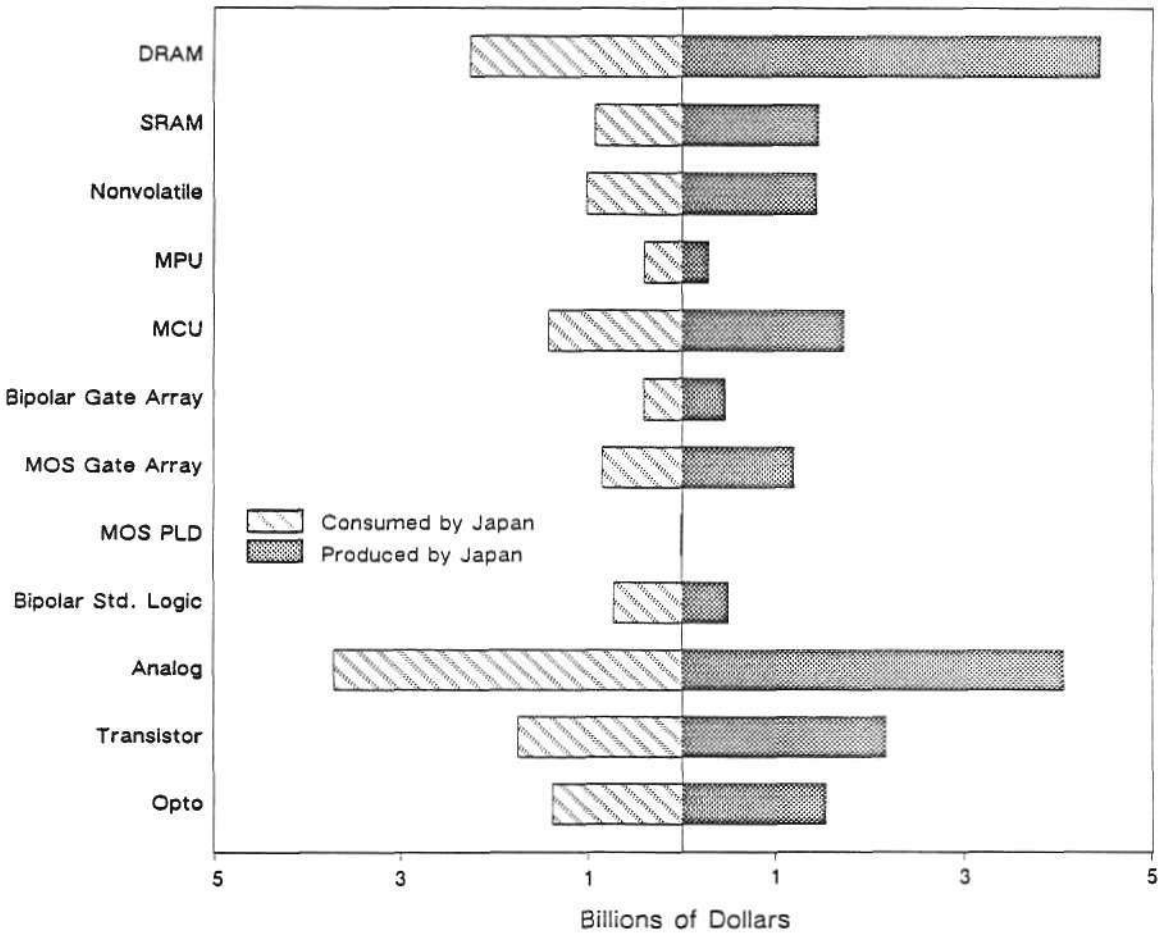
Source: Dataquest July 1989

Japanese Companies

Figure 3 presents the overlay of Japanese semiconductor consumption, and Figure 4 presents the net consumption/production chart as it relates to Japan. These figures illustrate that Japan is overwhelmingly a net producer of ICs and that it consumes only microprocessor units, MOS PLDs, and bipolar standard logic from foreign sources.

Figure 3

Semiconductor Consumption/Production Profile
Japan



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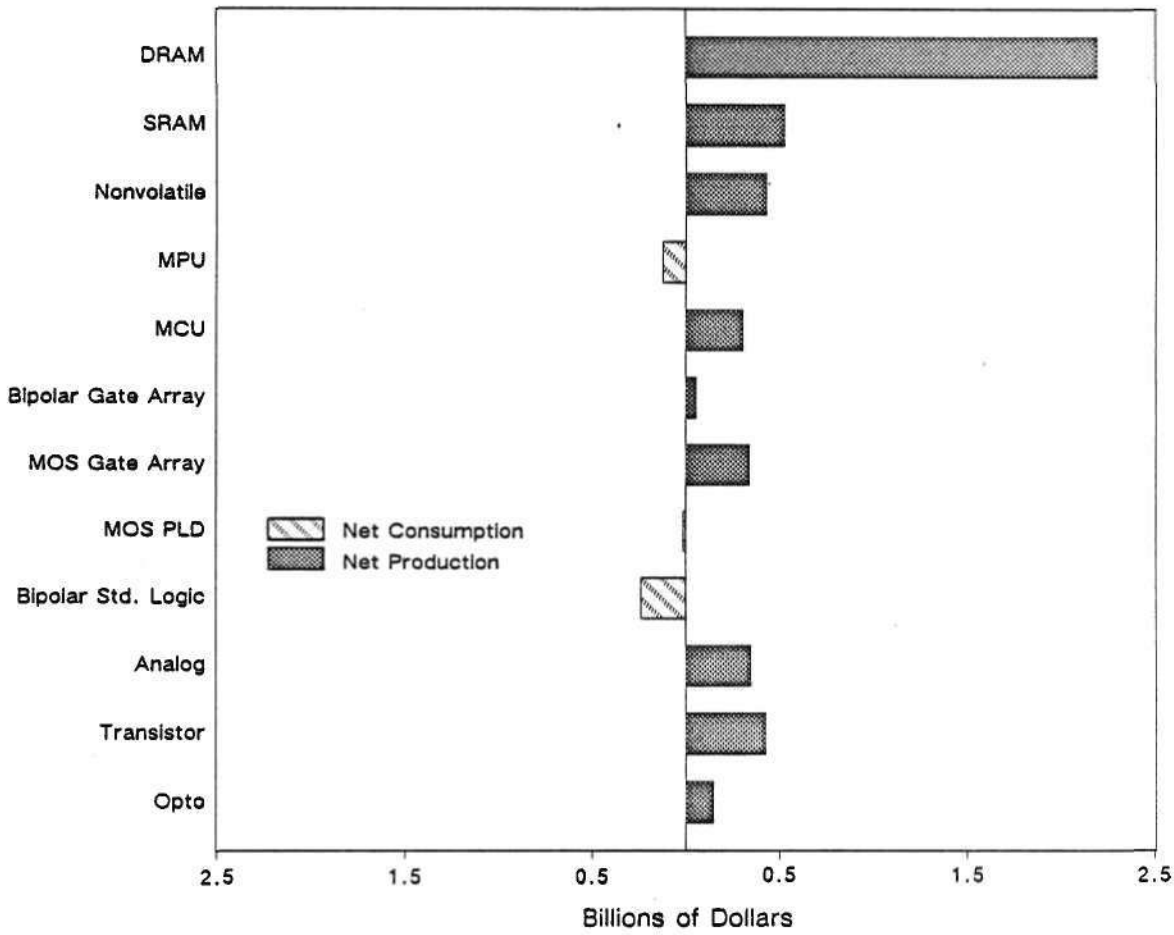
Source: Dataquest
July 1989

Figure 4

Difference between Semiconductor Consumption and Production
Japan



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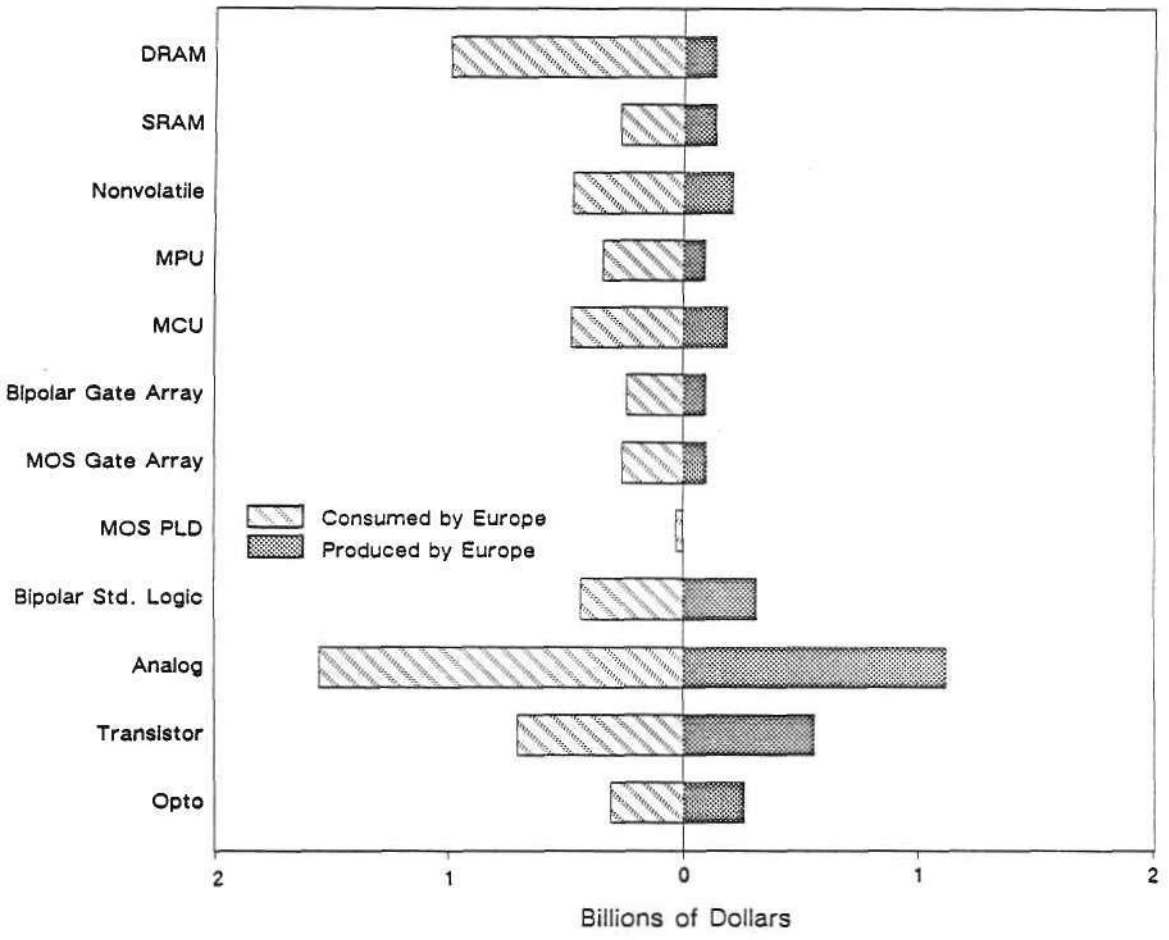
Source: Dataquest
July 1989

European Companies

Figures 5 and 6 depict the consumption/production scenario for Europe. As seen in Figure 6, Europe is a net consumer of foreign semiconductors in all categories.

Figure 5

Semiconductor Consumption/Production Profile
Europe



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Source: Dataquest
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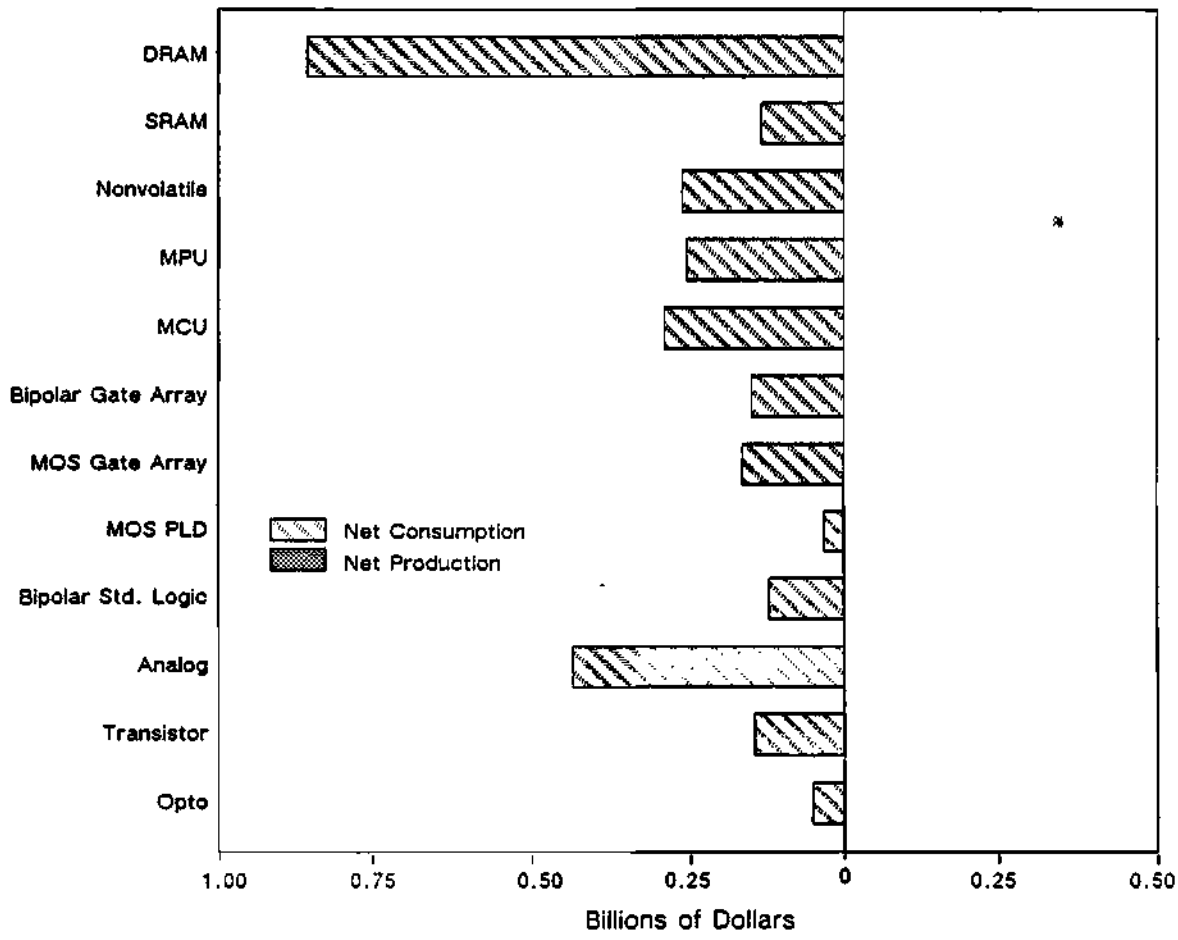
Figure 6

Difference between Semiconductor Consumption and Production Europe



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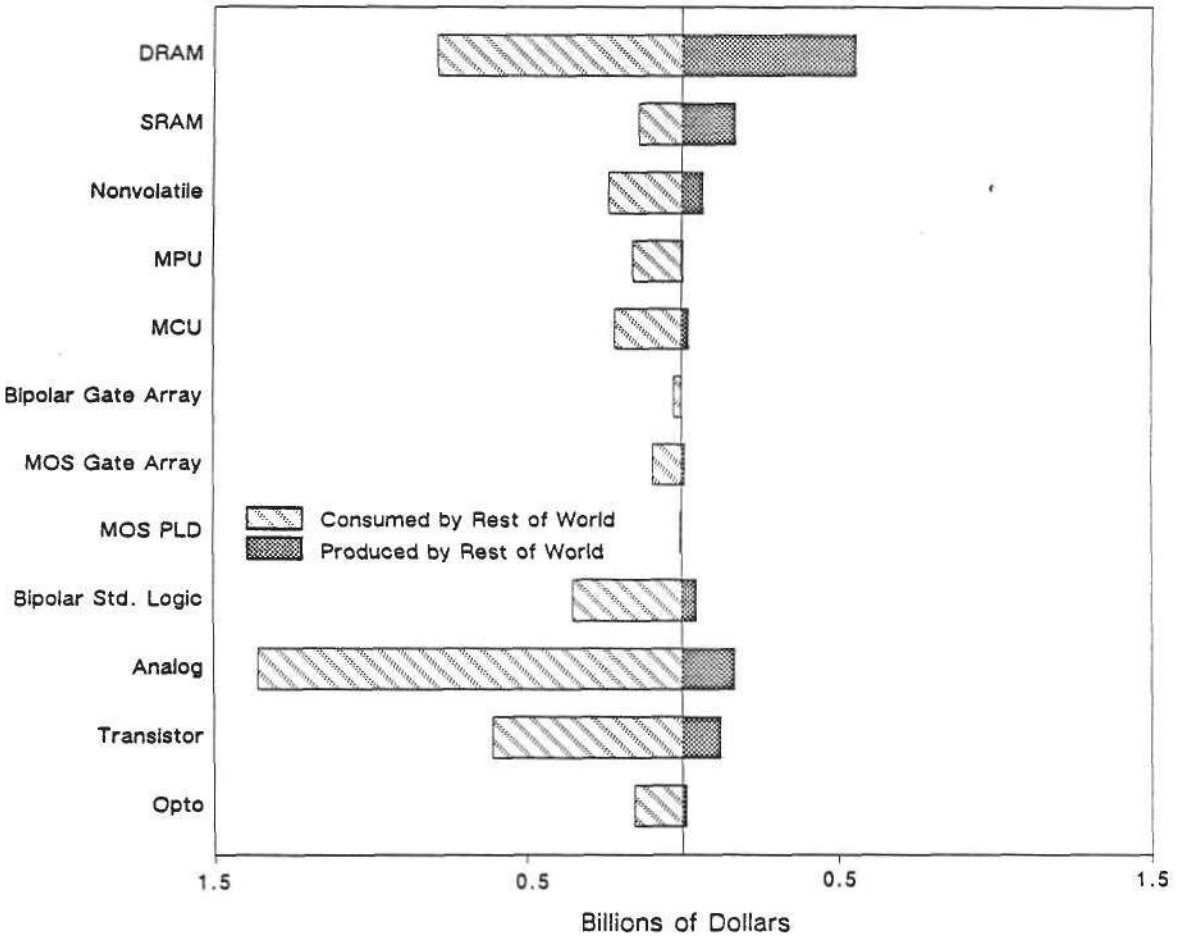
Source: Dataquest July 1989

Asia/Pacific and ROW Companies

Figures 7 and 8 depict the consumption/production profile for the rest of the world, which is essentially Asia/Pacific. As seen in these figures, ROW is a net consumer of foreign ICs, with the exception of SRAMs.

Figure 7

Semiconductor Consumption/Production Profile
Rest of World



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Source: Dataquest
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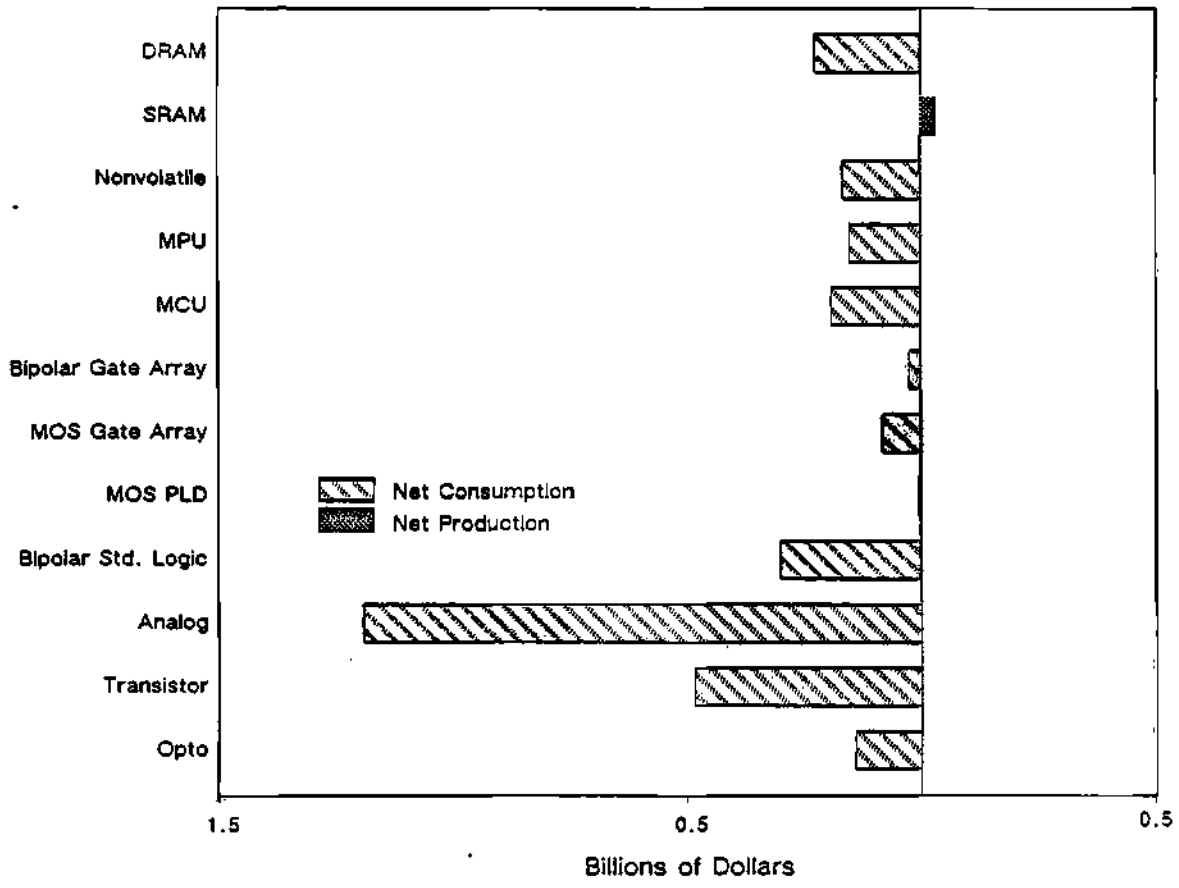
Figure 8

Difference between Semiconductor Consumption and Production
Rest of World



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Source: Dataquest
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DATAQUEST ANALYSIS

Viewing the information in the net consumer/producer format allows one to quickly assess the characteristics of a certain region and also allows one to anticipate strategic moves that the semiconductor producers and system manufacturers in the region may make to defend markets or to obtain a better balance between consumption and production. Viewing the U.S. consumption/production profile, Dataquest believes that the United States will become a larger producer of both DRAMs and SRAMs and may become a net exporter of SRAMs in the next four to five years. Most of the semiconductor start-up companies that have begun operations in the United States in the last four years have some plans in place to produce SRAMs and specialty memories. Therefore, we believe that the United States will take a stronger position in SRAMs in the 1990s.

Dataquest believes that U.S. producers will continue to exercise dominance in microprocessors, given their superiority in complex design and software expertise; however, we also believe that the United States will become a net consumer of microcontrollers as Japanese companies gain expertise in this technology. This is particularly true for the less complex microcontrollers, which are embedded into a vast array of consumer electronic products and office equipment.

The U.S. companies' position in gate arrays, both bipolar and MOS, is surprising. Already, in this relatively young market, the United States does not produce enough to satisfy its own needs, suggesting underinvestment in this important and growing market. Unless dramatic changes occur, and occur very soon, we believe that non-U.S. suppliers will gain dominance in MOS gate arrays and that the U.S. electronics industry will continue to consume more gate arrays than it produces in the 1990s. Finally, although the U.S. IC producers appear to have a strong position in analog ICs, we believe that this strength will diminish somewhat in the 1990s, resulting from the lack of an indigenous consumer electronics industry.

To no one's surprise, the Japanese IC suppliers are the world's leaders in DRAMs. Dataquest believes that the Japanese companies will continue in their dominance of these markets and will be substantial net producers of DRAMs in the 1990s. Numerous Japanese companies are well positioned in 4Mb DRAMs already and are beginning to focus their attention on the 16 and 64Mb DRAMs. With this much inertial energy, we believe that it will be difficult for anyone to dislodge the Japanese IC producers from this number-one status. We believe that the Japanese semiconductor producers will continue to strengthen their position in gate arrays and soon will begin to focus their energies on the MOS programmable logic device (PLD) area. Although it is purely speculation at this point, we believe that in the light of increasing trade friction, the Japanese suppliers may pursue microprocessor devices with less intensity and that the Japanese electronics industry will continue to be a net importer of MPUs, particularly 32- and 64-bit MPUs.

The European region forecast is less clear. The European electronics industry, at this time, is substantially dependent upon non-European sources for its critical semiconductor devices. We will have to wait to see if the "1992 Effect" and the recent consolidation of several European IC manufacturers will have a positive impact upon this profile as we head into the 1990s.

Dataquest believes that the area wherein the greatest change in profile could occur will be ROW--principally, Taiwan, Korea, Singapore, and Malaysia. Taiwanese and Korean companies are making substantial increases in semiconductor manufacturing capacity. In the last year alone, Taiwan has witnessed several new IC start-ups focused on the SRAM market as well as incorporation of SRAMs into the product profiles of many of the existing Taiwanese companies. Korean companies are well positioned to gain a major role in DRAMs. Singapore, Malaysia, and Taiwan, to some extent, have large amounts of installed foundry capacity. Dataquest believes that several of these foundries may begin to run SRAM-type products as technology drivers and as capacity balancers, further enhancing the region's image as a net producer of SRAM-type products. We also believe that there will be increased activity in both microprocessor- and microcontroller-type products, especially in Taiwan and Korea, as these regions' technical competency increases in high-end personal computers and workstations.

Dataquest anticipates an era of greater interdependence among geographic regions, beginning in the early 1990s. We believe that this will be especially true among the electronic IC companies of the United States, Japan, and Asia/Pacific, as all of these regions attempt to arrive at an amenable trade balance. We further believe that European industry will first focus on meeting a greater share of its own internal needs in the early 1990s and then join the other regions of the world in the mid- to late 1990s as the electronics industry becomes truly global in nature, with virtually no geographical boundaries.

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Byron Harding
David Angel

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Research Newsletter

ESAM Code: Volume II, Newsletters
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THE PC CHIP SET MARKET: WADE IN CAREFULLY—THE POOL IS FULL!

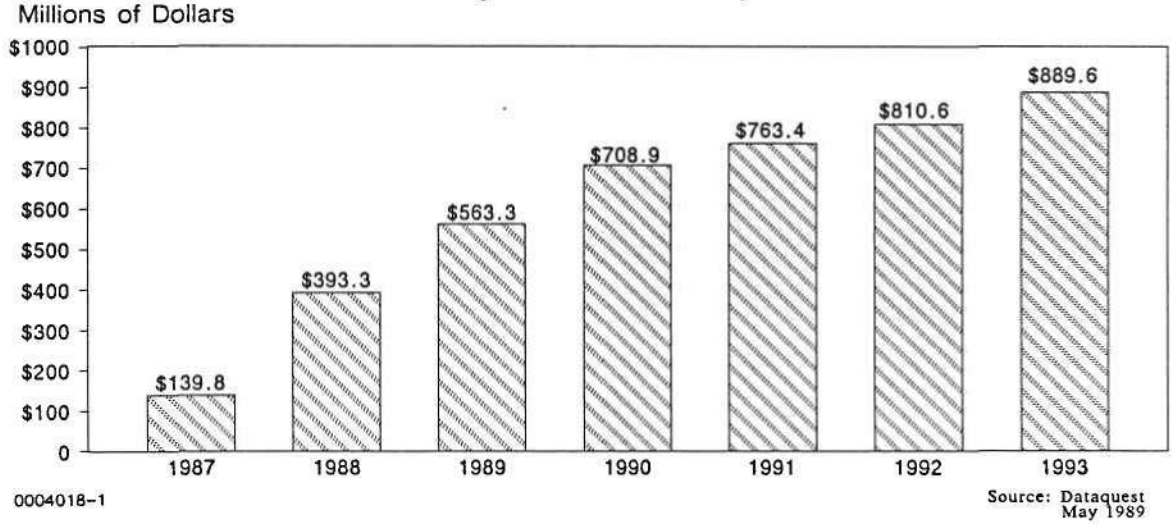
INTRODUCTION

Worldwide, there were only six PC logic chip set vendors in 1987. In 1988, the number climbed to 13, and by the end of this year Dataquest expects to see 19 vendors worldwide. The new entrants are both large, well-capitalized semiconductor manufacturers and small, start-up design houses. These new suppliers have been attracted by the tremendous growth rate of the market and the initially small number of participants. This is characteristic of any emerging market. The main differences between this market and other emerging markets are the large amount of standardization already present and the ease of sizing the market by examination of the total number of PCs shipped.

Dataquest believes that the rapid increase in new entrants and capacity will bring this industry to the saturation level by the end of this year, based on the Dataquest PC shipment forecast. We expect this saturation to lead to aggressive price competition, driving vendors to look for penetration of these products into new applications and markets. Figure 1 presents Dataquest's estimated actual and forecast revenue for the worldwide PC logic chip set market.

Figure 1

Worldwide PC Chip Set Market Forecast
(Millions of Dollars)



0004018-1

Source: Dataquest
May 1989

HIGH GROWTH RATE ATTRACTS MANY NEW ENTRANTS

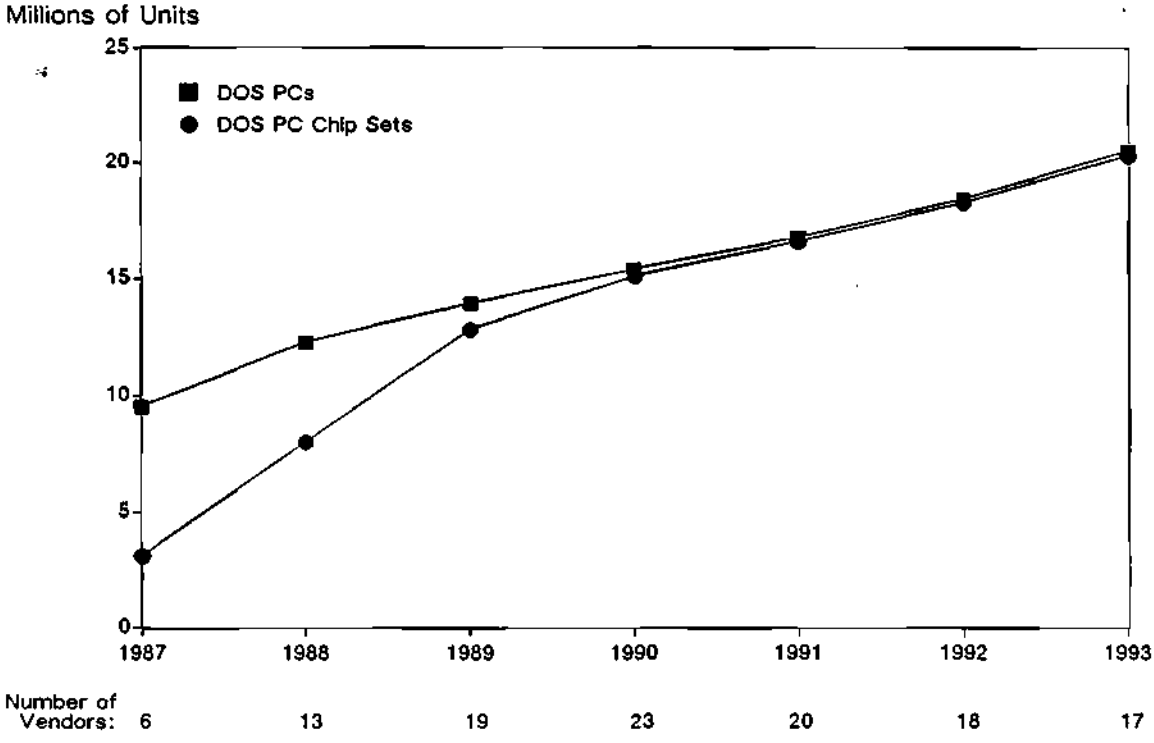
Dataquest estimates the compound annual growth rate (CAGR) for chip set unit shipments from 1987 to 1993 to be about 38 percent, an attractive rate of growth to investors, which should entice them to seek ways to participate in this industry. However, because of the nature of the relationship between PC consumption and chip set consumption, it is important for potential new entrants to look at the development of this market in terms of the product life cycle.

Figure 2 graphs shipments of chip sets against the shipments of DOS PCs, showing the rapid rise of chip set shipments as they approach the level of PC shipments. Between 1987 and 1988, chip set shipments grew by 157 percent. The estimated CAGR for 1987 to 1990 is still almost 70 percent. Dataquest estimates that during this same period, the number of chip set vendors will increase from 6 to 23.

Dataquest believes that, in 1990, the penetration of chip sets into PCs will likely approach saturation. By the end of 1989, the penetration will be about 92 percent. At this point, the growth rate of chip set shipments will be tied directly to the growth rate of PC shipments. In fact, the CAGR for chip set shipments from 1989 to 1993 is estimated at only 12.2 percent. This level of growth should attract fewer new entrants and cause some participants to exit the industry.

Figure 2

Worldwide PC Logic Chip Set Market Forecast as Compared with the DOS PC Forecast (Millions of Units)



A Case of Overcapacity

According to a Dataquest survey, worldwide logic chip set vendors expect to ship more than 15 million units in 1989. Table 1 lists the results of this survey along with Dataquest's estimated actual and forecast numbers for chip set and PC unit consumption for 1987 through 1989. The vendors expect to ship 17.5 percent more than the forecast for chip sets in 1989 and 8.1 percent more than the forecast PC consumption.

Table 1

Worldwide PC Chip Set Vendor Survey Results
(Thousands of Units)

	1987	1988	1989
Dataquest DOS PC Consumption Estimate	9,552	12,293	13,953
Dataquest DOS Chip Set Consumption Estimate	3,116	8,014	12,837
Vendor-Estimated Chip Set Shipments	3,116	8,014	15,095

Source: Dataquest May 1989

The difference between the vendors' expectations and the Dataquest forecast might be explained by aggressive goal setting on the part of the vendors. One could also argue that some units will be shipped into inventory. It is clear, however, that more than enough capacity exists to satisfy the demand for chip sets, and it is expected that new entrants to the industry will aggravate this situation.

The implications of this analysis should be obvious. The competition for market share in this industry is likely to lead to aggressive, if not predatory, pricing policies on the part of participants. Given the degree of standardization of these products, they will take on more of the attributes of a commodity, where pricing and service are the keys to success.

FORECAST METHODOLOGY AND ASSUMPTIONS

The PC chip set forecast is derived from the Dataquest Personal Computer Industry Service PC forecast and from a survey of worldwide chip set vendors. Each year, Dataquest forecasts worldwide shipments of personal computers. Table 2 gives the Dataquest estimated worldwide shipments for DOS PCs. Dataquest's new chip set forecast for 1989 through 1993 is derived as a function of saturation of the DOS market. The estimates for 1987 and 1988 are based on the chip set vendor survey and Dataquest analysis. The following significant assumptions were made in these forecasts:

- The worldwide DOS PC market will continue to grow through the period at a CAGR of about 14 percent.

- As a general trend, discrete chips will be displaced by very large scale integration. In personal computers specifically, discrete logic chips will be replaced by logic chip sets. Because of the advantages of chip sets for the systems manufacturers—lower cost, better performance, faster time to market—this displacement has happened very rapidly.

- Average selling prices (ASPs) will fall in 1989 because of price competition. They will rise in 1990 as the introduction of EISA chip sets and increased penetration of the MCA chip sets shifts the product mix toward the high end. ASPs will then come down slowly through the rest of the period as price decreases are offset by the continued move in product mix toward the high end.

Table 2

Worldwide PC Logic Chip Set Market Forecast
(Thousands of Units)

	1987	1988	1989	1990	1991	1992	1993	1987-1993 CAGR
DOS PC Shipments	9,552	12,293	13,953	15,444	16,807	18,491	20,570	13.64%
Chip Set Shipments	3,116	8,014	12,837	15,136	16,639	18,306	20,364	36.73%
Saturation	33%	65%	92%	98%	99%	99%	99%	
Chip Set ASP	$44.88	$49.08	$43.88	$46.84	$45.88	$44.28	$43.69	(0.45%)
Chip Set Revenue ($M)	$139.8	$393.3	$563.3	$708.9	$763.4	$810.6	$889.6	36.12%
Chip Set Revenue Growth	N/A	181.2%	43.2%	25.9%	7.7%	6.2%	9.7%	

N/A = Not Available

Source: Dataquest
May 1989

DATAQUEST ANALYSIS

Critical Success Factors for Participants

In order to participate successfully in this industry, vendors will require certain capabilities and resources, including the following:

- Systems Expertise—Systems designers are looking for vendors that can work with them from the beginning of the board design to integrate and sometimes customize a chip set into the system. Chip set vendors with board design and systems expertise will be able to provide this capability.

- Design Tools—Fast chip design turnaround will be required because of short product life cycles. Access to design tools will allow vendors to offer products as a core that can be modified to allow customers some degree of differentiation.

- High-Volume/Low-Cost Manufacturing—Because of the increasing commodity status of these products, access to high-volume/low-cost foundries will be essential.

- Customer Service/Support—Because of the lack of any major differentiation in these products, service and customer support is as important as pricing. A user might not switch vendors for either better pricing or better service, but if offered both, will find it difficult to resist.

Opportunities

As the chip set market approaches saturation and vendors find themselves with excess capacity, they will be forced to look for new applications for logic chip sets outside of the personal computer. Two areas that will benefit from this are the embedded DOS market and the personal workstation market.

Embedded DOS Market

At least one chip set vendor is pursuing embedded DOS applications as its primary strategy, and most others have thought about it as a secondary strategy but have not yet dedicated resources toward this market. The embedded DOS market can be defined as having applications that contain some form of keyboard (input device) and some sort of display (output device) that could benefit from the protocol of the DOS PC logic interface. These applications tend to be for low-end PC logic products. Examples are vending machines, traffic controllers, process controllers, communications, and medical and analytical instrumentation.

Personal Workstation Market

As the high-end personal computer products approach the functionality of low-end workstation products, a segment is developing that some have called the personal workstation market. With the introduction of the Intel 80486 and i860 microprocessors, opportunities exist to develop high-end chip sets that will combine the use of complex-instruction-set computer (CISC) and reduced-instruction-set computer (RISC) microprocessors to offer a system that will run both DOS and UNIX applications. One chip set vendor already has announced plans to develop a RISC chip set.

This market is not well defined. Questions exist as to the size and viability of this segment, and standardization issues need to be resolved.

DATAQUEST CONCLUSIONS

The rapid initial growth rate of the DOS PC logic chip set market has invited many new entrants to this industry and has brought the market from infancy to saturation in a very short period of time. Although a change in product mix toward the high-end products will somewhat offset price declines over the next several years, pricing pressure will be considerable. This will cause some vendors to exit this market altogether and others to dedicate resources to seeking out new applications for these products. Vendors with access to low-cost foundries, appropriate design tools and expertise, and high-quality global sales organizations will stand the best chance of success.

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Jennifer Berg
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Dataquest
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Research Newsletter

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WILL THE JAPANESE OWN THE 3.5-INCH RIGID MARKET?

SUMMARY

As of the end of 1988, no Japanese companies were credited with as much as 10 percent of the sales of the world's 3.5-inch rigid disk drives. This statistic probably will come as a surprise to most readers because Japan has effectively captured large shares of computer storage-related commodity markets.

This newsletter will examine the reasons behind the slowness of the Japanese in capturing this lucrative market. We will also lay out a time table for a reversal of the situation and the inexorable loss of one more U.S. market.

BACKGROUND

The first warning that we were about to lose the floppy disk drive (FDD) market should have been when the Japanese sewing machine industry (also once an American stronghold) converted its factories to the automated manufacture of 5.25-inch floppy drives. The U.S. drive-makers gave up and relinquished the FDD market to the low-cost assemblers. Today, no volume FDD factories are located in the United States, whereas, in 1981, 80 percent of these products bore the Made In USA label.

The large Japanese system companies also have kept pace with U.S. drive companies on rigid disk drives (RDDs), and are largely self-sufficient through captive production of 8- to 14-inch diameter products. Some of these drives have been well-accepted by OEM buyers around the world, with Fujitsu, NEC, and Hitachi often showing up as leaders in the high-capacity segments of the market. This Japanese leadership has not, however, excluded the U.S. firms, and the market has been fairly evenly divided around the world.

With the advent of the 5.25-inch RDD in 1980, it looked very much as if Americans might have found a new product where they could establish their leadership and maintain it for a long period of time. So far, the U.S. companies' market shares continue to exceed 80 percent. Unfortunately, however, only a small portion of the world's 5.25-inch disk drives are actually manufactured in the United States; most of these drives are coming from the Asian Rim where manufacturing costs can be minimized.

Experienced disk drive producers were the first to enter the 3.5-inch business, with initial units coming from American factories. As volumes increased, however, competitive pressures forced a rapid move to off-shore production facilities. Today, 90 percent of the 3.5-inch products are made by U.S. companies but are produced outside of the United States.

SO WHAT'S THE ALARM?

Even though the Japanese have so far been unable to make their presence felt in the 3.5-inch market, **nearly one-third of all these products are manufactured in Japan.** Whoops. . . . We have lost it again.

IBM has proven to be the world leader in 3.5-inch drive production from its factory in Fujisawa, Japan, where nearly 2 million units were made in 1988. The other U.S. company with drives coming from Japan is Quantum. Through a manufacturing relationship with Matsushita Kotobuki, Quantum and its subsidiary, Plus Development, are prepared to produce more than a million of these devices in 1989. The differentiating feature of the products from IBM and Quantum is their exceptional quality and reliability.

IBM's production is predominantly for captive use in the PS/2 desktop computers, although an increasing number of these little drives are showing up in the OEM and retail distribution channels. The luxury of having a captive requirement to fortify production economy-of-scale keeps IBM able to be price competitive in the distribution market.

Quantum's products are positioned in the high-performance, high-quality market and command a premium price. This extra revenue can be used to offset the dollar-yen imbalance and higher labor costs for a short period of time, but Matsushita Kotobuki probably will move offshore in order to be competitive in the future.

Although LaPine Technology established a manufacturing agreement with Kyocera to produce commodity 3.5-inch drives, the costs were high and the business relationship was tenuous. Kyocera is now left on its own and the lawyers will make more money on the venture than either of the principals.

THE DOMINOS WILL FALL

We have examined the American companies now leading the 3.5-inch fray and their movement into Japan for production. But what of the Japanese producers themselves?

The Japanese jumped into the 3.5-inch market in 1985 with Alps Electric, Epson, Fuji Electric, JVC, and NEC Information Systems the first to compete. By the time these companies had determined a worldwide sales strategy, they found they were not competitive. The U.S. marketeers had already established effective distribution channels and pricing policies with their 5.25-inch products, and the Japanese found themselves out-classed. Most of these Japanese companies have now retreated to their own country and to key OEM relationships with major electronic manufacturers.

We believe that the situation in 1989 will differ from that of 1985 in the following areas:

- The worldwide 3.5–inch RDD market will exceed 10 million units in 1989.
- The worldwide factory revenue available to 3.5–inch RDD sellers will approach $4 billion in 1989.

In other words, it has now become an interesting business for manufacturers of high–quality, commodity products.

Recently, we have seen announcements of, or have heard rumors regarding, a series of new products soon to be offered by major Japanese disk drive vendors. Most of these companies are vertically integrated manufacturers of components for 3.5–inch rigid drives, and most of them have demonstrated previous expertise in manufacturing automation techniques. What we are about to see is a logical extension of the capabilities we knew were there. Japan is ready to roll.

Matsushita Communications, better known in the United States as Panasonic, has constructed an awesome, robotically controlled factory for the assembly and test of 3.5–inch RDDs, with an estimated capacity of at least 100,000 units per month. Already shipping 100–Mbyte drives to Maxtor for remarketing, Panasonic has entered into a joint–development relationship with Priam for new, high–capacity drives. The team that designed the impressive Priam 760–Mbyte, 5.25–inch product is working on the next Panasonic family of drives.

Sony Corporation has not been effective in the RDD market but continues to offer noteworthy 3.5–inch FDD products. Sony owns a proprietary thin–film–media process and could easily become a world force in the high–density media market. This electronics giant has quietly entered the 3.5–inch RDD wars with products meeting or exceeding most of those available from U.S. companies. A long–standing relationship with Apple Computer has provided a built–in customer for volume purchases of drives. Dataquest anticipates that Sony will shortly offer a broad range of drives with between 40 and 200 Mbytes and access times well below 20 milliseconds.

Fujitsu has already announced SCSI–interfaced, 3.5–inch drives in the 100– to 200–Mbyte range, with access times in the 20–millisecond range. Matsushita Kotobuki is marketing the Quantum drives in Japan through Matsushita Electronics (in competition with Matsushita Communications). The manufacturing giant, Alps Electric, is known to be developing low–cost OEM devices with superior specifications. It is only a matter of a few months before other respected Japanese drive companies gear up for combat in this market.

DATAQUEST CONCLUSIONS

We are approaching a period when U.S. leaders such as Miniscribe, Western Digital, Conner, Quantum, and Seagate will expand their facilities to meet the intramural competition, showing little regard for the sleeping giant that is about to absorb the 3.5–inch RDD industry. A quick look over the shoulder might be appropriate at this time.

The Japanese may well make further moves into the Asian Rim countries to further reduce manufacturing costs. In fact, there seems to be continued interest in U.S. factories for Japanese vendors. It is not the currency imbalance that is dictating these moves because most of the large corporations can profitably weather an exchange rate of 110 yen/dollar.

American industry leaders can do little to slow the inevitable. Caution in technology exchanges, awareness of coming competition, and continued searches for the best low-cost, high-quality manufacturing situation are the only protective measures available. Partnerships are unavoidable and will become more commonplace.

The struggle will be to retain a reasonable market share for the U.S. drive business. The futures of many companies are tied to the outcome of this global industrial struggle, and, once again, the resolution is unlikely to be in the favor of the incumbent.

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Research Newsletter

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CT2—A RISING STAR IN EUROPE

SUMMARY

In this newsletter, Dataquest will examine the equipment and semiconductor markets that the new CT2 digital cordless telephone technologies will drive. We will develop two contrasting but feasible scenarios, an "upside" and a "downside," to assess the markets for the applications that will follow.

CT2 will allow users to make calls onto the public telephone network using portable handsets that will be both very compact and very inexpensive compared with cellular telephones. Calls must be made from fixed points. These may be private places, such as homes and offices, or public locations, such as airports, stations, and main streets. Tariffs for use of the public CT2 "telepoint" services will be smaller than existing cellular ones, and reflect the lower levels of investment per subscriber needed to set up a static cordless network compared with a mobile cellular one.

A common air interface (CAI) standard has recently been developed for CT2 that will transform the cordless telephone into a universal tool for use in homes, offices, and public places throughout Europe. We expect CT2 handsets to reach the market two years before CT2's rival, the technically superior Digital European Cordless Telephone (DECT) standard, is finalized.

In the upside example, we assume that the market for CT2 handsets will be driven mainly by a strong take-up of telepoint services across Europe. These services will allow subscribers to place calls on the public telephone network from pocket-size handsets, provided they are within about 100 meters of a public base station. Following trials in each country, telepoint is likely to begin using the CAI standard in at least five European countries: Finland, France, Spain, the United Kingdom, and West Germany. In this scenario, we estimate that there will be 16 million CT2 handsets in Europe by 1995, or 1 handset per 8 households. From this information, we estimate the total European market for CT2 equipment to be worth $334 million in 1991, rising to $1.2 billion by 1995. By the year 2000, the cordless telephone will have become as much a part of everyday life as the hand calculator is today.

The downside version takes a pessimistic view of the uptake of telepoint systems in Europe, restricting them to only the United Kingdom and France. Using this perspective, we estimate the total European market for CT2 equipment to be worth $75 million in 1991, rising to $666 million by 1995, driven mainly by the demand for office and home-based CT2 systems.

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CORDLESS STANDARDS

CT2 cordless technology developments have been most prolific in the United Kingdom, with six different applications for standards submitted to the United Kingdom's Department of Trade and Industry (DTI) by early 1988. To overcome these conflicts, a single CAI specification since has been developed by seven UK companies—British Telecom, Ferranti, GPT, Mercury, Orbitel, Shaye, and STC—under the guidance of the DTI.

After three public consultative meetings attended by manufacturers and operators from most European countries, the DTI now has frozen the CAI to make it the basis of a memorandum of understanding (MOU) between several countries for a roaming telepoint service in Europe. These countries are likely to include Finland, France, Spain, the United Kingdom, and West Germany, and may also include others such as Ireland, Italy, and Portugal if consumers accept the telepoint system.

The CAI standard outlines the minimum specifications necessary to permit handsets to interwork on a public telepoint or private network, yet afford manufacturers the maximum opportunity to differentiate and enhance their products with special functions. The following key features may be deduced from the CAI document:

- High call density—CAI provides for dynamic allocation of 40 100-kHz channels that span 864 to 868 MHz, compared with a fixed allocation of 8 channels for CT1. With its low transmit power levels (1mW and 10mW), CAI is expected to permit an active call density of at least 2,000 calls/km^2.

- Compactness and lightness—CAI handsets will consume less power than CT1 or cellular handsets and consequently will require smaller batteries. Use of the UHF radio frequency band will allow the handset to enclose the antenna, making it easy to hold in a hand or stow in a pocket.

- Bidirectional call capability—The CAI standard allows handsets to both receive calls from and send calls to nearby base stations. However, the United Kingdom's telepoint operators are licensed only to provide their subscribers with outgoing call capability.

- Digital transmission—In either direction, the CAI provides an average usable rate of 32 kbps for speech coding according to the Consultative Committee on International Telephony and Telegraphy (CCITT) G.721 Adaptive Differential Pulse Code Modulation (ADPCM) recommendation.

Cordless technology will remain in a state of continual change for some time. Like CT1, the CAI is not destined to become a European cordless standard. However, it may become an Interim European Telecommunications Standard (IETS) while the European Telecommunications Standards Institute (ETSI) works on the more advanced DECT standard. DECT uses a different method to transmit data and is expected to provide at least five-times-greater call density than CT2, but it will not be finalized until mid-1991—after CT2 has received consumer exposure in Europe. No compatibility is foreseen between CT2 and DECT equipment.

APPLICATIONS

CT2's new features will lead to many new products not technically or commercially feasible using current CT1 or cellular radio technologies. Table 1 shows new applications envisaged for CT2 in the four main operating environments: home, office, public places, and mobile.

Table 1

Suitability of CT2 Compared with Other Technologies by Application and Environment

	Home	Office	Public Places	Mobile
CT1	Single base station	T	T	T
CT2	Single base station	Multiple base stations	Telepoint handset	T
DECT	Single base station	Multiple nested base stations Cordless PBX extension	Telepoint handset	T
Cellular	U	U	Portable handset	Mobile handset

Note: T = technically not feasible; U = economically not feasible; CT1 = first-generation analog cordless telephones, as used in the home today; CT2 = second-generation digital cordless telephones, to reach the market after mid-1989; DECT = third-generation DECT standards currently being developed by ETSI. Handsets are expected to reach the market after 1992.

Source: Dataquest
July 1989

The first CT2 handsets (Shaye Communications' Forum and Ferranti's Zonephone) will go on sale in the United Kingdom this summer for use with the new telepoint services. These early handsets will use different and mutually incompatible standards, but will be superseded by handsets using the CAI standard after mid-1990.

CT2's strengths reside in its applicability as a universal communicator that can be used in public places, in the office, and as a replacement for CT1 units in the home. Little overlap is expected between the market for CT2 handsets and the market for cellular handsets. Homes and offices are places where the cellular application, with its low call density and high tariffs, will remain rarely used.

TELEPOINT FOR ALL

Telepoint services will be the main factor driving the demand for CT2 handsets, because they will be targeted to the largest possible group of end users—Europe's population of 267 million urban dwellers. During the first years, coverage will be limited to public places (shopping centers, airports, and railway stations) in major cities. For the five countries that are likely to participate in the MOU, this represents a smaller target population of 80 million people, or 32 million households.

The level of penetration will depend on whether or not telepoint can win people's hearts and minds in the same way the Sony Walkman did in the early 1980s. For the personal communicator concept to succeed, the handsets must be sufficiently small and light, so as not to intrude upon everyday life. The Shaye handset, weighing less than 130 grams (4.6 ozs)—just more than one-half the weight of the lightest cellular portable on the market today—does not yet conform to the CAI standard. We expect CAI handsets to weigh more at first, but to become progressively smaller, lighter, and less expensive as successive drives are made to reduce standard ICs into fewer custom parts.

We forecast that the CT2 handset will have become a mass consumer item retailing for about $140 by 1993, compared with at least $250 for the first proprietary CT2 handsets expected to be launched by Shaye and Ferranti within the next few weeks.

CT2 at Home

The handset manufacturers also will offer domestic base stations that connect to a telephone socket in place of a normal telephone. They will resemble existing CT1 base stations, but they will provide the following additional benefits:

- More than one cordless handset for use with a base station
- Improved speech quality
- Prevention of illicit outgoing calls
- Security from eavesdropping

CT2 base units will retail separately for about $250 by early 1990, but one cannot help but wonder if private consumers will pay $500 for a complete CT2 handset/base station combination when CT1 units can be purchased now for $150. Consequently, we do not expect the volume of CT2 home-base unit sales to match CT1 unit sales until around 1993. By then, CT2 prices should be greatly reduced.

CT2 in the Office

Greater demand for CT2 base stations will come from the business market. However, CT2 is unlikely to support sufficient call density for use in large, densely packed office environments, which will limit it to small office environments.

At least two manufacturers, GPT and STC, are expected to launch a range of standalone multiple-line cordless base stations in sizes ranging from 6 to 24 handsets. These will possess some PBX-like features such as individual extensions, call forwarding, and conference calling. A wide-area pager may be incorporated into some handset models, partly to overcome the telepoint restriction of making outgoing calls only.

DATAQUEST ANALYSIS

This is the beginning of a new market—a time when predictions are most difficult to make, but when, for investment purposes, they are most needed. The market for CT2 semiconductors depends on the market for CT2 equipment which will, in turn, depend on how widespread telepoint usage becomes. Dataquest foresees three factors most critical for the success of a CT2-based telepoint service in Europe. These factors are as follows:

- The CAI standard must succeed in becoming a European interim standard. This is a vital step toward the European PTTs recognizing and adopting it for telepoint use before DECT is finalized.

- The cost of a telepoint call compared with a normal call is significant. In the United Kingdom, with heavy competition likely between the four licensed consortia, we expect telepoint to cost roughly twice as much as a normal telephone call. It is less clear if similar low tariffs will be adopted by the PTTs in the other European countries.

- Handset prices must fall to about $140 by 1993 to make them affordable on a wide scale. The interest shown by many potential handset manufacturers, coupled with the several possibilities to reduce IC costs, suggests that this is achievable (as discussed later in this newsletter).

We believe that the variability of these factors undermines the reliability of a single forecast. Instead, we present estimates for the CT2 equipment markets according to the two contrasting views outlined in the summary.

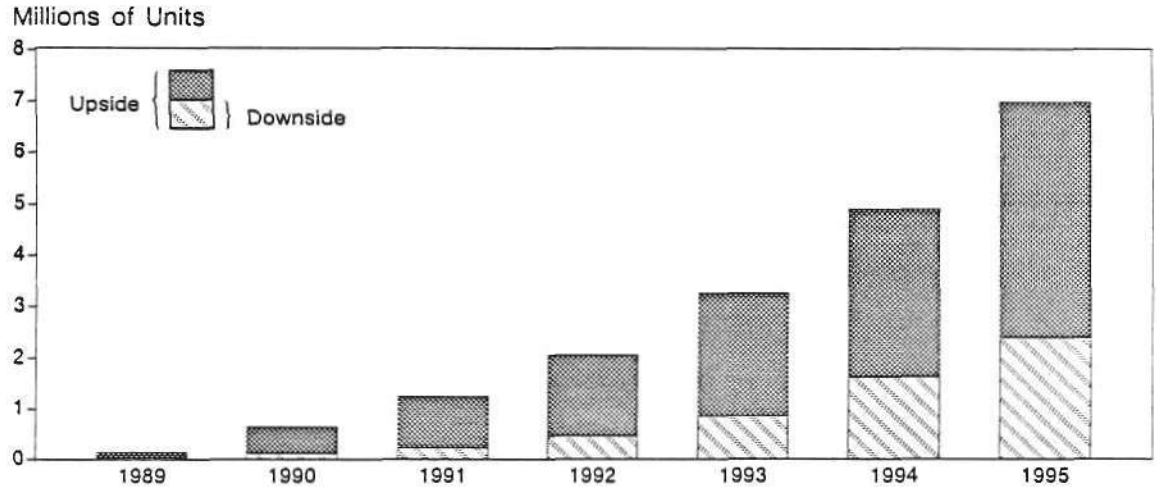
The Upside Scenario

Figure 1 shows a positive upside outlook for the unit sales of telepoint handsets in Europe, according to the upside perspective, which estimates a total installed base of 16 million CT2 handsets in Europe by the end of 1995. This is based on the following assumptions:

- The CT2 telepoint market will be in those countries expected to be party to the MOU—Finland, France, Spain, the United Kingdom, and West Germany.
- One in three households located in the major cities of these countries will possess a single handset by the end of 1995.
- Telepoint service subscriptions and call tariffs will be competitively priced in each country, so that a telepoint call will cost no more than double the price of an equivalent call placed through a normal payphone.
- Strong price erosion will weaken the average selling price (ASP) of a telepoint handset from $250 in 1989 to $100 by 1995.
- CT2 home base unit sales will match CT1 sales by 1993.
- By 1995, offices with PBXs of 100 lines or less will have reached a penetration of 1 in 10 installed lines.

Figure 1

Estimated CT2 Hardset Shipments for Europe
Upside and Downside Scenarios



0003915-1

Source: Dataquest
July 1989

We estimate that the total CT2 equipment market will rise from $334 million in 1991 to $1.2 billion by 1995, a 38 percent compound annual growth rate (CAGR). Telepoint handsets will account for the largest proportion of this revenue with 46 percent, followed by office handsets and base stations with 40 percent and home base stations with 14 percent.

The Downside Scenario

Figure 1 also presents a somber, yet conceivable, downside point of view for the unit sales of telepoint handsets in Europe if CT2 fails to win support from all but two European countries. We estimate that this would result in a total telepoint and office installed base of 4 million handsets in Europe by the end of 1995. Our assumptions are as follows:

- Telepoint services will be adopted in the United Kingdom and France only.
- One in 10 U.K. households located in major cities will possess a single handset by the end of 1995.
- Late commencement of telepoint and less aggressive pricing by France-Telecom will result in only 1 in 20 French households in major cities possessing a single telepoint handset by the end of 1995.
- Weaker price erosion will reduce the telepoint handset ASP from $250 in 1989 to $150 by 1995.
- CT2 home-base unit sales will match CT1 unit sales by 1995.
- There will be a lower penetration into small offices with PBXs of 100 lines or less, with cordless telephones attached to 1 in 20 of these lines by 1995.

This outcome would lead to a total CT2 equipment market of $75 million in 1991, growing to $666 million by 1995 (72 percent CAGR). Office equipment would account for the greatest part of this market with 36 percent, followed by telepoint handsets with 37 percent and home base stations with 27 percent.

SEMICONDUCTOR CONSUMPTION

Table 2 describes one typical integrated circuit (IC) breakdown for the first CAI handsets, which are expected to reach the market in early 1990. We estimate the total semiconductor content to be $51, giving an I/O ratio of 20 percent, which is high compared with that of other consumer electronic products.

The expensive radio frequency (RF) hybrid receiver module is a major candidate for cost reduction, which could be accomplished by integrating it into one or two ICs. Funded by British Telecom, one leading U.K. IC vendor is believed to have accomplished this using zero intermediate frequency (IF) techniques to reduce the input stages to a single BiCMOS full-custom IC.

Table 2

Estimated Semiconductor Content for an Early CAI CT2 Handset

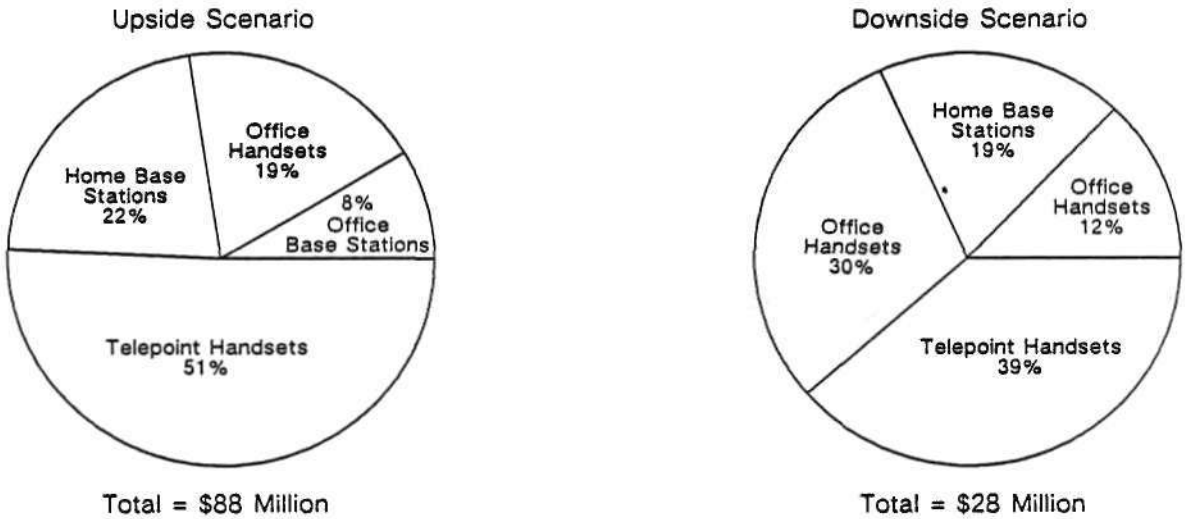
Function	Technology	Cost
4-bit microcontroller with special features	Standard CMOS	$ 3.50
27256 UV EPROM	Standard CMOS	4.00
Burst mode logic	CMOS ASIC(s)	3.50
RF receive circuit	Bipolar hybrid	20.00
G.721 ADPCM	Standard CMOS	14.00
CODEC	Standard CMOS	3.00
RF front end	RF MOSFET discretes	1.70
7-segment LCD driver	Standard CMOS	1.00
Total Semiconductor Content		$ 50.70
Average Selling Price		$250.00
I/O Ratio		20.3%

Source: Dataquest
July 1989

Other opportunities exist to integrate standard parts (LCD driver, MCU, PLL/synthesizer, CODEC, ADPCM). For example, the integration of the standard CODEC and ADPCM parts into a single IC not only reduces IC count, but also eliminates unnecessary features, thereby reducing power consumption. Given a strong market, we estimate that these and other cost reductions will squeeze the semiconductor content to $29 by 1992, leading to a less expensive and more compact product. Figure 2 presents our estimation of the breakdown of IC revenue by CT2 equipment type in 1992, according to each point of view.

Figure 2

Estimated IC Consumption Breakdown by
CT2 Equipment Type—1992



0003915-2

Source: Dataquest July 1989

The Players

Our forecast of who the players will be in the CT2 equipment market is as follows:

- First movers: Expected product announcements from second quarter of 1989 to second quarter of 1990—Ferranti Creditphone, GEC-Plessey Telecommunications, Shaye Communications, STC Telecommunications
- Later entrants: Possible announcements from third quarter of 1990—Alcatel, Autophon, Bosch, Crouzet, Ericsson, Matra, Motorola, NEC, Nokia-Mobira, Orbitel, Panasonic, Philip, Samsung, Sony, Uniden

The first handsets, non-CAI and for the United Kingdom only, will be announced by Ferranti and Shaye within the next few weeks. CAI units will go on sale in mid-1990, and initially come from those companies that participated in the CAI's development last year. These companies will continue to derive some temporal advantage from the standard's ambiguity in certain areas, despite the fact that it has been public for some weeks. The combined production plan for these firms alone is aggressive, building from 60,000 pieces per month in late 1990 to nearly 200,000 per month by 1992.

In the longer term, considerable Far Eastern interest is expected because CT2 is attractive as a global consumer product, and because Japan is considering similar cordless telepoint networks. Their presence is likely to fragment the market from the beginning, with European manufacturers opting to develop higher-margin products for the office market, and Far Eastern companies supplying the consumer segment of products.

DATAQUEST CONCLUSIONS

CT2's main application will be handsets for use with telepoint services, but its technical strengths will make it suitable for use in office environments where CT1 technology previously has failed. We expect CT2 handsets and base stations to make inroads mainly into small office environments, but the advent of cordless technology for large offices must await the arrival of DECT equipment in the early 1990s.

One major future possibility is that CT2 or its DECT successor might provide an alternative to the local loop that connects local exchanges to subscribers' premises. This is most conceivable in the United Kingdom, where the local telecommunications regulatory body, Oftel, has already expressed its desire to further break British Telecom's near-total monopoly of the public telephone network. A removal of the restriction on its four telepoint operators prohibiting incoming calls would create an enormous new opportunity for these consortia, resulting in a significantly greater market for CT2 equipment in the United Kingdom than was forecast in either scenario.

We believe that designers of CT2 handsets must avoid the temptation to target both telepoint and office users with the same product. The features sought by each group of users may prove mutually exclusive. Telepoint handsets will sell on the basis of compactness, style, and price, whereas office users will seek durability and functionality.

Judging from the large number of interested players, we expect the telepoint market to be extremely competitive. Cost reduction through mass production will be critical for success. This will favor many of the powerful potential later entrants to the CT2 market that we identified earlier. In contrast, we expect the office markets to be more differentiated and to offer safer, albeit smaller, opportunities for the smaller first movers manufacturers to tailor CT2 equipment to individual PBXs and office systems.

Jonathan Drazin

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EISA—WILL IT BE AN ALTERNATIVE FOR MCA?

SUMMARY

An alternative to IBM's microchannel architecture bus structure (MCA) was announced by a group of PC competitors on September 13, 1988. Support for the enhanced industry standard architecture (EISA) bus has been widely endorsed by PC vendors, hardware manufacturers, and software vendors.

This announcement has caused a strong reaction in the marketplace, with uncertainty as to which architecture to support. Businesses need to plan for the future, and the issue of whether to purchase MCA systems now or wait for EISA systems to become available is an important one. Dataquest believes that there will be some clear winners and losers with the EISA announcement and that the end result will be two "standards" playing to a confused customer base in the short term and a single MCA standard in the long term.

BACKGROUND

EISA was started by several PC manufacturers, led by Compaq, that did not want to pay the royalties that IBM demanded for using its microchannel architecture. They have argued that IBM developed MCA as a strategy to increase its market share and to limit the number of manufacturers of PCs by increasing the barriers to entry for low-cost manufacturers. IBM has denied this, stating that the MCA bus was developed because of its technical superiority and its ability to meet future computing demands.

At present, there is no product that uses the features of the MCA or EISA bus. The immediate requirement is for high-speed graphics, optical storage, scanners, distributed processing, LANs, and data base management to control the masses of paper that businesses must process in a single day.

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The present ISA, or AT bus, is not capable of solving this requirement. As Bill Lowe, president of IBM Entry Systems Division, stated at last September's PCIS conference, the introduction of the EISA bus simply proves that a new bus structure is essential.

Technically, both MCA and EISA can support the same applications. Although proponents of each group claim advantages for their own design, the real question is: Which bus structure will win or will they coexist?

EISA

EISA Delivery Time

The EISA bus is in its evolutionary phase. A technical synopsis has been developed with an outline and goals stated, and each member of the consortium has listed its input and needs. Agreement has been reached as to the design of the connector used. According to the company hired by the consortium to administer the details, the finished specification is on target to be published sometime in the first quarter of this year. Work still must be done to generate the silicon, build prototypes, test and benchmark the system, and obtain agency approvals, among other things.

Once PCs are introduced with the EISA bus, third-party manufacturers of add-in products will have a forum into which to sell their products. The board manufacturers' urgency to supply EISA boards will be limited to the size of this market. As EISA systems increase in the marketplace, third-party manufacturers will then allocate resources to service those systems. This delay in shipping EISA third-party boards can only boost MCA credibility.

EISA's success will depend greatly upon the perception of when an extended bus is required. The sooner the MCA bus can demonstrate that it can satisfy new demands, the fewer buyers will wait for the EISA bus to become available. Companies are balancing today's applications with tomorrow's advances and making risk decisions as to which bus structure to follow. If a company buys a PC without the extended bus today and an application that requires the new bus becomes available before the life of the newly purchased PC is over, then it has lost. On the other hand, why make higher expenditures for PCs if they will not provide a higher payback?

The average life of a PC is five years. Typically, older products are passed down to areas with no PCs, are discarded due to failure, or are sold to employees. A system purchased today, therefore, will perform the same tasks for its life. Dataquest believes that, perhaps as early as Fall 1989 Comdex, high-speed graphics cards, communications boards, and improved disk and I/O management products will be introduced. These products will use the MCA bus because it is the only extended bus architecture at present. This will immediately place the proponents of EISA in a catch-up mode.

EISA Backward Compatibility

According to its advocates, EISA's main advantage is its backward compatibility for the customer. Customers have large investments in LAN cards, communication boards, and peripheral products that can be moved to newly purchased systems.

Dataquest does not agree that this issue is strong enough to dis ıade businesses from purchasing a different bus architecture, for the following reasons:

- Because older systems are passed down intact to areas hat were previously devoid of PCs, businesses do not have surplus boards avail ıle.
- The new systems probably contain standard features that ere options on older systems.
- The third-party board manufacturers have added new fea res and functions to their products, which makes upgrading attractive.

These factors were amply demonstrated when the PC AT s tem was introduced. Imagine placing a 10MB, 85ms hard disk drive running on an 8-bit c ıtroller into the AT, or doing CAD/CAM with a CGA monitor driven by the original col card in an effort to save money.

Although backward compatibility is feasible with EISA, Dataqı st believes that in a business environment, the bus layout will not significantly alter sa s—provided support products, third-party boards, and peripherals are competitivel priced and readily available. The total system price and the support product avail ıility will ultimately determine which product will sell.

An important underlying issue is the question of who sets e standards for PC compatibility. Until now, IBM has been the standard, the model for the PC clonemakers. IBM has had control over the direction of this indu ry, even as it loses market share. Will the EISA consortium, led by Compaq, be cap ıle of breaking from this tradition to establish and maintain a new standard? Whose EIS machine will define the compatibility standard for the other consortium members? V ll it be Compaq's or will it be the first EISA machine on the market (if it is not Compa s)? The answer lies in the ability of Compaq to lead and to maintain the support, coop ation, and respect of the consortium members.

EISA Second Sources

Many companies selecting PCs prefer to have multiple s ırces for the same product. The number of PC manufacturers supporting the EISA bı makes the EISA PC attractive for this reason. Dataquest believes that this is an espe ally critical area to watch—to ensure that the EISA bus is identical from one PC to ano er.

The potential exists for one manufacturer to "improve" on eatures to leverage market share, as in the case, for example, of expanded memory. prominent group of companies developed an approach to use memory in protected m le to "stretch" real mode memory so that larger spreadsheets could be manipulated. I tead of staying with this scheme, another company developed a similar but different s ıeme with different features. Now, both Expanded Memory System (EMS) and Enhan d Expanded Memory System (EEMS) memory management techniques exist.

MCA Delivery Time

IBM has been shipping MCA bus PCs since April 1987. Dataquest estimates that 1.5 million MCA-based systems will be installed by the end of 1988. Thus, companies that expect to have new applications for their PCs do not have to wait for a PC with the MCA bus to be developed.

Dataquest believes that third-party manufacturers of application hardware initially will concentrate their resources on MCA-based PCs, simply because of the large marketplace into which they can sell product. Strong development of products using the MCA bus will place the EISA bus in a catch-up mode.

MCA Backward Compatibility

MCA's disadvantage is that is is not compatible with the nearly 33 million MS-DOS PCs shipped since 1983. However, Dataquest does not view this as a strong justification for not purchasing the MCA PC for the reasons stated earlier. Those reasons are: the requirement to use existing PCs intact, the desire to upgrade to the new features and functions offered by third-party boards, and the fact that certain features are now standard on new PCs.

MCA Second Sources

Several companies have announced plans to ship MCA PCs or have announced that they are already shipping them. These companies, which are members of the EISA consortium, have stated that, one way or another, they will satisfy the customer. The argument that there is only one vendor for MCA has therefore been eliminated.

Apple's success is another illustration that shows the fallacy of the argument that companies are reluctant to purchase products from a sole source. Although it has a completely noncompatible bus and operating system and is the only company producing the product, Apple holds the number two spot behind IBM with an estimated 14.5 percent of the 1988 U.S. market.

MARKET PARTICIPANTS

To examine the success or failure of EISA or MCA, the participants must also be examined.

IBM

Dataquest believes that IBM holds the winning hand in this card game. It is in a good position to influence the outcome of the EISA/MCA challenge and can sway the business community to embrace MCA. Our analysis is based on the following factors:

- EISA may not be available from PC manufacturers for 9 to 18 months. This gives IBM time to introduce products that can take advantage of MCA, and to establish a user base. The sooner useful MCA applications hit the market, the greater the market share MCA will capture.

- Although it has stated that the royalty structure will remain in place, IBM always has the option of changing its mind, if it becomes beneficial.

- Companies that have a universal cross-licensing agreement in place with IBM may not be required to pay the same royalty fees as companies that do not. This makes it more attractive for those companies to manufacture MCA-based PCs.

- It is being debated whether EISA or MCA, in the current configurations and environment, is technically superior. We believe that the issue is really which architecture will perform best in the future.

  - An expected requirement is the ability to expand to a 64-bit data path and handle processing speeds above 40 MHz.

  - ESIA will have problems with both the physical accommodation of a 64-bit bus and the electrical noise associated with high-speed processors.

  - IBM has the time and the option to redesign the current MCA to eliminate the debate and to clearly differentiate performance before the first EISA machine is even shipped.

- Most importantly, whereas MCA exists now, EISA is, at present, vaporware.

Compaq

Compaq Computer will hold an estimated 3.4 percent U.S. market share of personal computers shipped in 1988. Compaq is also the leader of the EISA consortium, and we believe that it holds enough market share and following to make EISA a viable product. It was the first company to introduce an 80386 PC and continues to be a leading force in the industry.

Dataquest believes that Compaq will follow through and introduce EISA regardless of how the rest of the PC industry reacts to extended bus architectures. In fact, Compaq has announced that, as of April 21, it will sever its relationship with Businessland. Businessland has stated that it may back only MCA technology; although Compaq denies that this caused the rift, many analysts believe otherwise.

EISA Consortium

Dataquest believes that the EISA Consortium is very serious. It is well organized and well supported by the members. Nevertheless, it faces an uphill battle against MCA with obstacles that IBM will exploit at every opportunity.

The first obstacle is that the EISA standard is being formed by a group of competitors anxious to increase their own market shares in an extremely competitive market. Even with the common interest of EISA, it is hard to believe that any group of competitors with a common goal will stay together. Any fragmentation in the ranks will be quickly noted by IBM.

A second obstacle is one of economics. Members of the EISA consortium will hedge their bets and will develop, or already have developed, MCA PCs, and will actively market them. This is partially because of the effort they have already put into cloning MCA systems and partially because of the fear of being caught without an extended architecture product if EISA stalls. Tandy, for example, is shipping MCA products now. John Roach, president and CEO of Tandy, stated at Dataquest's PCIS Conference that he would be ready to satisfy his customers whether they wanted MCA or EISA product. Dell also has announced that it has MCA systems. Companies with MCA systems that are shipping now, or will be very shortly, are ALR, Dell, Mitac, Olivetti, and Tandy.

The Winners and the Losers

The Winners

Dataquest believes that, provided Apple Computer can capitalize on its stable NuBus platform, it will be a clear winner as a result of the chaos caused by multiple PC bus standards. Corporations vacillating between the Apple and the IBM product will purchase Apple because it has a viable 32-bit bus technology without competitive confusion. Other winners will be the third-party board manufacturers that will sell their products to both buses—MCA and EISA. Board vendors view the two standards as expanded opportunities. They see the MCA and EISA markets as a larger total market that offers increased opportunities for selling their products. Certainly, Microsoft will win as it is hardware independent and will sell products to both MCA and EISA-based PCs.

The Losers

The losers will be the public, which ultimately will pay the price for this confusion, and the manufacturers, which must invest limited funds into both standards. Designing two products is costly because of development time, distribution and revision changes, service, and repair.

DATAQUEST CONCLUSIONS

Dataquest thinks that IBM will react strongly to the introduction of EISA in the following ways:

- Introducing applications—possibly at Fall 1989 Comdex—that use the unique characteristics of the microchannel architecture

- Encouraging companies with cross-licensing agreements to introduce MCA products quickly and offering assistance to third-party vendors in order to increase the use of MCA

- Squeezing PC-clone vendors by lowering prices to make MCA PCs more attractive

- Seizing every opportunity to discredit the viability of EISA, as members of the EISA group introduce MCA products

However, Dataquest believes that IBM will reduce its licensing fees for MCA technology only as a last resort.

In the near term, we expect sales of MCA-based PCs to increase because of the creditability given to a new bus structure by the PC-clone manufacturers. In our opinion, IBM's influence, EISA's late entry, and fragmentation within the EISA ranks will hinder the acceptance of EISA systems. Compaq's strong influence and determination ensure that MCA systems and EISA systems will coexist in the market, at least in the intermediate term, with MCA products gaining market share as other vendors offer MCA systems. EISA will survive as a bridge, to extend the use of the current installed base of XT and AT machines. In the long term, however, Dataquest believes that EISA will not meet the challenge of future performance and expandability requirements and that this market will become a shrinking niche market, serviced by only a few surviving vendors.

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Jennifer Berg
Robert Charlton

Dataquest

Conference Schedule

1989

Semiconductor User/ Semiconductor Application Markets	February 27–28	Le Meridien Hotel San Francisco, California
Japanese Components	April 20–21	Tokyo Bay Hilton International Tokyo, Japan
Computer Storage	April 26–28	The Doubletree Hotel Santa Clara, California
Document Processing	May 16–18	Monterey Sheraton Hotel Monterey, California
Copiers	May 16–17	
Printers	May 16–17	
Electronic Publishing	May 18	
Imaging Supplies	May 18	
Color	May 18	
SEMICON/West Seminar	May 24	The Dunfey Hotel San Mateo, California
Telecommunications	June 5–7	Silverado Country Club Napa, California
European Components	June 7–9	Park Hilton Munich, West Germany
Asian Semiconductor and Electronics Technology Seminar	June 28	Radisson Hotel San Jose, California
Financial Services	August 22–23	The Doubletree Hotel Santa Clara, California
Technical Computing and Applications	September 11–13	The Doubletree Hotel Santa Clara, California
European Copying and Duplicating	September 18–19	Majestic Hotel Cannes, France
Western European Printer	September 20–22	Majestic Hotel Cannes, France
Taiwan Conference	September 25–26	Grand Hotel Taipei, Taiwan
Distributed Processing	September 26–28	The Doubletree Hotel Santa Clara, California
SIA/Dataquest Joint Conference	September 27	Santa Clara Marriott Santa Clara, California
Information Systems	October 2–6	Tokyo American Club Tokyo, Japan
Semiconductor	October 16–18	Monterey Sheraton Hotel Monterey, California
Asian Semiconductor and Electronics Technology	November 2–3	Kunlun Hotel Beijing, China
European Telecommunications	November 8–10	Grand Hotel Paris, France
European Personal Computer	December 6–8	Athens, Greece

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Research Newsletter

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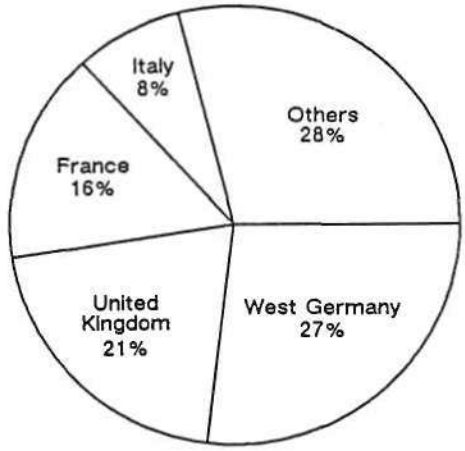
EUROPE—A HEALTHY MARKETPLACE FOR UNIX

INTRODUCTION

The Western European UNIX market is developing rapidly and becoming an increasingly significant part of the European computer market as a whole. In 1987, total Western European computer shipments amounted to $22.4 billion. Of this, $2.6 billion were UNIX systems, accounting for 12 percent of the market. The UNIX systems distribution by country is shown in Figure 1.

Figure 1

European UNIX Computer Shipments by Country 1987



Total – $2.6 Billion

0003656-1

Source: Dataquest
April 1989

Background

The UNIX penetration into Europe largely has followed the historic path of the introduction of Information Technology there. For example, the United Kingdom is the favorite entrance point for U.S. technology. As a result, the United Kingdom has 21 percent of the Western European UNIX market, but only 17 percent of computer shipments as a whole, with particularly strong presence in the small department computers (SDCs) sector. (See Attachment A for Dataquest's computer market definitions.) Despite the United Kingdom's early development, it is now Germany that leads Europe in UNIX systems shipments with 27 percent. This is mainly because of the heavy promotion of UNIX on Siemens' systems over the last two years, primarily in the work group (WG) computers marketplace. While France's position in the UNIX market is very similar to its position in the market as a whole, Southern Europe has been slower to adopt UNIX; in particular, the Italian market has fallen behind, with only 8 percent of UNIX shipments compared with 13 percent of the total market. Dataquest expects the Italian market to adopt UNIX as a standard over the next few years.

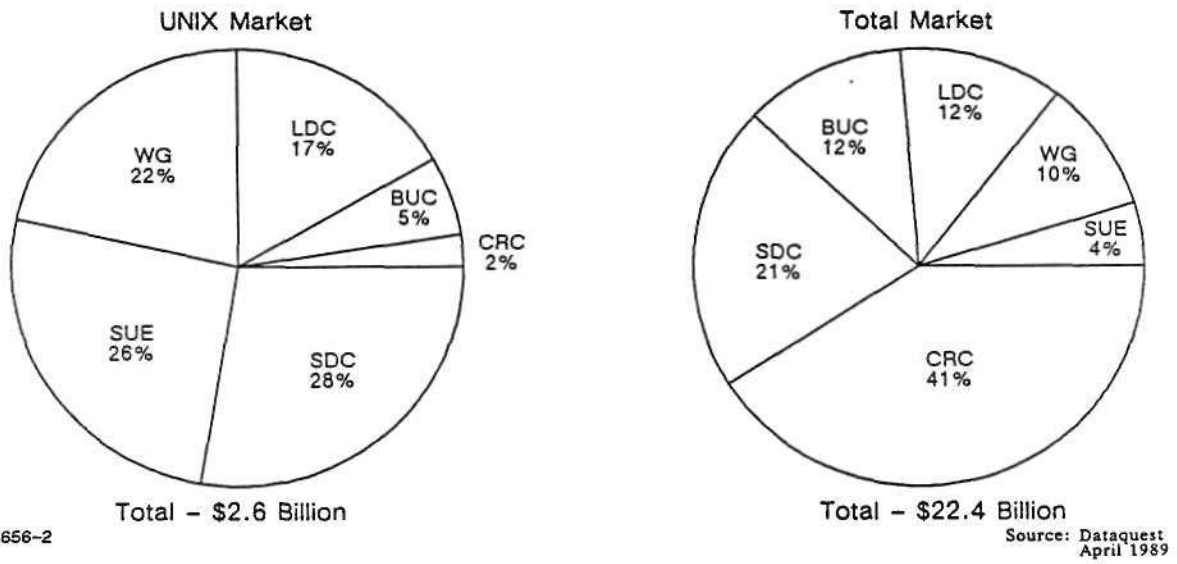
MARKET OVERVIEW

The structure of the UNIX market is determined by the nature of the machines running the operating system. As can be seen in Figure 2, UNIX systems shipments show a very different profile than the computer market as a whole. The most dramatic difference is in the corporate resource computers (CRCs). Whereas these constitute 41 percent of 1987 shipment value for the market as a whole, only 2 percent of UNIX systems revenue came from this segment. Very few large systems run UNIX; the exceptions are mostly supercomputers that have average systems values of twice the norm. Even the business unit computers (BUCs), which constitute 12 percent of the total market revenue, have only 5 percent of the UNIX market. On the other hand, single-user enhanced (SUE) systems have 26 percent of the UNIX market, though they constitute only 4 percent of the total market.

CRCs and BUCs constitute 53 percent of the total market but only 7 percent of the UNIX market. The high-value CRC market is dominated by IBM with a share of more than 55 percent, increasing to two-thirds of the market if IBM compatibles are included. UNIX usually operates as a guest operating system in the CRC market, so IBM's major revenue base is not threatened by UNIX. However, the CRC market is not forecast to grow as fast as midrange systems.

Figure 2

European Computer Market and UNIX Market by Segment
1987



Major Participants

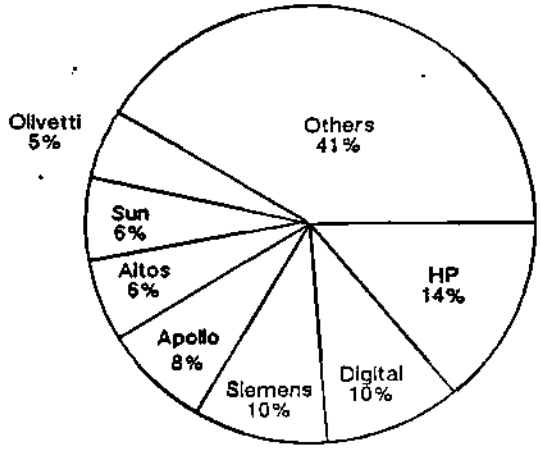
Figure 3 shows the major participants in the UNIX market. The largest vendor is Hewlett-Packard (HP), mainly because of its technical workstation sales. In this category, HP has a 36 percent share. HP's sales of large department computers (LDCs) are also significant; its market share is twice the size of any other company in this group. Although HP has a significant presence in most European countries, it is particularly strong in Germany. HP's strong commitment to UNIX is evident by its investment in a RISC-based architecture optimized for running UNIX. With 42 percent of the company's shipments currently being UNIX systems, it is in a strong position to benefit from future UNIX market growth.

HP's strength in Germany has helped that country become the largest in the European UNIX marketplace, but the major reason has been Siemens' use of UNIX in its line of departmental systems. More than 70 percent of Siemens' UNIX revenue comes from the WG sector, where it has a third of the European market, and the rest from SDCs. However, fully 70 percent of the company's sales have been in Germany.

Digital Equipment Corporation's UNIX penetration is spread throughout Europe mainly because of its midrange systems strength. More than 10 percent of VAXs run Ultrix; however, this means that nearly 90 percent of VAXs are running VMS, to which Digital remains heavily committed. This accounts for Digital's cautious approach to UNIX, while embracing open systems developments.

Figure 3

European UNIX Computer Shipments by Vendor Market Share
1987



Total - $2.6 Billion

0003656-3

Source: Dataquest
April 1989

Altos is a UNIX specialist, supplying UNIX systems at the lower end of the market. The majority of these are in the WG sector, where Altos is the only significant competitor to Siemens in Germany, and the rest in the SDC sector, where Altos is the leading supplier in the United Kingdom. Altos's share of the UNIX market inevitably will fall as the other major vendors grow their UNIX bases.

Sun's 6 percent share of the UNIX market falls entirely within the SUE sector where it has a quarter of the market. This is a sector in which the company competes with HP; whereas HP dominates in Italy and Germany, Sun has the largest share in France and the United Kingdom. Apollo, Digital, and other vendors are also aiming for the SUE market and are standardizing on UNIX.

Olivetti's strength in the UNIX market is in departmental systems, particularly the SDCs, where it has more than half of the Italian market. The company's commitment to UNIX started with the AT&T 3B systems and now includes the LSX line. It supplies both its own proprietary operating system (MOS) and UNIX on the LSX line. New applications are being developed for the UNIX environment, while MOS users are offered a growth path from their current systems to LSX. Olivetti also sells an AT&T version of UNIX on its 3B Series. In fact, these systems represented all of Olivetti's UNIX sales in 1987. In 1988 and beyond, the 3B Series will be phased out in favor of the LSX Series.

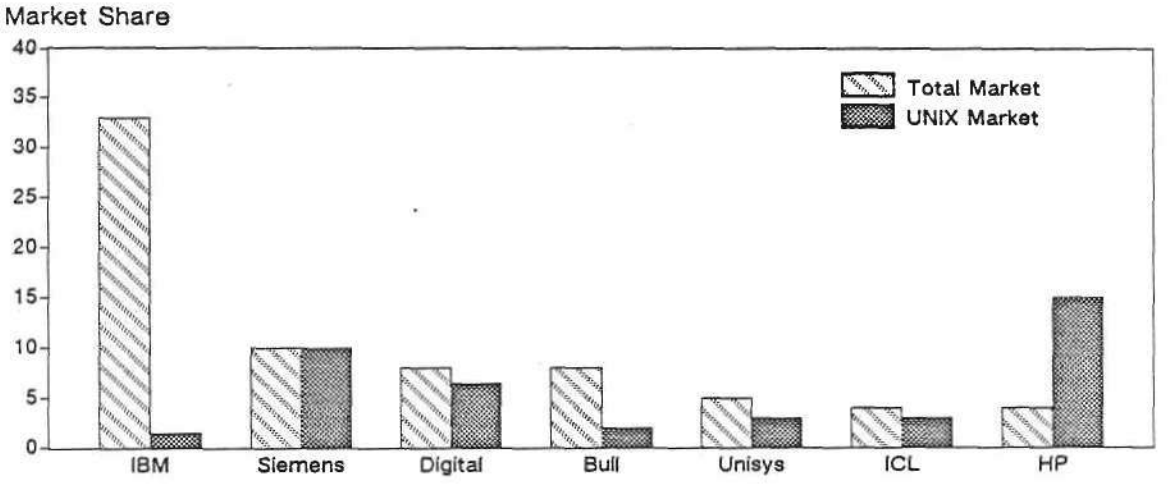
NCR, like Altos and Siemens, is prominent mainly in the SDC and WG sectors of the UNIX market. Its presence in the SDC market is particularly significant in Scandinavia where the Tower system is selling well. In the WG market, it is the largest UNIX supplier in France, Italy, and the United Kingdom.

A GROWING MARKET

The significance of the UNIX marketplace to the major systems vendors is clearly shown in Figure 4. The total Western European computer systems market is expected to grow at an 8 percent compound average growth rate (CAGR) between 1987 and 1991. For UNIX systems shipments, the equivalent figure is 25 percent. By 1991, the total systems market will likely be worth $31 billion and the UNIX market $6 billion, which means that the UNIX systems share of the market will increase from 12 to 19 percent, as can be seen in Figure 5.

Figure 4

Selected Vendors' Share of Systems Shipped
Total Market and UNIX Only
1987

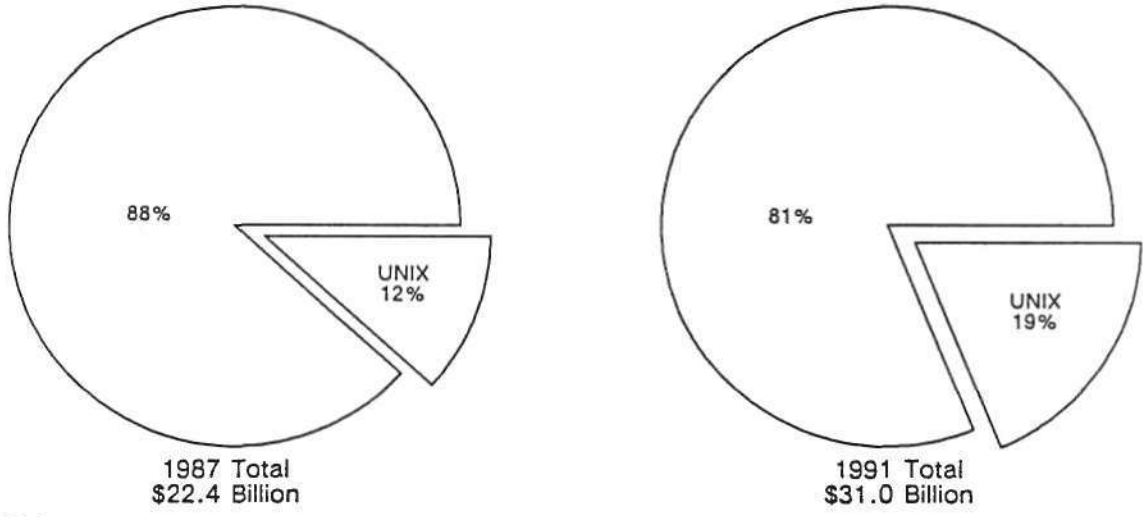


0003656-4

Source: Dataquest
April 1989

Figure 5

UNIX Systems' Share of Total Systems Market
1987 and 1991



UNIX is primarily used on low-end and midrange systems. These systems are expected to show higher growth than larger systems in the next few years. The proportion of these systems running UNIX is expected to increase. These factors result in a forecast growth rate of 25 percent for UNIX systems. UNIX therefore is highly attractive to the many vendors who are finding it difficult to maintain high levels of growth.

Much of the activity in the UNIX market will be concentrated around IBM and Digital sites, since they have very large customer bases in the European market. Many of their large users will see UNIX as a means to compatibility, portability, and a wider choice of software with less dependence on any one supplier. This is a threat to IBM and Digital. Third-party solutions are essential to penetrate vertical markets, and third-party software developers are attracted to the UNIX environment for similar reasons to the users. Nevertheless, IBM and Digital are large enough to attract large numbers of third parties for their proprietary AS/400 and VAX architectures. Other systems vendors in the main are turning to UNIX as a means to participate in the fast-growing midrange market.

Sales Channels

Two key factors in the UNIX marketplace are therefore vertical markets and the use of third-party sales channels. The use of third-party channels will greatly aid niche market penetration and enhance vendors' vertical market strengths. It is also apparent that there will be a different rate of acceptance of UNIX in the different industry markets.

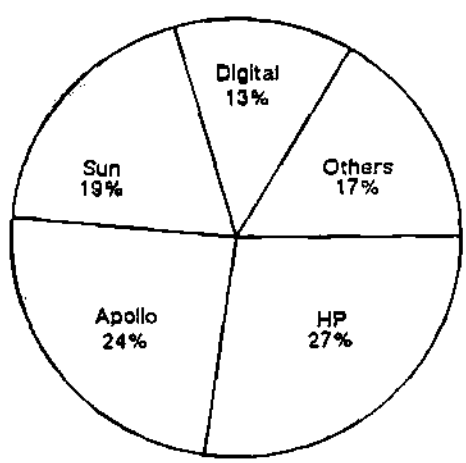
TECHNICAL WORKSTATIONS

Substantial benefits are to be had from penetrating particular market segments effectively. Figure 6 shows the vendor shares of the technical workstation market, which is particularly significant as it is a very fast-moving and fast-growing market. Of the total end-user market value of $0.8 billion, more than 75 percent is UNIX-based. From 1987 to 1992 the total market is expected to grow in revenue at a CAGR of nearly 32 percent. With the average 1987 unit price value falling to less than one-third during this time, the unit shipment growth runs at more than a 60 percent CAGR.

HP is the technical workstation market leader. Apollo also has achieved significant penetration, mainly through its vertical market emphasis. However, it is estimated that Sun, with more than double Apollo's UNIX shipments, took over second place in 1988 and is challenging HP for leadership. Digital is also rising fast in this market, although most of its technical workstation shipments have not been UNIX-, but VMS-based, to be used by its very large VMS user base. Both HP and Digital are benefiting from their third-party reseller networks through which many technical workstations are sold; HP in particular is doing relatively better in Europe than in the United States.

Figure 6

Western European Technical Workstation Market by Vendor Market Share 1987



Total - $0.8 Billion

0003656-6

Source: Dataquest April 1989

DATAQUEST ANALYSIS

The issue of UNIX standards also will affect the future market growth. The greater the development of common standards, the greater the portability of UNIX—its major selling point. Standards are derived through industry development and vendor agreement, such as the X/Open initiative.

Considerable disarray exists in the UNIX standards arena at the moment, along with considerable controversy about the control of the development of the UNIX standard. AT&T's reluctance to give up control of the standard resulted in the formation of the Open Systems Foundation (OSF). However, many significant vendors chose not to join OSF for a variety of reasons including the choice of the precise version of UNIX to be the basis of OSF's standard. Recently, most if not all major systems vendors that were not active in OSF have come together in an alternative grouping code-named Archer. AT&T is part of Archer.

DATAQUEST CONCLUSIONS

The key difference between the two forces attempting to shape future UNIX standards is that they have chosen different versions of UNIX. It is nevertheless hoped that they will reach a compromise as no doubt exists that there is very strong demand for a single UNIX standard. Failure to provide a single standard will undoubtedly hinder growth in the UNIX market.

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Bipin Parmar
Philippe de Marcillac

Attachment A

The Dataquest market segment definitions are as follows:

- Corporate resource computers (CRCs)
  - These systems are large-scale computers capable of supporting more than 128 concurrent users and supporting the central data processing needs of a large organization or the needs of a smaller number of users performing computationally intensive applications.
  - CRCs require the support of dedicated personnel.
  - Current pricing typically exceeds $1 million.
- Business unit computers (BUCs)
  - These systems are medium- to large-scale computers that typically support from 65 to 128 concurrent users and serve the data processing needs of a large business unit or organization, or they serve the central data processing needs of a smaller organization with equivalent requirements.
  - BUC systems may also support a smaller number of users engaged in computationally intensive applications.
  - BUC systems require limited support personnel.
  - Current pricing typically ranges from $150,000 to $1 million.
- Large department computers (LDCs)
  - These systems are medium-scale computers that typically support from 21 to 64 concurrent users and serve the data processing needs of a large department in a large organization or the central data processing needs of a smaller organization with equivalent requirements.
  - They also may support a smaller number of users performing computationally intensive applications.
  - LDC systems require limited support personnel.
  - Current pricing typically ranges from $75,000 to $250,000.

- Small department computers (SDCs)
  - These systems are small- to medium-scale computers that typically support from 11 to 20 concurrent users and serve the data processing needs of a department in a large organization or the central data processing needs of a small organization with equivalent requirements.
  - They may also support a smaller number of users performing computationally intensive applications.
  - SDC systems usually require no dedicated support personnel.
  - Current pricing typically ranges from $25,000 to $75,000.
- Work group computers (WGCs)
  - These systems are small-scale computers that typically support from 2 to 10 concurrent users.
  - They have resident multiuser capability and are commonly referred to as multiuser microcomputers.
  - These systems require no dedicated support personnel.
  - Work group computer systems are typically priced at less than $25,000.
- Single-user enhanced (SUE)
  - These systems are standalone general-purpose systems with integrated graphics and extensive network interfaces.
  - They support only a single user.

Technical computer systems are segmented by product into the following categories:

- Supercomputers
  - Supercomputers are designed for extremely high-speed mathematical computation and optimized to perform vector mathematics.
  - They must perform scientific applications using 64-bit floating-point arithmetic at peak speeds of 100 mflops or higher.
  - Supercomputers are typically priced between $1 and $20 million.

- Minisupercomputers
  - Minisupercomputers are designed for high-speed mathematical computation, and most have the architecture to perform vector mathematics.
  - Minisupercomputers must perform some scientific applications using 60- or 64-bit floating-point arithmetic at a speed at least one-fourth that of a Cray-1/S.
  - Pricing typically ranges between $300,000 and $2 million.
- Mainframes
  - Mainframes have at least a 32-bit CPU and I/O structure with very large capability.
  - They are typically priced at more than $500,000 and are designed for batch processing or a large number of users.
  - Mainframes support a large number of disks and tapes.
- Superminicomputers
  - Superminicomputers have a CPU-to-memory data path and a CPU bit width greater than 24 bits (usually 32 bits).
  - They are priced between $20,000 and $600,000.
- Technical workstations
  - Technical workstations are complete standalone general-purpose systems or distributed network-based systems that contain integrated networking capabilities in the operating system.
  - Technical workstations contain graphics controllers integrated on the system bus.
  - They have a resident operating system and local programming capability, and they are typically priced at less than $75,000.
  - This category fits directly into the single-user enhanced computer system market segment.

Dataquest

Conference Schedule

1989

Semiconductor User/ Semiconductor Application Markets	February 27–28	Le Meridien Hotel San Francisco, California
Japanese Components	April 20–21	Tokyo Bay Hilton International Tokyo, Japan
Computer Storage	April 26–28	The Doubletree Hotel Santa Clara, California
Document Processing	May 16–18	Monterey Sheraton Hotel Monterey, California
Copiers	May 16–17	
Printers	May 16–17	
Electronic Publishing	May 18	
Imaging Supplies	May 18	
Color	May 18	
SEMICON/West Seminar	May 24	The Dunfey Hotel San Mateo, California
Telecommunications	June 5–7	Silverado Country Club Napa, California
European Components	June 7–9	Park Hilton Munich, West Germany
Asian Semiconductor and Electronics Technology Seminar	June 28	Radisson Hotel San Jose, California
Financial Services	August 22–23	The Doubletree Hotel Santa Clara, California
Technical Computing and Applications	September 11–13	The Doubletree Hotel Santa Clara, California
European Copying and Duplicating	September 18–19	Majestic Hotel Cannes, France
Western European Printer	September 20–22	Majestic Hotel Cannes, France
Taiwan Conference	September 25–26	Grand Hotel Taipei, Taiwan
Distributed Processing	September 26–28	The Doubletree Hotel Santa Clara, California
SIA/Dataquest Joint Conference	September 27	Santa Clara Marriott Santa Clara, California
Information Systems	October 2–6	Tokyo American Club Tokyo, Japan
Semiconductor	October 16–18	Monterey Sheraton Hotel Monterey, California
Asian Semiconductor and Electronics Technology	November 2–3	Kunlun Hotel Beijing, China
European Telecommunications	November 8–10	Grand Hotel Paris, France
European Personal Computer	December 6–8	Athens, Greece

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Research Newsletter

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EUROPEAN PERSONAL COMPUTER PRODUCTION AND ITS IMPACT ON THE SEMICONDUCTOR MARKET

SUMMARY

European personal computer (PC) production continued to increase substantially in 1988, by 42 percent in unit terms. This was reflected in the rise of semiconductor consumption. The total semiconductor market in Europe reached $8,355 million in 1988, and Dataquest estimates that PC manufacturers consumed $955 million of this total, representing 11.4 percent.

This newsletter examines PC production and its impact on the semiconductor market with particular emphasis on:

- the effect of DRAM shortages and price increases
- expanding manufacturing locations within Europe
- semiconductor content in PCs
- future trends in semiconductor consumption by the PC sector.

INCREASED PRODUCTION DESPITE MEMORY SHORTAGES

Most personal computer manufacturers increased their unit production in 1988, despite the now well-publicized shortages of DRAM memories, and the resulting price increases. Table 1 shows Dataquest's estimates of unit PC production in Europe from 1986 to 1988 by different PC type.

Unit production of the old 8086/88-based machine continued to increase at a rate of 43 percent over 1987, and represents the largest PC platform. We expect the 286-based machine to overtake 8086/88-based machines in 1989. The 286-based machines saw a 32 percent growth in unit production in 1988, while 386-based machines are now coming of age, with an estimated 1988 unit production of 167,000, a huge 568 percent increase over 1987. We expect this trend to continue in 1989, with the official release of OS/2 operating system software. In 1988 most 386-based machines were used for network controllers, and file servers, as very few OS/2 software applications were available at this time.

Table 1

Estimated Unit PC Production in Europe
(Thousands of Units)

	1986	1987	1988	1987/88 Growth
8086/88	957	1,112	1,593	43%
286	538	815	1,072	32%
386	NA	25	167	568%
Non-compatible	288	333	404	21%
Total	1,783	2,285	3,236	42%

NA = Not Applicable

Source: Dataquest
March 1989

European PC production now provides over 60 percent of the local PC market. We would have expected a growth higher than 43 percent in unit PC production in 1988, had it not been for the DRAM shortages and price increases which badly affected several manufacturers in both production and reduced operating margins.

HIVE OF VENDOR ACTIVITY

IBM, Olivetti, and Apple are the leading PC manufacturers in Europe, and they all increased production in 1988 over 1987. Apple's production facility in Cork, Ireland is close to full capacity. Hewlett-Packard has greatly increased production at its Grenoble facility, while Zenith has also increased production at its Irish plant, and similarly NCR at its facility in Augsburg, West Germany. Table 2 provides preliminary estimates of unit production by major vendor and PC type for 1988.

Some vendors are going through a transition phase; either switching over to newer models or reassessing their market positions. Siemens and Nixdorf are at the stage where increased sales are a must to ensure viability of their local production. Bull is now integrating its business with that of Honeywell's PC business. ICL appears to have an unclear strategy and is well behind Apricot and a rapidly rising star, Research Machines, United Kingdom.

We have included Amstrad and Commodore in our market estimates of manufacturers as they purchase semiconductors locally in Europe, even though the PC manufacturing is done in the Far East. Acorn, who subcontracts its production, has shown a considerable growth, particularly in its RISC architecture model, the Archimedes, of which we estimate 15,000 were produced in 1988 out of the total 70,000 PCs produced by the company.

Table 2

Total Estimated 1988 European PC Unit Production
by Leading PC Manufacturers

		8086/88	286	386	Non-comp	Total
1	IBM	350,000	440,000	60,000	NA	850,000
2	Olivetti	350,000	200,000	15,000	NA	565,000
3	Amstrad	332,000	16,000	2,000	NA	350,000
4	Apple	NA	NA	NA	260,000	260,000
5	Hewlett-Packard	104,000	45,000	1,000	NA	150,000
6	Commodore	44,250	14,000	NA	64,000	122,250
7	Zenith	94,500	15,870	6,230	NA	116,600
8	Tulip	35,000	28,000	15,000	NA	78,000
9	Bull	38,000	32,000	5,000	NA	75,000
10	Acorn	NA	NA	NA	70,000	70,000
	Others	245,250	281,250	63,420	10,000	599,920
	Total	1,593,000	1,072,120	167,650	404,000	3,236,770

NA = Not Applicable

Source: Dataquest
March 1989

Dataquest has noticed some new trends where small manufacturers such as Kontron and Olympia are supplying OEM PCs to the industrial market. Olympia, which is owned by Daimler Benz via AEG, will increase production to satisfy the in-house needs of the holding company. Newcomers to the local production scene include Compaq and Sun in Scotland, Tandon in Austria, and Thomson, who will manufacture PCs in the old Nordmende TV factory in Germany. We have not included these four vendors in our estimates as they made no semiconductor purchases in 1988. One noticeable absentee from our list is Philips, who is a strong player in the market, but manufactures its PCs in Canada. Schneider, the former distributor of Amstrad in West Germany, will be included in our 1989 estimates; we believe that they produced 80,000 PCs in 1988, but did not purchase semiconductors from Europe.

The Japanese Absence

Japanese vendors are noticeable by their absence from our 1988 list of manufacturers. Fujitsu has started production in Spain, for OEM business, and Toshiba, the laptop PC leader, will begin manufacturing in Regensburg, Germany. We do not expect any local semiconductor purchases to be made for at least two years.

As the 1992 open European market approaches, we expect to see more Japanese vendors moving their laptop production to Europe. The only laptop PC manufacturer currently in Europe is Goupil.

ANALYSIS OF SEMICONDUCTOR CONTENT

The average total semiconductor content in PCs has more than tripled in dollar terms since 1986. Table 3 shows our estimate of semiconductor content by dollar value and PC type. Clients of Dataquest's European Semiconductor Application Market (ESAM) segment will receive an in-depth PC service section, containing details of the PC models used for the anaysis in Table 3, giving type, quantity, and average selling price of semiconductors used per PC model. For example, the model used for calculating 386 semiconductor content was the Compaq 386 Deskpro.

Table 3

Average Semiconductor Content by PC Model

	1986	1987	1988
8086/88	$150	$ 196	$ 250
286	253	269	354
386	NA	1,034	991
Non-compatible	150	180	138
Total	$553	$1,679	$1,733

NA = Not Applicable

Source: Dataquest
March 1989

Semiconductor Consumption by PC Sector

Table 4 shows Dataquest's estimates of total semiconductor consumption by the European personal computer market for 1986 through 1988. The total value of semiconductors used by European PC manufacturers rose to $955 million in 1988, almost doubling over 1987. This represented 11.4 percent of the total estimated semiconductor market of $8,355 million in Europe. Of the 94.5 percent increase in PC semiconductor demand, 42 percent resulted from increases in unit production, with the remaining 52.5 percent due to price inflation caused by shortages of key memory and microprocessor devices. We expect the price of DRAMs to come down to a more stable level in 1989 and expect to see a slower growth in demand for PC semiconductors in terms of dollar revenues.

Our preliminary analysis shows that 58 percent of all DRAMs sold in 1988 were consumed by the PC sector. These figures do not include an additional 10 percent of demand from related PC add-on board manufacturers. Clearly DRAMs are overexposed in this equipment market, a precarious situation that can easily result in a repeat of the 1984 scenario of ROM memory in the video game market.

Table 4

Estimated Total Semiconductor Consumption by Personal Computer Market (Millions of Dollars)

	1986	1987	1988
8086/88	$143	$217	$398
286	136	220	380
386	NA	26	165
Non-compatible	21	28	12
Total	$300	$491	$955

NA = Not Applicable

Source: Dataquest
March 1989

We were surprised at the comparatively low level of microprocessor exposure in the PC market in Europe, where 23 percent of the 1988 microprocessor total available market (TAM) went into the PC sector. This is due to the more balanced nature of the European market where the use of microprocessors is spread over other market sectors such as telecoms and industrial. Although exposure at the market level is relatively low, some vendors are overexposed in the PC sector.

Major vendors to the PC sector could be severely jolted by even a slight downturn in the PC market, due to factors such as:

- Price erosion in the market caused by additional plant capacity
- Inventory build-up at the dealer network
- Confusion about different bus standards for newer PC models
- A general slowdown in economic activity.

Following the general industry trend, ASIC and application-specific standard products (ASSP) devices are rapidly cannibalizing the bipolar standard logic and microprocessor peripheral TAM. The microprocessor peripheral TAM in the PC sector has fallen from 39.8 percent of the total TAM in 1986 to 24.4 percent in 1988, while the ASIC and ASSP TAM in the PC sector rose from almost zero in 1986 to 16.9 percent in 1988.

FUTURE TRENDS

The advent of markets for PCs, local area networks (LANs), disk controllers and graphics chip sets, together with single in-line memory modules (SIMM) using 4-Mb DRAM and higher-speed processors, will result in a highly integrated motherboard design. Most PC vendors currently facing increased margin pressure on their standard hardware platforms have been exploring new ways of adding further value to their boxes. The higher integration of the motherboard provides additional room for adding extra features and will permit a degree of product differentiation in the overcrowded market. Some PC vendors will incorporate PS/2, AT-compatible disk controller ICs on the motherboard, while some disk drive manufacturers will incorporate the controller board electronics via highly integrated VLSI chip sets inside the drive itself.

Dataquest expects a high explosion in the LAN market for PCs. Currently LANs are provided by a multitude of small vendors, but we expect further integration of LAN chip sets to be offered as standard features on the motherboard. Other features which will be integrated on future motherboards are modems, faxes, and high-end graphics chip sets, providing new product differentiation.

CONCLUSIONS

The European personal computer market now forms a critical driving force behind growth in the semiconductor market. It consumed almost 12 percent of the 1988 European semiconductor TAM, up from 8.2 percent in 1987. This was due both to increases in unit production and to price rises in key semiconductor memories and microprocessors. We expect the recent price increases to stabilize. The demand for semiconductors in the PC sector will continue to grow, as more use is made of highly integrated chip sets.

Bipin Parmar

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Research Newsletter

ESAM Code: Newsletters
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REGIONAL REVIEW 1989—A YEAR OF CONSOLIDATION

SUMMARY

In 1988 the European semiconductor market experienced strong growth fueled by a healthy personal computer demand and subsequent price increases, particularly in DRAM and SRAM components. Dataquest predicts that the high growth experienced in 1988 will be followed by a year of consolidation in 1989. Production rates in the data processing segment have slowed, and prices are expected to decrease in the areas of MOS memory and MOS microprocessor components. The European semiconductor market is forecast to grow by 8.6 percent in 1989.

This newsletter outlines the reasons for growth in each of the European regions in 1988 and 1989. It pays particular attention to application trends and addresses the impact that the "Single Europe Act" in 1992 is already having on these regional markets. The key points are highlighted below:

- The United Kingdom and Ireland once again outgrew West Germany in 1988. The two regions are now of almost equal size in Europe. The U.K. and Ireland market is forecast to grow at 11.0 percent in 1989 to become the largest region in Europe at $2,475 million.
- Rest of Europe experienced the largest growth of all the regions in 1988, driven by the high percentage growth in semiconductor consumption in Spain and Portugal. Rest of Europe will continue to exhibit growth well above the market average, growing 20.1 percent in 1989 to $829 million.
- West Germany grew the least of all the European regions in 1988 when measured in both dollars and local currency. West Germany is forecast to grow at 6.7 percent in 1989, approximately 2 percent below the total market growth.
- Italy will grow slightly in 1989 at 2.0 percent, having exhibited a 49.4 percent local currency growth in 1988.

Table 1 summarizes the regional growth analysis for 1988 and 1989 and Figure 1 shows the forecast percentage market share of each region in 1988 and 1989.

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Table 1

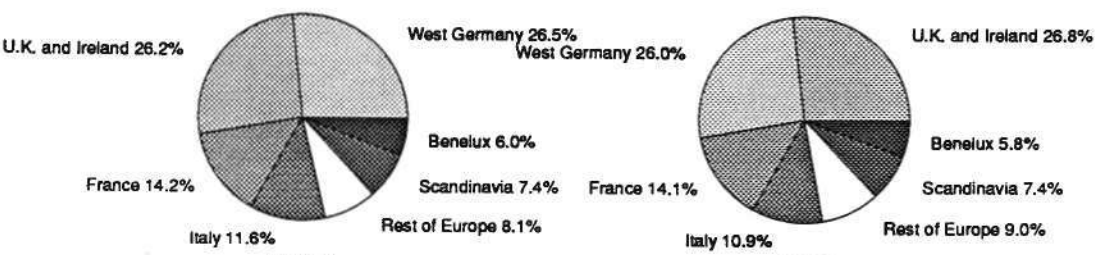
European Regional Growth Analysis
(Millions of Dollars)

				Dollar Growth		Local Currency Growth	
	1987	1988	1989	1987-88	1988-89	1987-88	1988-89
Benelux	$407	$504	$532	23.8%	5.5%	21.8%	5.5%
France	940	1,210	1,303	28.7%	7.7%	27.7%	7.7%
Italy	660	982	1,002	48.8%	2.0%	49.4%	2.0%
Scandinavia	458	625	681	36.5%	9.0%	32.3%	9.0%
U.K. & Ireland	1,570	2,230	2,475	42.0%	11.0%	30.6%	11.0%
West Germany	1,890	2,250	2,399	19.0%	6.7%	16.4%	6.7%
Rest of Europe	430	690	829	60.5%	20.1%	52.5%	20.1%
Total Europe	$6,355	$8,491	$9,221	33.6%	8.6%	29.2%	8.6%

Source: Dataquest
March 1989

Figure 1

European Regional Market Share 1988–1989
(Millions of Dollars)



Source: Dataquest
March 1989

REGIONAL SEMICONDUCTOR ANALYSIS

Dataquest's European semiconductor consumption forecast for 1989 shows Europe growing 8.6 percent over 1988. In 1989 the European market will be worth $9,221 million.

Benelux

In 1988 the Benelux semiconductor market was estimated to be worth $504 million. This represented a local currency growth of 21.8 percent over 1987. The main source of this growth was from the telecoms segment. Demand from Alcatel/Bell Telephone was particularly strong as a result of the company's strong sales to Mexico and China. An increase in PC production assist the region, along with memory and microprocessor device price inflation due to shortages. However, the large consumer total available market (TAM) was significantly impacted by Philips moving production of its compact disk player to the Far East.

The outlook in 1989 for Benelux is one of lower than average growth at 5.5 percent. With the absence of compact disk player production from the consumer segment the outlook is flat compared to 1988. The data processing sector will decline through reduced PC production and price erosion on MOS memories and microprocessor devices. Growth will again be fueled by Alcatel/Bell Telephone, and to some extent Siemens/GTE in the telecoms segment.

France

The French semiconductor market grew by 27.7 percent in local currency in 1988. This was slightly below the European market average of 29.2 percent local currency growth. The telecoms segment, which represents a major part of the region's semiconductor demand, grew marginally. The production rate of Minitel, the French videotex system, virtually halved compared to 1987. Demand for telephone switching exchanges was low and this significantly reduced semiconductor demand from Alcatel. The data processing and transportation segments were the driving forces behind the overall growth.

In 1989 the French market is forecast to grow by 7.7 percent over 1988 to $1,303 million. The telecoms segment will continue to be affected by reduced demand for switching equipment and Minitel equipment. However, France Telecom's strenuous efforts to drive ISDN will stimulate new demand in the telecoms segment. The fastest growing segments will be transportation and consumer. PSU, the electronic component division of the Peugeot Citroën Group, is considerably expanding its consumption of semiconductors, while consumer demand from Thomson is expected to be high. The data processing segment will experience low growth; Bull is still in a phase of restructuring; this, coupled with price erosion in MOS memories and microprocessors, leads us to expect to see only modest growth in the data processing segment.

Italy

The Italian market exhibited the second highest local currency growth of the seven European regions in 1988. It reached $982 million growing at 49.4 percent in local currency compared to 1987. The data processing and transportation markets exhibited very strong growth. In the data processing segment Olivetti had a bumper year, though the growth in dollar demand was obviously exaggerated by memory and microprocessor price increases. Marelli Autronica, the electronic components division of Fiat, did exceptionally well in 1988. This in turn drove a large demand for ASIC and smart power components.

Following dramatic growth in 1988, the Italian semiconductor market is expected to show a below-average growth of 2.0 percent in 1989, pushing the market size to $1,002 million. This slower growth will be due to a decline in demand from the data processing segment, coupled with price decreases in memories and microprocessors as excess inventories are burned off.

Scandinavia

Although Norway and Denmark both experienced modest growth, the positive market conditions in Sweden and Finland resulted in Scandinavia growing at 32.3 percent in local currency for 1988. In Finland, Nokia represents a large portion of the market, and Nokia's consumer division, Salora, had a particularly good year. Sweden, the largest of the Nordic countries, saw Ericsson's telecoms business grow well. The distribution market in Sweden also showed positive growth of 25.0 percent after three years of flat and declining consumption.

In 1989 Scandinavia is expected to have a positive growth of 9.0 percent over 1988, due to the positive outlook for Ericsson and Nokia in the telecoms, data processing, and consumer segments. This will boost the Scandinavian semiconductor market to $681 million in 1989.

United Kingdom and Ireland

The U.K. and Irish semiconductor market grew slightly above the European average at 30.6 percent local currency growth for 1988, reaching $2,230 million. The high demand for PCs in the U.K. market was a major contributor to the semiconductor market growth. This, coupled with the increase in prices for MOS memories and the higher average selling price (ASP) for 32-bit microprocessors, drove the market. The promises of the "Single Europe Act" and the imposition of import tariffs on Japanese printers and office equipment by the EEC during 1988 is starting to have a positive effect the semiconductor TAM, particularly in the U.K. and Ireland market. A number of Japanese and U.S. companies have either set up or announced plans to set up factories in the United Kingdom and Ireland. These manufacturers included NEC, Compaq, Oki, Citizen, Sun, and Sanyo.

The U.K. and Ireland semiconductor market is forecast to grow by 11.0 percent in 1989. With this growth it will become the largest of the seven regions in Europe at $2,475 million. Despite the reduction in demand from PC manufacturers such as IBM and Amstrad, and price erosion in memory and microprocessors, the region will still show the second largest growth in Europe mainly as a result of demand from new applications such as cellular telephony. The new manufacturers that have set up in the region, as described earlier, will also have a positive effect on the TAM.

West Germany

The West German market grew by 16.4 percent in local currency in 1988. In 1988 it was the largest semiconductor market of all regions within Europe at $2,250 million. Both the data processing and telecoms segments showed little growth. High labor rates and restrictive labor laws have encouraged German companies over the past few years to locate their manufacturing facilities outside West Germany, either in other European countries or in the Far East. The two key growth areas in the region during 1988 were consumer and transportation.

The outlook for the West German market is for below-average growth in 1989 of 6.7 percent. The data processing segment will be affected by low demand from Nixdorf as the company restructures and repositions its emphasis in the higher growth area of computers.

Following the EEC's green paper on the liberalizing of the European telecoms market, the Bundespost has entered a phase of complete restructuring. This is having a massive impact on the West German telecoms sector. As a result, demand from the telecoms segment is expected to be relatively flat in 1989. It is the consumer and transportation sectors that will show the strongest growth in 1989. A large demand for state-of-the-art color televisions and satellite receiver equipment should see the consumer segment grow by 15 percent. In transportation improved demand for high-end, electronics-filled executive cars will result in about 8 percent growth in semiconductor consumption in this segment.

Rest of Europe

Austria, Portugal, Spain, and Switzerland, which together comprise Rest of Europe, exhibited a 52.5 percent local currency growth in 1988. Their combined semiconductor markets amounted to $690 million. The basis for this growth was the rapid expansion of the equipment market in Spain and Portugal. Companies such as IBM, Ericsson, Olivetti, Alcatel, Samsung, Fujitsu, Siemens, and Philips now have manufacturing facilities in Spain and Portugal. They manufacture equipment for consumption both locally and in other EEC countries. The primary segments are data processing, telecoms, and consumer. The demand for telecoms equipment in Spain is particularly strong.

The Rest of Europe market is expected to continue to show the highest growth in 1989. Dataquest forecasts the growth at 20.1 percent over 1988, reaching $829 million. Once again growth in Spain and Portugal will drive the market; these two countries are expected to continue to attract considerable investment from equipment manufacturers wishing to set up manufacturing capability within the EEC and benefit from the source of good quality, inexpensive labor.

CONCLUSIONS

From double-digit growth in 1988, Europe and its regions will experience slower growth in 1989. However, as Europe attracts more foreign investment in electronics manufacture in readiness for a "Single Europe" in 1992, the semiconductor market is on an upbeat trend. This is particularly obvious in the United Kingdom and Ireland.

The liberalizing of the European telecoms market had a major impact on the local PTTs. Their buying patterns are changing radically and this is particularly impacting the semiconductor demand in France, Italy and West Germany.

Through mergers and acquisitions Europe now has three major consumer companies, ITT-Nokia, Philips and Thomson. The focus that they have brought to Europe is having a strong positive effect on the semiconductor market in Finland, France, Portugal, Spain and West Germany.

The data processing sector is still reeling from the strong PC growth in 1988. This, coupled with high memory and microprocessor prices, causes concern that the market may be on course for negative growth; the U.K. and Ireland market is the most exposed here.

The increased usage of electronics in cars has meant strong growth in semiconductor consumption from Bosch, Siemens/Bendix, Marelli Autronica and Peugeot Citroën. The French, Italian and West German semiconductor markets will continue to benefit from this.

The consumption of military semiconductors in France and the United Kingdom, the two main European regions, continues to be flat. The light on the horizon is the Eurofighter. Companies including Aerospatiale, British Aerospace, Ferranti, Marconi, and Thomson will all be in line to benefit from these military contracts. The outlook for 1989 is still for little or no growth in military semiconductor consumption.

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Research Newsletter

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THE EEC RULES ON "MADE IN EUROPE" —ARTICLE 5 No. 802/68 ANALYZED

EXECUTIVE SUMMARY

This bulletin examines the European Commission's new interpretation of its rules to determine the origin of integrated circuits. Dataquest believes that it will have a major impact on the European and worldwide semiconductor industries.

The Origin Rules

The "non–preferential" rules (Article 5 of the Council Regulation No. 802/68) states that "a product in the production of which two or more countries were concerned shall be regarded as originating in the country in which the last substantial process or operation that is economically justified was performed, having been carried out in an undertaking equipped for the purpose, and resulting in the manufacture of a new product or representing an important stage of manufacture".

The New Interpretation

The phrase "last substantial process or operation" has recently been interpreted by the Origin Committee to mean that "diffusion shall be considered as the last substantial operation in the manufacture of integrated circuits".

The EC defines "diffusion" as the "operation where integrated circuits are formed on a semiconductor substrate by the selective introduction of an appropriate dopant". As long as diffusion is carried out within the EC it will no longer be necessary for ICs to be assembled in Europe to qualify them as "EC sourced".

Impact on European Diffusion Plants

In future, vendors will need to perform the diffusion steps within Europe for the IC to qualify as originating from within the EEC. Dataquest expects to see a spate of cross–licences, second sourcing and foundry deals with vendors who have local diffusion plants in Europe. Vendors with world–class fab plants located in Europe (such as Philips, SGS–Thomson, Siemens and Plessey) will be able to negotiate licence and foundry deals with vendors who perform diffusion in Europe.

Intel and National Semiconductor have fab plants in Israel. Israel currently enjoys preferential trade access with the EEC; whether this will be the case after 1992 is a topic of hot debate within the EEC. It is very likely that parts diffused in Israel will carry normal EEC import tarrifs.

Dataquest believes that Europe will benefit as more U.S. and Japanese vendors introduce state-of-the-art technology and capital intensive fab plants in Europe. This we believe will increase competition and cost efficiency of integrated circuit manufacturing, as more vendors compete for larger market shares within the EEC.

Local Content

Dataquest believes that the IC origin interpretation has set a precedent for further interpretations governing the origin of partially assembled goods such as printed circuit boards. Many electronic equipment manufacturers have, so far, been able to satisfy the EC's 40 percent local content ruling by the use of local sub contractors who make printed circuit boards (PCBs) with imported ICs who invoice in local currencies. Examples are those companies that run "screwdriver" operations in Europe to assemble VCRs, photocopiers, printers or microwave ovens.

Vendors with local fabs will have a further market advantage as these "screwdriver" operations start purchasing locally-made ICs in anticipation of new rulings affecting PCBs. Over a longer term, we expect a number of vendors, mainly Japanese, will set up local diffusion plants in the face of pressure from local Japanese equipment manufacturers to supply locally diffused components.

DATAQUEST CONCLUSIONS

The new interpretation of the existing origin rule will have a major impact on both the IC market and on IC production in Europe. It will offer a multitude of opportunities to vendors to strike up licensing and foundry deals with vendors who presently have fabrication plants in Europe.

Over a longer period we expect other EC rules and interpretations to spread downstream to determine the origins of component sub-assemblies, such as PCBs. When these rulings occur, they will open up lucrative markets for IC vendors with local fabs. This could result in higher semiconductor penetration into U.S. and Japanese OEMs who manufacture in Europe.

Dataquest's European Semiconductor Industry Service (ESIS) will be regularly analyzing and reporting on the EEC directives, highlighting to our clients the ramifications that these changes will bring to the European high technology infrastructure.

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Research Newsletter

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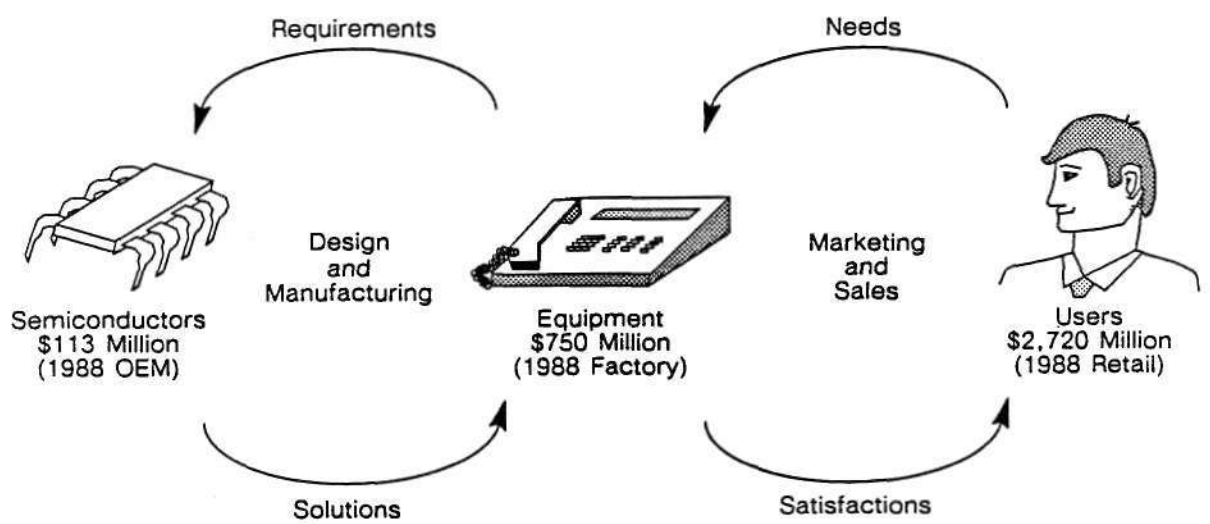
FACSIMILE MACHINES: TERMINALS TODAY, TOOLS TOMORROW

EXECUTIVE SUMMARY

A revolution in personal communications is occurring today because consumer demands and technology capabilities are now impacting each other. Figure 1 illustrates the favorable environment needed to create the type of progress that is currently happening. Equipment designers and semiconductor suppliers are presented with challenging opportunities whenever consumer needs or component technologies change or advance. This newsletter focuses on the specifics for facsimile machines from the standpoint of these concurrent and interrelated market and product evolutions.

Figure 1

Linking European Market and Product Evolution



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Source: Dataquest April 1989

Dataquest believes that continuing advancements in semiconductors will make a revolution in facsimile machines possible. End-user needs drive equipment designs, and equipment requirements drive semiconductor components. However, advances in semiconductors make better equipment designs possible, and the end users receive more value for the purchase price of the equipment. We conclude that the result will be the widespread acceptance of facsimile by the business community within the next few years, and that facsimile will be as essential to running a business as the telephone is today.

Dataquest estimates that in Europe facsimile machine prices will continue to decline at a compound annual growth rate (CAGR) of negative 8 percent; unit shipments will continue to increase at a CAGR in the 30 to 35 percent range; penetration of the business market, which was approximately 14 percent in 1988, will increase to about 80 percent in 1992; and a home market for facsimile will emerge in the early 1990s. We also forecast that, over the next decade, the capability for remote hard copy replication will become a standard feature on the deluxe models of some computer and communications equipment, such as laptop computers, laser printers, cellular telephones, and personal computers.

THE MARKETING SIDE OF FACSIMILE MACHINES

Market Estimates

Dataquest's estimate of facsimile machine sales in Europe is presented in Table 1, with estimates for 1987 vendor market share illustrated in Figure 2. Between 1983 and 1988, Dataquest estimates that unit sales increased at a CAGR of 92 percent, while the average retail price declined at a CAGR of negative 7 percent. For 1988 through 1992, Dataquest estimates that unit sales will increase at a CAGR of 33 percent, while the average retail price will continue to decline at a similar CAGR of negative 8 percent. Semiconductor content is calculated using an average input/output ratio of 4.1 percent of retail sales.

Table 1

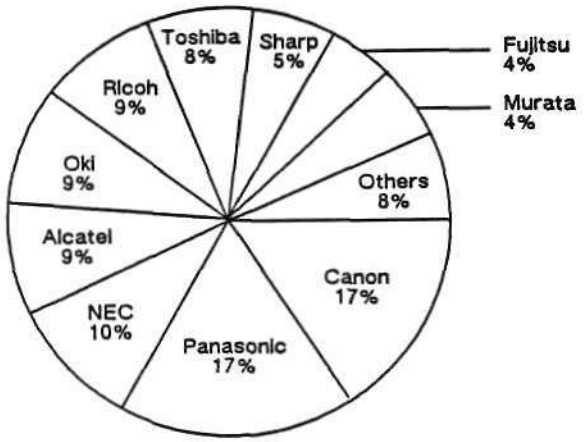
Estimated Sales of Facsimile Machines in Europe

Year	Unit Shipments (Thousands)	Average (Price)	Sales (Millions)	Total Semiconductor Consumption (Millions)
1983	30.7	$4,598	$ 141	$ 6
1984	49.9	$4,111	$ 205	$ 8
1985	86.4	$3,555	$ 307	$ 13
1986	199.0	$3,767	$ 749	$ 31
1987	433.9	$3,665	$1,590	$ 65
1988	818.9	$3,320	$2,718	$113
1989	1,289.0	$2,979	$3,839	$157
1990	1,772.0	$2,733	$4,843	$199
1991	2,194.0	$2,578	$5,656	$232
1992	2,555.0	$2,399	$6,129	$251

Source: Dataquest March 1989

Figure 2

Estimated 1987 European Market Shares
for the Facsimile Market by Shipments
(Thousands of Units)



Total = 433,900 Units

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Source: Dataquest
April 1989

User Base Expansion is Under Way

Dataquest predicts that as the retail price of facsimile machines continues to decline, these machines will begin to be located at the department level in larger companies. (We understand that most facsimile machines today are located in centralized facsimile rooms.) We also predict that in Europe the installed base of facsimile machines will increase from 1.5 million units in 1988 (or 14 percent of the 11 million business establishments) to 9 million units in 1992.

THE MANUFACTURING SIDE OF FACSIMILE MACHINES

Dataquest's estimate of the semiconductor content of economy and midrange facsimile machines is presented in Table 2. Virtually all facsimile machines today are made in Japan and meet the Group III standard of the CCITT, which means they use digital transmission techniques based on modems and require approximately 30 seconds to a minute to transmit a page of information. Facsimile machines based on the Group IV standard currently being defined will use the ISDN network and will require about 2 to 5 seconds to transmit a page of information.

Table 2

Estimated Semiconductor Content of Group III Facsimile Machines

Semiconductor Components	Economy Machines	Midrange Machines
Integrated Circuits		
Memory		
SRAM	1 (64K)	1 (256K)
EPROM	1 (256K)	1 (512K)
Microcomponents		
Microprocessor	1	1
Microcontroller	0	2
Microperipheral	1 (modem)	2 (modem, watch)
Logic		
Standard Logic	10	10
Gate Array	2	2
Linear	10	10
Discrete	51	57
Optoelectronic		
CCD	1	1
LED Array	1	1
Total Semiconductors	$124	$152
Facsimile Equipment		
Factory Cost	$696	$1,146
Retail Price	$2,510	$4,130
Input/Output Ratio (factory)	17.9%	13.2%
(retail)	4.9%	3.7%

Source: Dataquest March 1989

Facsimile machines based on the Group I or Group II standards are being retired from the installed base, and Dataquest estimates that they will no longer be in use after 1990. Group I and Group II machines use analog transmission techniques and require 3 to 6 minutes to transmit a page of information.

Component Prices Continue to Decline

The negative 11 percent CAGR reduction in facsimile machine prices is made possible in part by the reduction in numbers and prices of the components used to make the facsimile machine. For example, the facsimile modem component was a complete card in 1983, with an estimated OEM-volume price of approximately $300, and it was supplied only by Rockwell. In 1988, Dataquest estimates that this same circuit function is implemented as either one or two semiconductor components with an OEM-volume price in the $80 to $100 range, and that more than six component manufacturers have entered the market. (The facsimile modem suppliers include Hitachi, Hycom/Sharp,

Matsushita, Oki, Rockwell, Toshiba and Yamaha. Dataquest believes that SGS–Thomson will enter the facsimile modem market soon.) In 1989, Dataquest estimates that the OEM–volume price of the facsimile modem component will be reduced to the $40 to $50 range, as these component manufacturers attempt to grow their sales by competing for more design wins.

Component Functionality Continues to Increase

Another trend in facsimile machines is the use of components that can be programmed with software to perform a number of different operations. For example, the Next Computer system will use a digital signal processor (DSP) component made by Motorola that can be configured with software to be either a facsimile modem, high–speed data modem, a speech synthesizer, or a CD–quality sound generator. Dataquest believes that OEM–volume pricing for such a component will be less than $40 in 1989, and if a user needs all of these features in an item of equipment that already has a microprocessor, the equivalent cost of the facsimile modem would be just a fraction of the cost of the DSP component itself.

Facsimile component opportunities may exist also for suppliers of application–specific integrated circuits (ASICs). Dataquest believes that additional opportunity exists for the standard logic, linear, and discrete components to be further integrated into single–chip ASIC solutions, further reducing the manufacturing cost and product footprint size.

Component Technology Continues to Advance

As users are becoming experienced with facsimile , new feature–related needs are emerging that will affect the components required inside a machine. Dataquest believes that there are potential markets for facsimile machines with capabilities for color, store–and–forward memory, plain paper, error correction, local copies, gray–scale, and broadcasting. These deluxe model features will become more practical and more common as technology advancements continue to reduce their implementation costs to the point where users can afford them.

For example, the reliability and resolution of the scanning operation could be improved by changing from charged–couple device (CCD) to contact image sensor (CIS) technology. However, Dataquest believes that the cost of the CIS technology will have to be reduced before it becomes a widely accepted substitute for the CCD technology currently used in most machines. Also, the current typical transmission time of 20 seconds per page for Group III machines using the Modified Huffman coding technique could be reduced by 55 percent to about 9 seconds per page using the Modified Reed (MMR) coding technique. Memory and microprocessor components are needed to run the software programs used to implement these coding techniques, and Dataquest estimates that the prices on these components will continue to decline in general at CAGRs in the negative 5 to negative 15 percent range over the next four years.

Production in Europe

Dataquest estimates that, in 1988, only 15 percent of facsimile machines sold in Europe were also produced in Europe, giving rise to an estimated local IC consumption market of $16 million. This excludes those Japanese companies that currently operate screwdriver plants in Europe but import ICs from outside. Most of the European demand for facsimile ICs originates from Alcatel, which had a 77 percent share of the French market in 1987. However, Alcatel's local production will reduce as a consequence of its decision to label Japanese machines.

Japanese manufacturers have been accelerating overseas production since 1986 to compensate for the high yen and the selective EC antidumping duties. Unlike Japanese printers and photocopiers, facsimile machines have not been subjected to local content requirements because there is now little European facsimile manufacturing to protect. Nevertheless, Dataquest expects the proportion of local IC content in Japanese locally assembled facsimile machines to increase. This follows the EC's recent proposals to deduce point of origin according to the "most," as opposed to the "last," substantial production process. Clearly, this is intended to favor locally purchased and fabricated ICs.

DATAQUEST CONCLUSIONS

Except for the special case of videotex in France, facsimile is the fastest-growing method of text transmission in Europe. Furthermore, the number of different user types is increasing. These trends will open opportunities for vendors to identify new niche markets for facsimile equipment and services.

Facsimile Machine Sales Expected to Continue

Dataquest estimates that the maximum potential installed base for facsimile machines in the European business sector is 5 million units. Although there were an estimated 11 million business establishments in Europe in 1988, the majority of these have fewer than 10 employees. While a large company may own several hundred facsimile machines, some of the smaller companies may decide that the services of a local facsimile center are sufficient to meet their needs.

Dataquest also believes that a sizable home market for facsimile-related equipment will emerge from about 1994 on. Our estimate for the potential installed base of facsimile equipment in the home is 2 million units by 1996. Some of these home users would be telecommuters who work at home several days each month, and a facsimile machine would supplement the office-compatible personal computer systems they already use at home for their work. There were approximately 60 million white-collar workers and 137 million households in Europe in 1988, and we believe that the potential installed base of 2 million facsimile machines in the home is a conservative projection.

Dataquest believes that the application markets for facsimile components are beginning to diversify. Today, most facsimile components are used in standalone facsimile machines; we expect that application to be the major market for facsimile components over the next five years. There are, however, other application markets currently in the niche stage that could expand as additional users discover the potential benefits of these facsimile-related products.

Opportunities in Niche Markets

The declining cost of facsimile machines will result in increasing sales to the home market. Dataquest believes that the successful models will be those that satisfy the special requirements of telecommuter users. Essentially, these are to provide office facilities in the home with a maximum of economy, by offering the following features:

- Shared voice and facsimile on a single line
- Combined photocopy and printer capability—ideally, onto plain paper using laser printer technology
- Text compatibility with PC word processor users

The following two segments have emerged within the office market:

- Office workstation facsimile machines that are low in cost and small enough to sit on a desktop as an extension to a standard featurephone
- Office resource facsimile machines for general office use (These machines represent the high end of the market and are frequently second purchases to cope with rising facsimile traffic in the office.)

Long-Term Implications of Present-Day Developments

As communications networks continue to evolve throughout the 1990s, Dataquest expects that more image storage and transmission will take place electronically.

Dataquest believes that separate pieces of equipment, such as personal computers, copiers, and facsimile machines, will begin to merge during the 1990s into an all-electronic communications network. Peripherals such as scanners and printers will be attached to this network as the link to the world of hard copy. The likelihood of this happening sooner rather than later depends on how fast the business community adopts facsimile as a necessity. That acceptance depends, to a large extent, on technology continuing to find ways to reduce the manufacturing cost of a facsimile machine today.

(Some of the data in this research newsletter were supplied by Dataquest's Japanese Semiconductor Application Markets service and Telecommunications Industry Service.)

Jonathan Drazin
Anne Barbançon
Roger Steciak

Dataquest

Conference Schedule

1989

Semiconductor User/ Semiconductor Application Markets	February 27–28	Le Meridien Hotel San Francisco, California
Japanese Components	April 20–21	Tokyo Bay Hilton International Tokyo, Japan
Computer Storage	April 26–28	The Doubletree Hotel Santa Clara, California
Document Processing	May 16–18	Monterey Sheraton Hotel Monterey, California
Copiers	May 16–17	
Printers	May 16–17	
Electronic Publishing	May 18	
Imaging Supplies	May 18	
Color	May 18	
SEMICON/West Seminar	May 24	The Dunfey Hotel San Mateo, California
Telecommunications	June 5–7	Silverado Country Club Napa, California
European Components	June 7–9	Park Hilton Munich, West Germany
Asian Semiconductor and Electronics Technology Seminar	June 28	Radisson Hotel San Jose, California
Financial Services	August 22–23	The Doubletree Hotel Santa Clara, California
Technical Computing and Applications	September 11–13	The Doubletree Hotel Santa Clara, California
European Copying and Duplicating	September 18–19	Majestic Hotel Cannes, France
Western European Printer	September 20–22	Majestic Hotel Cannes, France
Taiwan Conference	September 25–26	Grand Hotel Taipei, Taiwan
Distributed Processing	September 26–28	The Doubletree Hotel Santa Clara, California
SIA/Dataquest Joint Conference	September 27	Santa Clara Marriott Santa Clara, California
Information Systems	October 2–6	Tokyo American Club Tokyo, Japan
Semiconductor	October 16–18	Monterey Sheraton Hotel Monterey, California
Asian Semiconductor and Electronics Technology	November 2–3	Kunlun Hotel Beijing, China
European Telecommunications	November 8–10	Grand Hotel Paris, France
European Personal Computer	December 6–8	Athens, Greece

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Research Newsletter

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HIGH–DEFINITION TV IN EUROPE—AN INCREMENTAL APPROACH

EXECUTIVE SUMMARY

This newsletter analyzes the critical factors necessary for high–definition television's (HDTV's) success in Europe, and discusses in detail the television receiver IC market that will follow with HDTV's acceptance.

Dataquest predicts that the European Commission, supported by local receiver manufacturers, will spurn adoption of Japan's Multiple Sub–Nyquist Sampling Encoding (MUSE) standard in favor of the European High–Definition Multiple Analog Component (HD–MAC) transmission standard. Europe's HD–MAC transmission standard will lag five years behind Japan's MUSE. It will be preceded by a number of intermediate MAC receivers, before it finally reaches consumers in the mid–1990s.

Dataquest does not expect the appearance of HD–MAC receivers in Europe from 1995 to be accompanied by a sharp increase in receiver IC sales. Instead, HD–MAC will mark the horizon to which a series of intermediate MAC receiver technologies will lead. Consumers are likely to switch to HD–MAC gradually as the benefits of HDTV become both perceivable and affordable. Dataquest predicts a moderate success for HD–MAC penetration by the year 2000, with a resultant market for HD–MAC ICs worth $217 million in Europe. In the same year, the market for HD–MAC ICs will account for 34 percent of the whole receiver IC market, worth an estimated $641 million.

Participants that address only the HDTV receiver market will not stay in this business for long. Enormous fixed costs in HTDV R&D and production will necessitate sharing these costs across the other product segments that benefit from HDTV technology.

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THE STANDARDS: MAC VERSUS MUSE

Europe: MAC

Activity in HDTV in Europe has focused on the development of the high-definition HD-MAC standard. HD-MAC will be compatible with the family of existing European Broadcast Union MAC standards. D2-MAC was developed as a cable and satellite standard by the CCETT in France and later taken over by Deutsche Bundespost. D-MAC, a wider bandwidth variant that includes conditional access has been recommended by the Independent Broadcasting Authority for satellite broadcast to the United Kingdom. Both D2-MAC and D-MAC offer some advantages over PAL and SECAM in terms of improved sound, greater picture resolution, and an optional 16:9 wide picture aspect ratio.

Japan: MUSE

During the last decade, new television technology evolved mainly in Japan, where companies have spent an estimated $700 million on R&D. Japan's HDTV standard, MUSE, was developed by NHK in collaboration with a number of major Japanese set manufacturers, principally Sony and Toshiba. MUSE offers more than twice the resolution of NTSC receivers with a wider aspect ratio of 16:9, and can be received by NTSC sets fitted with an adaptor. MUSE was demonstrated at EXPO 1985 in Tsukuba, Japan. NHK plans to start a nationwide MUSE broadcasting service, Hi-Vision, in 1990 when its DS-3 satellites are launched. The prototypes for this service presently cost $80,000 each, but mass production will reduce the price to between $3,000 and $5,000 by the mid-1990s.

Adoption of MUSE in Europe is flawed because the European frame rate is 50Hz compared with 60Hz for the United States and Japan. Consequently, Europe's existing PAL and SECAM sets could not be fitted with low-cost adaptors to receive MUSE transmissions in the early years.

POLITICAL FORCES

Europe maintains a fairly strong consumer electronics industry against fierce competition from Far East suppliers. Currently, European companies (Philips, Thomson, Nokia) represent some of the most formidable competitors in the global consumer markets. Thomson of France has become the largest manufacturer of color televisions in the world through its recent acquisition of RCA's consumer division and Thorn-EMI's Ferguson.

The largest potential block of viewers worldwide is post-1992 Europe and Eastern European SECAM viewers. This population will provide the European companies with the necessary economies of scale to compete in their home markets.

The European Commission (EC) now is actively promoting HD-MAC as a world standard. Last November, it allocated ECU 45 million to a Brussels consortium, European Company for the Research and Promotion of HDTV (ECRP), to be set up in July 1989 in conjunction with 30 European manufacturers. ECRP will promote HD-MAC as a world-class standard to the CCIR (International Radio Consultative Committee) and, more specifically, to those East European countries that presently use SECAM. European consumer manufacturers will benefit from other EC-related programs such as Megaproject with its 4- and 16-Mbit DRAMs and Jessi with its submicron processes and related CAD tools for DSPs and ASICs.

The Commission's central argument for not accepting the 60Hz MUSE transmission standard in Europe is that the standard is incompatible with current 50Hz PAL and SECAM standards. It argues that accepting MUSE would require huge investments simultaneously from three parties:

- Program makers would be required to purchase new MUSE recording and editing equipment.
- Broadcasters would need to invest in new transmission equipment.
- Consumers would need to purchase a new receiver to watch MUSE HDTV broadcasts. Consumers also would need to own another PAL, SECAM, or MAC receiver to access the many non-MUSE broadcasts.

THE SPIN-OFFS

To appreciate the full impact that HDTV will bring, it is necessary to identify the many other applications that will benefit from HDTV innovations in signal processing, IC, and display technologies. They include the following:

- Video recorders (professional and consumer)
- Still and motion video cameras (professional and consumer)
- Video disk players (consumer)
- Computer displays (industrial, consumer, and military)
- Image processing engines (industrial and military)

These secondary markets will be strongly synchronized with the emergence of reasonably priced HDTV receivers, and each is likely to equal the receiver market in size.

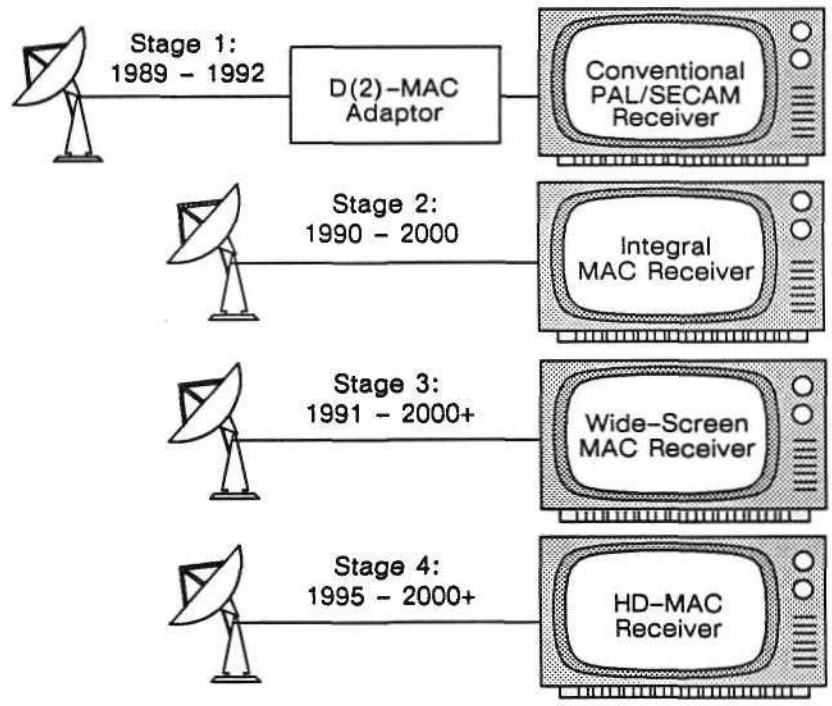
DATAQUEST ANALYSIS

Evolution of MAC

We expect MAC to follow a step-by-step evolution in Europe, as shown in Figure 1. The first step begins this year when subscribers connect conventional PAL or SECAM sets to MAC adaptors to receive U.K. BSB and French TDF-1 satellite channels. MAC adaptors also will be needed to receive the new cable television networks, mainly in France and West Germany. By the end of 1990, manufacturers will have incorporated MAC decoders into their receivers and, by 1992, we expect wide-screen versions to be available. The appearance of high-definition HD-MAC receivers in the mid-1990s will mark the final stage in MAC's development. These high-definition receivers will use light projection in place of CRT displays to allow large-screen viewing without adding bulk to the receiver.

Figure 1

MAC Development Path



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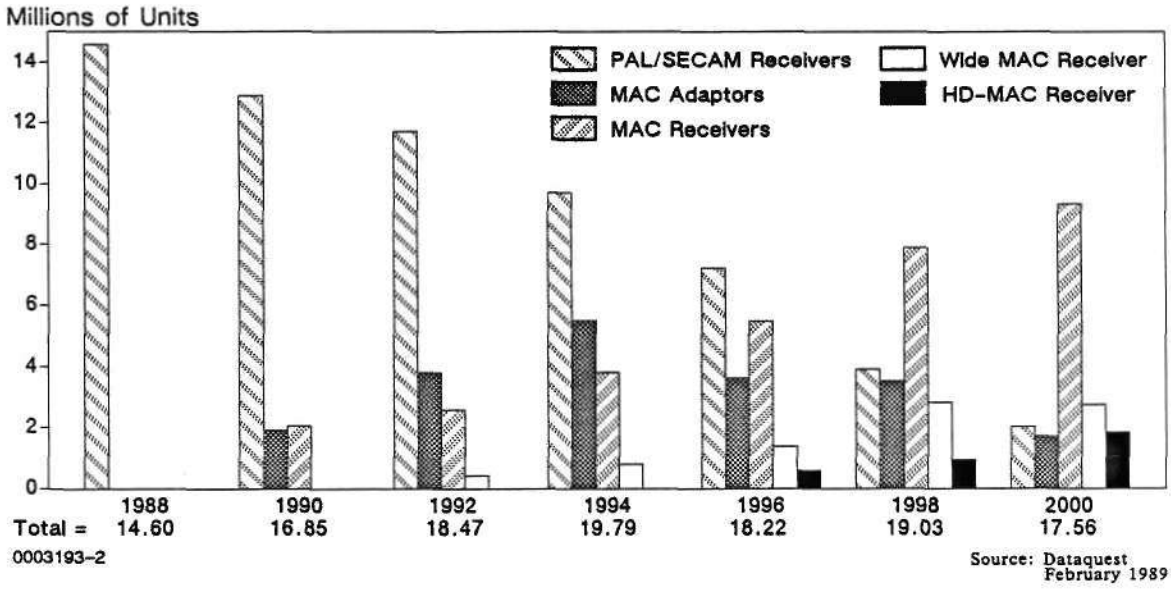
Source: IBA

Figure 2 presents Dataquest's forecast on how production volumes of these receiver types will change over the next 12 years. Conventional PAL/SECAM receivers will succumb gradually to MAC receivers (which may continue to offer a PAL or SECAM option). We expect this transition to be slow for two reasons. First, it will be obligatory in the initial phase for cable operators in Germany to convert their MAC signals to PAL, with a similar move expected in France. Second, PAL has received a new lease on life following its adoption by News International to broadcast its Sky channels via the Astra satellite. The appearance of Palcrypt conditional access adaptors later this year will enable Sky to carry pay channels, and further weakens a key selling point for D-MAC.

Figure 2

Estimated European Television Receiver Production



Impact on the Semiconductor Market

The extent to which HD-MAC receivers will penetrate the European consumer market is unclear. When they appear, their real cost will be about the same as that of the early color receivers of the late 1960s—but the move to a cleaner picture may not be as desirable as the move to color. HD-MAC's acceptance also will be inhibited by the fact that, when it arrives in 1995, it will compete with the improved D-MAC sets already available in the stores.

Despite the imminent appearance of D-MAC and D2-MAC receivers, major growth in European receiver IC consumption depends on the acceptance of HD-MAC. These receivers will have a greater IC content compared with their MAC predecessors. Table 1 presents our forecast of the relative mix between IC function for PAL/SECAM, MAC, and HD-MAC receivers.

Table 1

Estimated IC Value by Function for
PAL/SECAM, Integrated MAC, and HD-MAC Color TV Receivers

	PAL/SECAM*	Integrated MAC	HD-MAC
Year	1989	1990	1995
Content			
Analog	30%	20%	15%
DSP	60%	50%	15%
Memory	10%	30%	70%
IC Content	$32	$38	$150
Average Selling Price	$425	$475	$2,500
I/O Ratio	7.5%	8.0%	6.0%

*Digital PAL/SECAM receiver

Source: Dataquest
February 1989

A survey of potential HD-MAC manufacturers reveals that between 70 and 80 percent of HD-MAC's IC content by value will be composed of 30 to 35 Mbits of specialized video RAM. The remaining content will be split between the HD-MAC decoder, DSP circuits, and the analog rf and video stages. We forecast the IC content to be about five times higher than for a PAL/SECAM set. However, we expect the I/O ratio to decline slightly from 7.5 percent to 6.0 percent because high-definition display costs (tube plus projection optics) will be high.

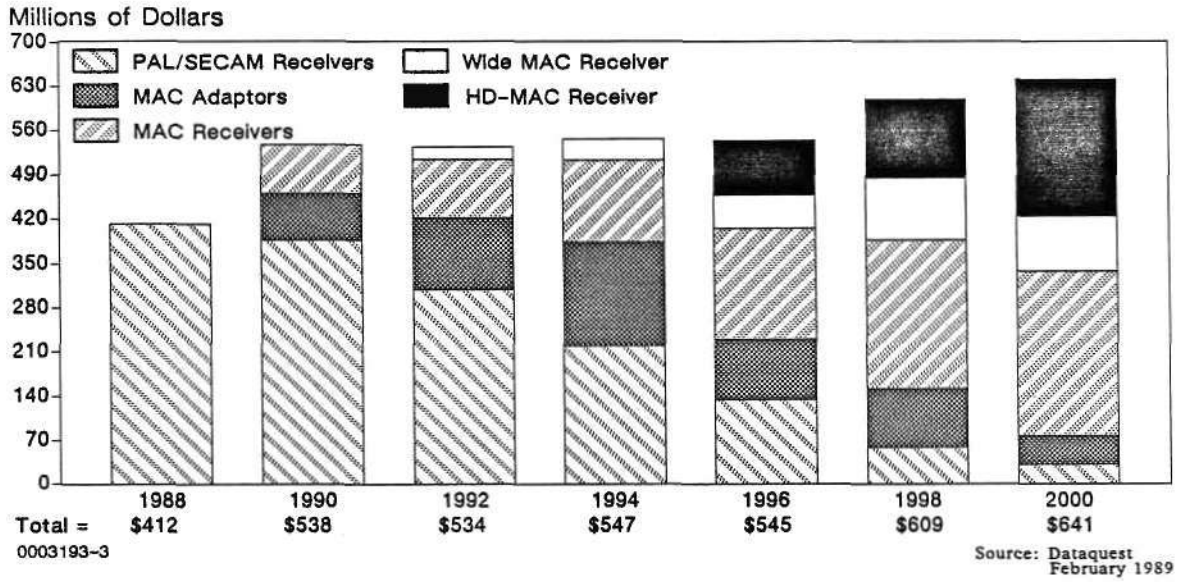
Figure 3 presents our forecast for European TV receiver IC consumption by receiver type. We estimate a 5 percent overall compound annual growth rate (CAGR) between 1988 and 1994 due to the following major factors:

- Unit volume growth resulting from a continued demand for second receivers
- A gradual switch to MAC and wide-MAC receivers with higher IC content and a higher proportion of local European production than that for PAL/SECAM receivers
- MAC royalties may be payable on non-European fabricated chip sets, which would further favor local receiver manufacturers
- New demand for MAC adaptors for use with existing PAL/SECAM receivers

Beyond 1994, the European receiver IC market will be influenced largely by the rate at which HD-MAC is accepted. Assuming that, by the year 2000, one in five receivers purchased will be HD-MAC compatible, we estimate that this amount will represent 34 percent of a total receiver IC market worth $641 million.

Figure 3

Estimated European TV Receiver IC Consumption



DATAQUEST CONCLUSIONS

Strong lobbying by the European Commission will ensure HD-MAC's acceptance as Europe's HDTV standard. There will be no single worldwide HDTV standard. HD-MAC's entry into the European consumer market will lag MUSE in Japan by five years. However, the MAC family of standards will give a head start to those companies with manufacturing and R&D facilities in Europe.

Dataquest forecasts an overall CAGR of 14 percent in the European television receiver IC market from the end of 1988 to the end of 1990, due to strong local European production of intermediate MAC receivers/adaptors and a rising demand for second receivers. However, the outlook between 1990 and 1995 is of zero growth until the arrival of IC-intensive, HD-MAC receivers in 1996. With moderate success expected for HD-MAC by the year 2000, Dataquest estimates that HD-MAC will constitute $217 million (34 percent) of a total European receiver IC market worth $641 million by that time.

In addition to the $217 million market for receiver ICs in Europe, we expect a market two to three times greater from spin-offs such as VCRs, CD players, and computer graphics. Success will go to those vendors that deliver a broad range of interrelated HDTV products.

Jonathan Drazin
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Research Newsletter

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PART II
ISDN—THE EARLY MARKETS, 1988–1992

EXECUTIVE SUMMARY

This newsletter discusses the major issues affecting the markets for ISDN integrated circuits over the period from 1988 to 1992. ISDN is not growing as rapidly as expected in Europe. This is due to the following three major obstacles:

- Conflicting ISDN standards
- Lack of tariff harmonization between countries
- Alternative LAN technology

With these constraints, Dataquest estimates that the market for ISDN semiconductors in Europe will be $137 million in 1992.

A SERIES OF THREE NEWSLETTERS

This is the second in a series of three newsletters that Dataquest is preparing in order to reflect the level of impact that ISDN will have on the European semiconductor markets. These newsletters are entitled:

- Part I: ISDN—The ICs and Their Applications
- Part II: ISDN—The Early Markets, 1988–1992
- Part III: ISDN—Long-Term Market Outlook, 1992–2000

Readers should refer to the first newsletter for an explanation of the ISDN concept and the ICs and their applications. Part I also contains a glossary of ISDN and related terms. Part III will analyze the long-term outlook for the ISDN semiconductor markets in Europe; it will be published in the third quarter of 1989.

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TOO MANY HURDLES?

The promise that ISDN will answer most of our communications needs has been steadily eroded. It is clear that the European Commission's target for 5 percent (4 million lines) of all public digital lines to be ISDN by 1992 cannot be met until the mid-1990s.

ISDN's two most advanced PTTs, France Telecom and Deutsche Bundespost, are now working to targets of only 150,000 and 370,000 Basic Rate lines, respectively, by 1992. British Telecom, the first to experiment with ISDN, is not expected to launch a Basic Rate service until late in 1989. Until recently, these delays had been attributed to ISDN's technical unreadiness (i.e. incomplete CCITT standards, lack of central office and PBX ISDN software, and chip unavailability). These technicalities are now largely resolved, but ISDN must overcome other tougher hurdles before it can live up to expectations. These hurdles include the following:

- Rival technologies
- Conflicting standards
- Unclear tariffs

Rival Technologies

The new IEEE-802.6 and 802.9 Integrated Voice Data LAN standards may displace ISDN from large corporate users. IEEE 802.6 will provide a 140-Mbit/sec (Mbps) fiber-optic Metropolitan Area Network (MAN) suitable for connecting large sites. The 802.9 LAN will give Primary Access data rates (2 Mbps) on twisted-pair lines, albeit limited to a 100-meter range. Many argue that these are more appropriate technologies for large offices populated with personal computers and workstations. If 802.6 and 802.9 prevail, existing cheap analog telephones will be difficult to displace for voice applications. This will leave ISDN relegated to providing external communication between a PBX and a public network.

Conflicting Standards

In spite of emerging European Commission directives and CCITT recommendations, some European PTTs may retain their old Primary Rate signaling standards. The continued use of British Telecom's DASS-2 and Deutsche Bundespost's 1TR6 signaling standards to connect central offices will harm close interworking between private and public networks. A similar connectivity problem exists with PBXs, where GEC-Plessey Telecommunications (GPT) has adopted DPNSS and Siemens has gone with CorNet. This situation reduces the attraction of private ISDN networks in Europe, particularly international ones.

The short-term prospects for Basic Rate are not wholly clear either. The CEPT is likely to endorse ANSI's adoption in the United States of British Telecom's 2B1Q U-interface line code in the next few months. The PTTs will then have to decide whether to postpone expansion of their present Basic Rate service or commit to a costly retrofit later on. In any case, 2B1Q ICs will not become available until the end of 1989.

Unclear Tariffs

The bottom line for all potential ISDN users will be how the cost of using the public ISDN compares with alternative services. Enormous disharmonies exist between tariffs in each European country. The cost, for instance, of leased lines in the United Kingdom is many times lower than that in Germany. To abide with the EC Green Paper on telecommunications, the PTTs are expected to harmonize their tariffs over the next few years. But the fear is that multinational users will not commit to a public ISDN until the result is known.

THE EARLY MARKET: 1988–1992

Considering the above constraints, our estimation of the ISDN installed base in Europe by 1992 is:

- 450,000 Basic Rate lines
- 9,000 Primary Rate lines connected to offices with full internal ISDN

We forecast the market for ISDN semiconductors in Europe to be $137 million in 1992. This assumes that semiconductor demand leads line installations by 12 months. Our estimation of the market shares by IC category is shown in Figure 1, and Figure 2 gives the estimated market size of each category from 1988 to 1992.

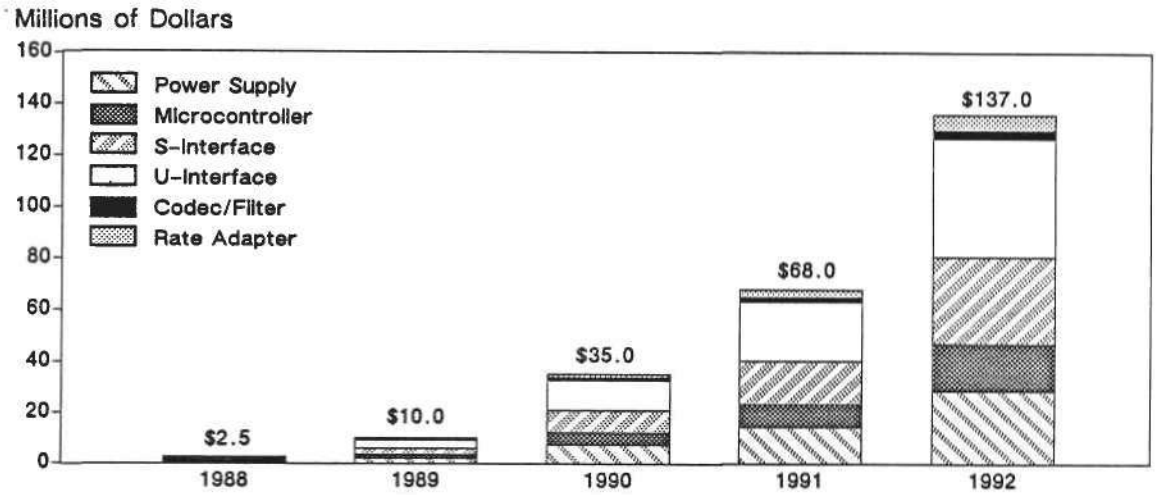
We expect public Basic Rate services to represent most of the demand for ISDN transceiver ICs. Although the volume of S–interface chips will far exceed that for U–interface ICs, we expect the U–interface to have greater dollar market share (34 percent) than S–interface ICs (25 percent). This is due to the U–interface ICs' higher average selling price. Microcontrollers (13 percent) are expected to be less numerous than transceivers and confined mainly to terminal equipment.

Unglamorous ISDN power supply ICs are forecast to occupy a sizeable 21 percent of the market. These are required in every application and provide specialized ISDN functions (power feed, shutdown, line drivers) not provided by other non–ISDN power supply ICs. Vendors are offering advanced technologies, ranging from AMD's 65V bipolar process to SGS–Thomson's mixed 100V bipolar/CMOS/DMOS process currently under development.

We expect ISDN rate adapters and speech codec/filters to take only a small fraction of the market, 4 percent and 2 percent of market share, respectively. The codec market will be small for two reasons. First, unlike S– or U–interface ICs, they are not required at the LT or NT1 reference points. Second, we expect the traditional COMBO suppliers to compete aggressively, resulting in low average selling prices.

Figure 1

Estimated European ISDN IC Markets (Millions of Dollars)



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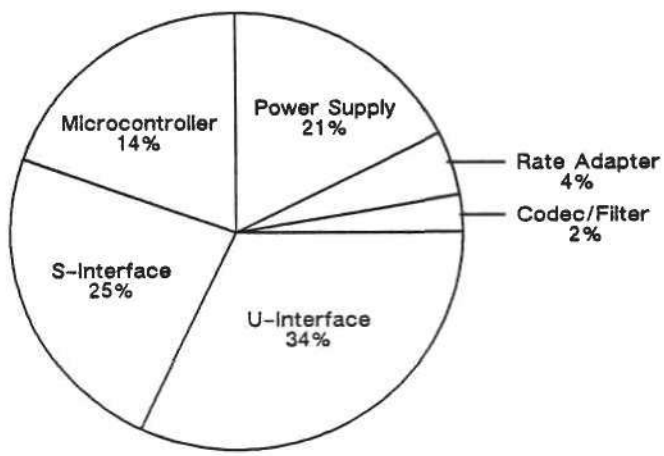
Source: Dataquest January 1989

Figure 2

Estimated European ISDN Market Share by Chip Type 1992



Total = $137 Million

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Source: Dataquest January 1989

DATAQUEST CONCLUSIONS

Major obstacles continue to hinder ISDN's acceptance as a true standard for telecommunications in Europe. Time is running out as newer, more aspirant MAN and LAN technologies threaten to rob ISDN's markets in large corporate environments.

So who will use the ISDN? The brightest future lies with small business and residential Basic Rate subscribers for whom *no* alternative to ISDN exists. Small business users will benefit from a wide range of bearer services (telephone, packet switch, telex, facsimile) provided through a single physical socket. Further, the economic impetus for Basic Rate will strengthen as the number of small businesses in Europe increases and the trend toward residential teleworking starts to grow.

If the standards and tariffs hurdles can be overcome, we believe that ISDN's momentum will recover in Europe and bring a probable two– to threefold increase in ISDN semiconductor revenue.

ACKNOWLEDGEMENT

We would like to thank Dataquest's European Telecommunications Industry Service for sharing their insight and estimates on ISDN line takeup in Europe.

Jonathan Drazin

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PART I
ISDN—THE ICs AND THEIR APPLICATIONS

EXECUTIVE SUMMARY

This newsletter explains the basic concepts of the Integrated Services Digital Network (ISDN) and describes the main functions and applications for ISDN semiconductors.

The diverse range of applications that ISDN embraces has caused most vendors to opt for highly modular chip sets. As a result of high design costs, most vendors have formed cross-sourcing agreements to offer a full ISDN product range.

Dataquest estimates that from 1988 through 1992, 40 percent of the total market for ISDN ICs will go to providing an infrastructure for the public Basic Rate services, with 16 percent going into the infrastructure for public and private Primary Rate services. Customer premises equipment (CPE) manufacturers will account for the remaining 44 percent of demand.

A glossary of ISDN terms has been included at the end of this newsletter for those who are unfamiliar with ISDN terminology.

A SERIES OF THREE NEWSLETTERS

This is the first in a series of three research newsletters that Dataquest is preparing in order to reflect the level of impact that ISDN will have on the European semiconductor markets. These three newsletters are entitled:

- Part I: ISDN—The ICs and Their Applications
- Part II: ISDN—The Early Markets, 1988–1992
- Part III: ISDN—Long-Term Market Outlook, 1992–2000

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The two subsequent newsletters, Parts II and III, will analyze the market for ISDN semiconductors in Europe. Part II of this newsletter accompanies Part I, and Part III will be published in the third quarter of 1989.

INTRODUCTION

ISDN is a collective term for the I series of telecommunications standards recommended by the Consultative Committee on International Telephone and Telegraph (CCITT) and ratified by the Conference Européenne des Administrations des Postes et des Télécommunications (CEPT). These standards will have a strong influence on the telecommunications semiconductor markets because they describe a single physical interface to be adopted worldwide for many forms of electronic communications equipment, including the following:

- Voice telephony
- Facsimile transmission
- Data transmission (packet switch and virtual circuit)
- Telex

Many new applications for ISDN are likely to appear in the mid-1990s and to increase further the market for ISDN semiconductors. These include the following:

- Integrated voice and data workstations (IVDWs)
- Video telephony
- Mixed video/text terminals
- Home automation and remote diagnosis

ISDN ACCESS AND REFERENCE POINTS

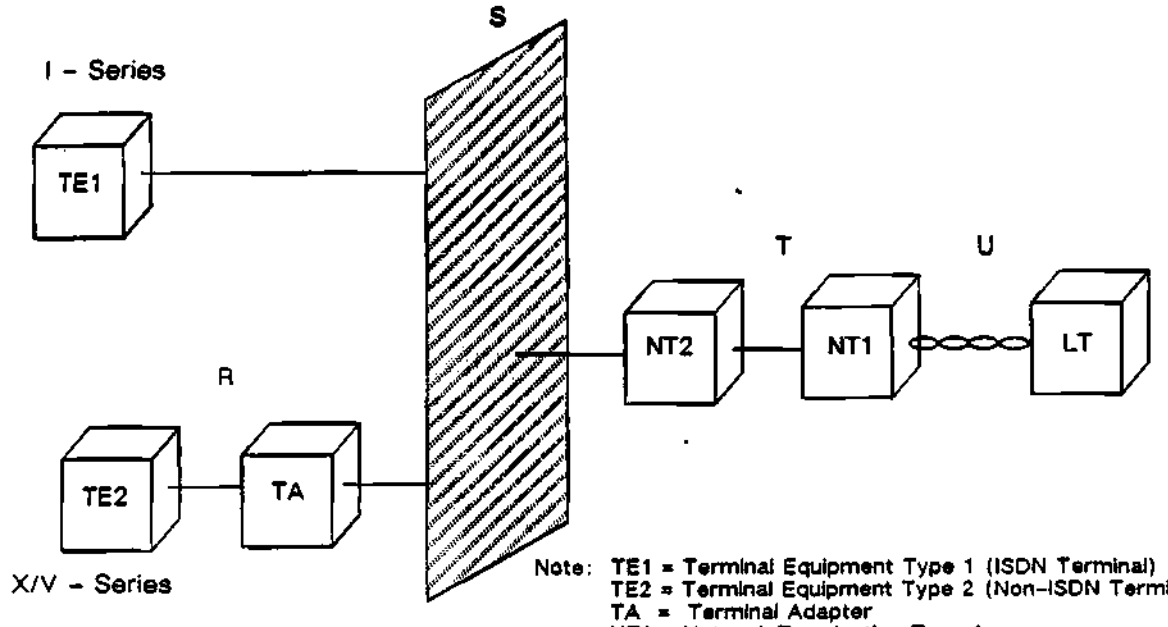
The existing I series recommendations define the following two forms of ISDN access:

- Basic Rate Access consists of two 64-Kbps B channels and 1 16-Kbps D channel with a total bandwidth of 144 Kbps, suitable for transmission across existing two-wire loops between subscribers and central offices or PBXs.
- Primary Rate Access consists of 30 B channels and 1 D channel with a total bandwidth of 2.048 Mbps (in Europe).

Figure 1 shows how the ISDN fits together for the Basic Rate service. TE1 represents new ISDN terminal equipment that connects directly to the ISDN at the S-interface. TE2 represents existing equipment such as RS-232-C or X.21 terminals. This equipment may connect to the S-interface via a terminal adaptor, TA. NT2 is a multiplexer that concentrates two or more TE1s or TAs. The NT1 provides physical and electrical termination between the S-interface and U-interface transmission lines. The U-interface transmission is two-wire transmission at 144 Kbps and uses echo-canceling techniques to correct for signal reflections along the line. Transmission at the S-interface is four-wire transmission and will require substantial rewiring of most buildings to accommodate it.

Figure 1

ISDN Functional Entities



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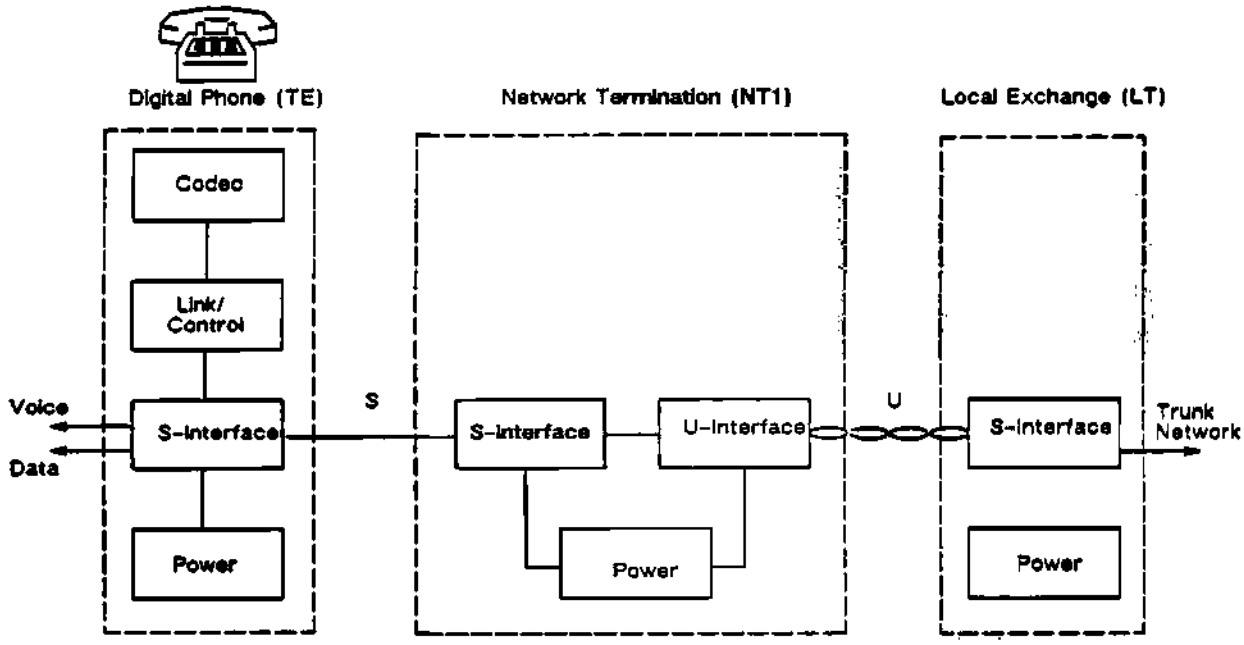
Source: Dataquest January 1989

THE CHIP SETS

The same types of ISDN ICs are used in several different ISDN applications. Figure 2 describes one possible example of an ISDN chip set by function for a digital telephone handset connected to a central office (CO) exchange via a U-interface. For future volume applications, these functions are likely to be integrated into a single IC.

Figure 2

Main ISDN Chip Functions



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Source: Dataquest January 1989

Most vendors offer a modular family of CMOS devices that can be mixed and matched for a given application. No ISDN recommendations for connectivity at the IC level have been drafted or planned, although a single bus format would be desirable to maximize chip-to-chip compatibility between different vendors.

Table 1 describes some of the bus schemes adopted. Most European vendors have chosen the General Component Interface (GCI). This is similar to Siemens' ISDN-Oriented Modular Revision 2 (IOM-2) scheme. The GCI bus has four lines: two for data receive and transmit, one for frame synchronization, and one clock line. Data for the D and two B channels are multiplexed onto a single line. Intel's Subscriber Line Datalink (SLD) combines the receive and transmit signals onto a single bidirectional line. Mitel's ST bus works in a similar way to GCI but can operate in an alternate mode where the B and D channels are transmitted on different lines.

Control pins are eliminated from the GCI, ST, and SLD buses by interleaving data and control codes onto one line. This increases the complexity of the IC but eases the design process of integrating onto one piece of silicon.

Table 1

Bus Formats Adopted by the Major ISDN IC Vendors

Bus Name	Vendors
GCI/IOM-2	Advanced Micro Devices National Semiconductor Philips Plessey SGS-Thomson Siemens Signetics
SLD	Intel National Semiconductor
ST	Mitel
IDL	Motorola National Semiconductor

Source: Dataquest
January 1989

ISDN IC FUNCTIONS

Exchange and terminal equipment will be composed mainly of the following types of ISDN ICs.

- U-Interface IC—echo-canceling 192-Kbps digital transceivers for twisted-pair subscriber loops
- S-Interface IC—four-wire S-interface transceivers providing link layer functions
- Microcontroller IC—provides layer 2, LAPD data link control; may also perform higher-level functions (e.g., keyboard control)
- Codec/Filter IC—performs codec and filter functions for voice telephone applications
- Rate Adaptor IC—adaption of the ISDN B channel to non-ISDN protocols (e.g., V.24, X.21) for terminal adaptor (TA) applications
- Power supply IC—voltage regulation, line driver, and power-down functions

The major ISDN applications over the next five years will be the following:

- Central Office (CO) and PBX line cards (LT)
- Network Termination (NT1) at customers' premises
- Terminal Adapters (TAs) to allow connection of existing terminal equipment (e.g., RS-232/V.24, X.21) to the ISDN network
- Intelligent voice/data workstations (IVDWs)
- Facsimile Group 4
- Digital feature phones
- Digital handsets

Table 2 describes typical IC uses for the different ISDN applications.

Table 2

ISDN IC Use by Application

	Application*						
	LT	NT	TA	IVDW	Fax	Feature Phone	Digital Handset
IC Function							
U-interface	X	X					
S-interface		X	X	X	X	X	X
Microcontroller			X	X	X	X	X
Codec/Filter				X		X	X
Rate Adaptor			X	X			
Power Supply	X	X	X	X	X	X	X

*Please see glossary for terminology

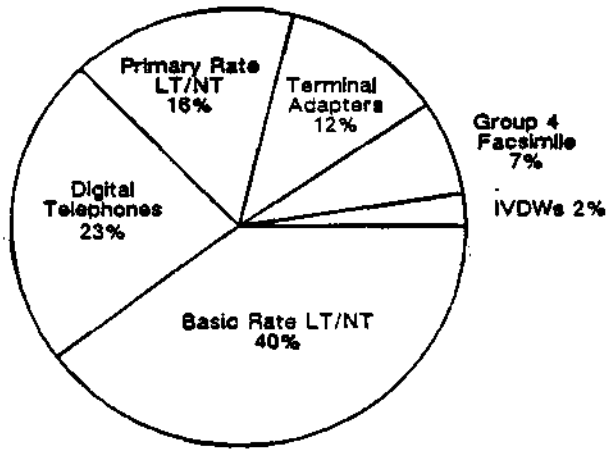
Source: Dataquest
January 1989

DEMAND BY APPLICATION

Figure 3 illustrates Dataquest's forecast for the ISDN IC market revenue shares by application in Europe from 1988 through 1992. The infrastructure (line cards, repeaters, and network termination) for the public Basic Rate services will receive 40 percent of the ISDN ICs. Public and private Primary Rate networks will take a smaller 16 percent share.

Figure 3

ISDN Semiconductor Demand by Application



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Source: Dataquest January 1989

Among customer premises equipment, the digital telephone will represent the largest single market (23 percent) for ISDN ICs. ISDN terminal adaptors will take second place with 12 percent, followed by facsimile machines (7 percent) and IVDWs (2 percent).

DATAQUEST CONCLUSIONS

Vendors are offering a number of highly modular ISDN chip sets. The CGI standard, a derivation of Siemens' IOM-2 bus protocol, has been most widely adopted by vendors for the European market. ISDN ICs are highly application independent at present. However, as volume applications develop (e.g., digital handsets), multiple ISDN functions will be integrated onto one piece of silicon.

Dataquest estimates that during the period from 1988 through 1992, 40 percent of the total market for ISDN ICs will go to providing an infrastructure for the public Basic Rate services, with 16 percent going into the infrastructure for public and private Primary Rate services. Customer premises equipment (CPE) manufacturers will account for the remaining 45 percent of demand.

Jonathan Drazin

GLOSSARY

ANSI (American National Standards Institute). A subcommittee of the Electrical Industry Association (EIA) that prepares software and electrical standards for U.S. industry.

CCITT (Consultative Committee on International Telephone and Telegraph). A body of the ITU (International Telegraph Union) that prepares recommendations to resolve technical telegraph and telephone problems.

CEPT (Conference Européenne des Administrations des Postes et des Télécommunications). A body that coordinates the policies of the PTTs of Western Europe.

CPE (Customer Premises Equipment). All forms of equipment used on customers' premises, excluding the termination (NT1) with the public network.

DASS–2 (Digital Access Signaling Standard–2). British Telecom's signaling protocol for connecting Primary Rate subscribers with its central offices.

DPNSS (Digital Private Network Signaling Standard). British Telecom's signaling protocol for connecting PBXs together to form a private network.

GCI (General Component Interface). A common bus standard for ISDN chip sets, based on Siemens' IOM–2 standard and agreed between the main European vendors.

Group 4. A high–speed facsimile protocol specific to ISDN, as defined in the CCITT F.5 recommendations.

IDL (Interchip Digital Link). An ISDN bus developed by Motorola, consisting of separate data and control lines.

IOM–2 (ISDN Oriented Modular Revision 2). A modular bus devised by Siemens for its ISDN chip set.

IVDW. Integrated voice/data workstation. Provides multiple functions, including voice/video telephony, PC features, and data transmission.

LAPB. The Link Access Protocol for the ISDN B channel defined in the CCITT X.25 packet switch recommendations.

LAPD. The Link Access Protocol for the ISDN D channel as defined by the CCITT I.440 and I.441 recommendations.

LT (Line Termination). A line card that provides termination of the subscriber loop at the PBX or central office.

NT1 (Network Termination 1). A unit that provides physical and electromagnetic termination of the U–interface two–wire transmission line.

NT2 (Network Termination 2). A unit that provides switching and concentration of subscribers' lines at the S–interface (mainly for Primary Rate).

PTT (Post, Telegraph, and Telecommunications administration). Refers to the state-run telecommunications administrations of Europe.

S-Interface. The interface that connects an ISDN terminal (TE1) or a terminal adapter (TA) to the NT2 reference point as defined in the I.411 recommendation.

SLD (Subscriber Line Datalink). A three-line serial ISDN bus devised by Intel for its ISDN chip set.

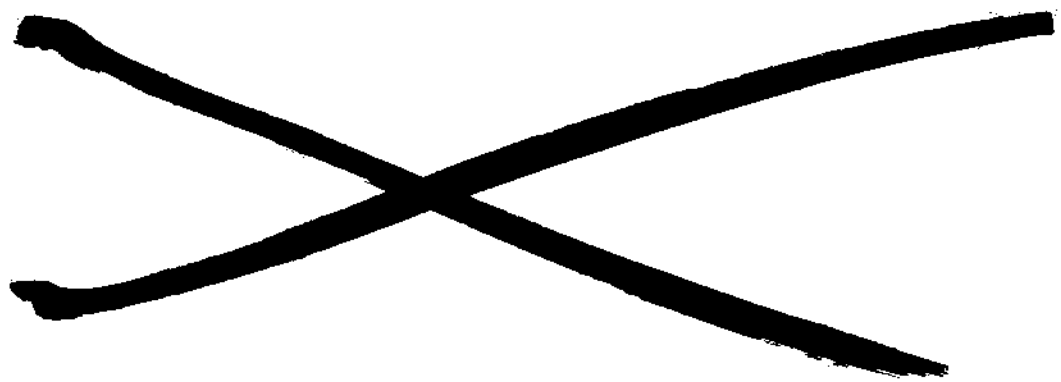
ST-Bus. A four- or six-line time division multiplexed bus devised by Mitel for its ISDN chip set.

TA (Terminal Adaptor). A unit that interfaces non-ISDN TE2 equipment to the S-interface.

TE1 (Terminal Equipment 1). Represents all ISDN-compatible terminal equipment.

TE2 (Terminal Equipment 2). Refers to all non-ISDN terminal equipment, i.e., existing RS232/V.24, X.21, or X.25 equipment.

U-Interface. A twisted pair subscriber loop that connects the NT1 reference point to the ISDN network, as defined in the I.411 recommendation. This interface provides Basic Rate access with a capacity of 144 Kbps.



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Research Newsletter

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EUROPE REFRESHES ITS STAGNANT WHITE GOODS MARKET

SUMMARY

The European white goods market is estimated to be worth $12.5 billion in 1988. This newsletter provides Dataquest's forecast for this white goods market (major household appliances) and a brief overview of the major white goods manufacturers in Europe.

Low growth in the European white goods market, combined with overcapacity in the industry, has resulted in a massive restructuring of the major manufacturing companies and a shake–out among the smaller manufacturers. Many mergers have taken place over the last few years, of which the most noticeable have been the Whirlpool/Philips merger and Electrolux/Zanussi/Thorn–EMI mergers, with both companies vying to become the dominant market leader. These events can be compared with what has happened in the automotive industry, where the market is fragmenting between high–volume, low–cost suppliers and low–volume, high–cost luxury model suppliers. AEG and Bosch–Siemens, following the German tradition, are becoming luxury model suppliers, while Electrolux and Philips are targeting the low–cost, high–volume end of the market.

MARKET ESTIMATES

Tables 1 and 2 show Dataquest's estimates for the European white goods market in both dollar and unit terms.

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Table 1

Estimated and Forecast European White Goods Market (Millions of Dollars)

	Estimated		
	1985	1986	1987
Air Conditioners	$ 30	$ 18	$ 17
Microwave Ovens	114	162	191
Washers, Dryers	2,797	3,105	3,213
Refrigerators	2,021	2,293	2,380
Dishwashers, Disposals	583	655	702
Ranges, Ovens	1,840	2,064	2,043
Vacuum Cleaners	1,080	1,176	1,187
Food Processors	273	308	323
Heaters	1,140	1,235	1,260
Others	437	452	466
Total	$10,315	$11,468	$11,782

	Forecast					
	1988	1989	1990	1991	1992	1993
Air Conditioners	$ 16	$ 17	$ 20	$ 21	$ 23	$ 26
Microwave Ovens	232	380	401	422	445	469
Washers, Dryers	3,499	3,375	3,260	3,149	3,041	2,938
Refrigerators	2,609	2,664	2,738	2,812	2,868	2,942
Dishwashers, Disposals	748	791	842	893	925	1,000
Ranges, Ovens	2,181	2,284	2,291	2,296	2,301	2,374
Vacuum Cleaners	1,243	1,197	1,201	1,204	1,260	1,292
Food Processors	326	333	349	356	374	387
Heaters	1,212	1,236	1,261	1,286	1,312	1,338
Others	480	488	496	496	512	528
Total	$12,546	$12,765	$12,859	$12,935	$13,061	$13,294

Source: Dataquest
December 1988

Table 2

Estimated and Forecast European White Goods Market (Millions of Units)

	Estimated		
	1985	1986	1987
Air Conditioners	0.2	0.1	0.1
Microwave Ovens	0.7	0.9	1.1
Washers, Dryers	11.1	11.5	11.9
Refrigerators	12.4	13.1	13.6
Dishwashers, Disposals	2.2	2.5	2.7
Ranges, Ovens	9.2	9.6	9.5
Vacuum Cleaners	10.8	11.2	11.3
Food Processors	3.9	4.1	4.3
Heaters	22.8	23.3	23.8
Others	5.6	5.8	5.9
Total	78.9	82.1	84.2

	Forecast					
	1988	1989	1990	1991	1992	1993
Air Conditioners	0.1	0.1	0.2	0.2	0.2	0.2
Microwave Ovens	1.2	2.0	2.1	2.2	2.3	2.5
Washers, Dryers	12.5	12.5	12.1	11.7	11.3	10.9
Refrigerators	14.1	14.4	14.8	15.2	15.5	15.9
Dishwashers, Disposals	2.9	3.1	3.3	3.5	3.7	4.0
Ranges, Ovens	9.5	9.7	9.8	9.8	9.9	10.0
Vacuum Cleaners	11.3	11.4	11.4	11.5	12.0	12.3
Food Processors	4.5	4.8	5.0	5.2	5.5	5.8
Heaters	24.2	24.7	25.2	25.7	26.2	26.8
Others	6.0	6.1	6.2	6.2	6.4	6.6
Total	86.3	88.8	90.1	91.2	93.0	95.0

Source: Dataquest
December 1988

COMPANY ANALYSIS

Detailed below is a brief overview of the major white goods manufacturers in Europe.

AB Electrolux

AB Electrolux is Europe's largest white goods manufacturer. The group as a whole has 450 operating companies in 40 countries manufacturing 26 product lines in five business areas, covering household appliances, forestry and gardening, industrial, commercial, and components. The household appliances area is Electrolux's largest business area, with 1987 sales of $6.23 billion.

Electrolux has made several substantial acquisitions over the last few years. In 1986, it acquired White Consolidated Industries, the third-largest U.S. white goods manufacturer, for $750 million. This acquisition made Electrolux the largest white goods manufacturer in the world. In 1984, Electrolux acquired 49 percent of Zanussi, the Italian white goods manufacturer. In 1985, Electrolux acquired Zanker of Germany, manufacturer of washers and dryers, and, in 1987, it acquired Thorn EMI's white goods division.

Electrolux has striven toward economies of scale, knitting together its many acquisitions into a coherent and cohesive global entity. It now manufactures all its front-loading washing machines for Europe at Perdenone, Italy. Electrolux builds all top-loaders at Revin, France; all microwave ovens in Britain' and all top-price refrigerators in France. Other manufacturing locations are in Sweden, Norway, Switzerland, and the United States.

Dataquest estimates Electrolux's market share of the total European white goods market to be 25 percent.

AEG Aktiengesellschaft

Daimler-Benz has been the majority shareholder of AEG Aktiengesellschaft since 1986. White goods account for a small part of the corporation turnover, representing less than 10 percent of the total. Dataquest estimates that Daimler-Benz's 1986 white goods sales were $955 million and believes that AEG's share of the total European white goods market is approximately 6 to 7 percent. AEG has four white goods manufacturing plants in Germany.

Bosch-Siemens Hausgerate

Bosch-Siemens Hausgerate is a jointly owned company between Robert Bosch and Siemens in equal shares. Its sales reached $2.2 billion in 1987. Dataquest estimates that Siemens-Bosch has an 11 percent share of the European white goods market.

Bosch-Siemens has four plants in Germany and one in Austria. The company owns 100 percent of Neff GmbH, which has manufacturing plants in Germany, France, the United Kingdom, and Austria. Bosch-Siemens also has a 55 percent interest in Pitsos SA of Athens.

GEC

GEC owns Hotpoint and the Tube Investments' white goods division. Tube Investments is known for its Creda range. Refrigerators, freezers, and washing machine motors are made in England in Peterborough, and washing machines are made at their Llandudno and Rhyl plants in Wales.

Hoover U.K.

Hoover U.K., a subsidiary of the U.S. Group, manufactures vacuum cleaners in Cambuslang, Wales, and washing machines in Merthyr Tydfil, Wales.

Merloni

Merloni, a privately owned Italian company, recently purchased 75 percent of Indesit of Italy. Indesit was formally controlled by the Campioni family. The of combination Merloni (better known for its Ariston brand) and Indesit gives it a 9 percent share of the European white goods market.

Miele

Miele is a privately owned German company. Miele made the first wooden washing machine in 1903 and the first electric unit in 1929. The company has six manufacturing plants, five located in Germany and one in Austria.

NV Philips

Philips' white goods sales reached $3.1 billion in 1987, approximately 11 percent of the Philips Group's total turnover. Dataquest estimates Philips' share of the European white goods market to be 13 percent.

Whirlpool, one of the largest U.S. white goods manufacturers, with an estimated 15 percent share of the U.S. white goods market in 1986, acquired a 53 percent stake in Philips' white goods business in 1987.

Philips has acquired several white goods manufacturers, including Bauknecht of Germany and IRE of Italy in 1984 and, in 1972, Ignis of Italy.

Philips has a microwave plant in Sweden and white goods plants in the Netherlands, Spain, France, Portugal, the United Kingdom, Germany, and Austria.

Thomson SA

Thomson is bringing its consumer electronics operations (brown and white goods) together under one holding company called Thomson Consumer Electronics. This holding company will also incorporate the RCA consumer business acquired by Thomson in 1987. Dataquest believes that this will make Thomson the third-largest consumer manufacturer worldwide, after Matsushita and Philips. Dataquest estimates Thomson's white goods market share in Europe to be 6 percent.

Others

Other European white goods manufacturers include Moulinex (France), Gruvesa (Spain), Eurelsa (Spain), Unelsa (Spain), and Candy (Italy).

FUTURE OUTLOOK

Sales revenue will continue to exhibit low growth rates, in the 1 to 2 percent range. Because this is well below the average inflation rate, it represents a decline in real terms.

The driving force behind the white goods market growth can be seen by measuring the penetration level of these goods in European households. Key mature products—for example, refrigerators, washing machines, and vacuum cleaners—have already reached saturation levels of approximately 80 percent. The resultant low growth is accounted for mainly by the replacement market. Products with lower penetration levels—hence, room for growth—are dryers, microwave ovens, freezers, and dishwashers.

Microwave sales will be dampened slightly due to the European Commission's imposition of dumping duties on Korean and Japanese suppliers. This may result in high prices to the consumer. However, unit volume growth will continue as more suppliers set up manufacturing facilities in Europe.

Dataquest analysts believe that the white goods market, which has remained relatively stagnant since its inception, is ready for technical innovation. Increased penetration of electronic controls for ease of use and user convenience will be developed. Electronic systems will migrate from top-end models to mass market models. For example, the industry is considering futuristic systems, such as laser scanners, for use in refrigerators and freezers to read food expiration dates. The potential for innovation in this market should not be underestimated.

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1992—WHAT'S IN A NUMBER?

SUMMARY

On June 21, 1988, Malcolm Penn, Vice President and Director of Dataquest's European Operations, gave a keynote address at the Semiconductor Equipment and Materials Industry (SEMI) European Industry Focus Conference held in Munich, West Germany. The theme of this conference was "Can Europe Make It?" The theme of the Dataquest keynote address was "1992—Has Europe Got It? An Analyst's View." A copy of this speech with its accompanying slides is attached and is being published by all the Dataquest European Services.

1992—HAS EUROPE GOT IT? AN ANALYST'S VIEW

1992 represents the metamorphosis of the European Economic Community (EEC)—the transition from caterpillar to butterfly. The genesis was in 1957 when the six founder member states (Belgium, Federal Republic of Germany, France, Italy, Luxembourg, and Netherlands) formed the EEC. It grew to nine in 1973 (Denmark, Republic of Ireland, and United Kingdom), ten in 1981 (Greece), and twelve in 1986 (Spain and Portugal).

The next move is now coming—in 1992 the EEC will grow into one—the single market.

The objective of creating a single "common market" in the EEC goes back to the EEC Treaty of Rome which established the Community 31 years ago. In 1985, the EEC heads of government committed themselves to completing the single market progressively by 31 December 1992. Their commitment has been included in a package of treaty reforms known as the Single European Act, which came into force on 1 July 1987.

Dataquest's European Research Operations have been tracking the European electronic equipment industries since 1981 and recently, with the significant winds of change that have been dominating the European industrial scene, the potential that the 1992 single European market could have. This keynote address presents the issues and analysis of the present situation, one year after the passing of the Single European Act, together with the challenges and opportunities that lie ahead.

This speech was written using research material provided by the European Semiconductor, Computer, Telecommunication, Printer, Copying and Duplicating, Industrial Automation, and Personal Computer groups.

(Slide 1)

Ladies and gentlemen, good morning. Yesterday Guy de Jonquieres from the Financial Times opened the proceedings of this conference with what I thought was a very thought-provoking speech entitled "1992: Has Europe Got It?—A Political View." I would like to continue from where Guy left off and look at the same issue from an analytical perspective.

We analysts are charged with a challenge to piece together all the available data on a particular subject, rationalize it, sanitize it, and come up with a consensus view on what the issues and facts are—actually more specifically, the facts behind the facts; the trend behind the first glance. That is what I will attempt to do over the next 45 minutes or so.

Dataquest held its seventh annual European Semiconductor Industry Conference approximately two weeks ago, at which we gathered together the top executives from makers and users of semiconductors. Part of the proceedings included a workshop to look at the issues of 1992.

From this workshop, four major barriers to the growth of business and trade in Europe emerged: technical barriers—differing technical standards in broadcasting, telecoms, and consumer electronics; environmental barriers—different levels of safety in the various national laws on pollution, drugs, radiation levels on computer terminals, etc; government barriers—differing tariffs, duties, local subsidies, procurement policies and monopolies; and finally financial barriers—differences in the cost of capital, availability of venture capital, and tax incentives. These are the front-line analyses. So what was the fact behind the facts?

Ignorance is the single biggest key barrier to the implementation of the single European market due to be created in 1992. While nearly everyone present knew something about the significance of 1992, no one there really knew how it was going to effect them or what the specific implications were for their business.

(Slide 2)

I'd like to draw your attention to a statement Jacques Delors, the president of the EEC made earlier this year. Specifically I'd like to refer you to the following words: "The 31st December 1992 deadline is now enshrined in a Single European Act."

Ladies and Gentlemen, 1992 is a reality. On 31st December 1992, that Act will become law. That law will override local governments. Majority voting, as opposed to the present almost universal procedure of unanimous voting, will ensure that the days of filibustering are finally dead and buried. The four major barriers to trade mentioned above will no longer exist.

The first of my recommendations this morning is that we had all better take this reality seriously—the days of the cozy cartels, monopolies, hidden tariffs, and other protectionist or self-interest motivated practices are numbered—1,653 days to be precise.

Nobody likes change—we're all very much creatures of habit—but this is one change that will be viewed with hindsight as worthwhile. That is my second prognostication of the morning.

What, I hear you ask, gives me the confidence to make such an equivocal statement? To answer that I would like to look back over past decades of the western world's economic performance.

(Slide 3)

The single biggest contributor to the postwar world economic recovery was market liberalization. The 1920s/'30s saw trade barriers dismantled, government-nurtured cartels broken up and controls on direct foreign investment lifted. The western world enjoyed a market-led sustained high GNP growth throughout this period.

The oil shocks of the 1970s triggered a gradual shift away from market-led forces with an increasing tendency for cozy self-interests to prevail. GNP growth has slowed—unemployment has reached an intolerably high level (pan-Europe) and doggedly refuses to nudge down. EEC estimates reveal that the cost of non-European unity currently exceeds $100 billion dollars—$100 billion revenue lost due to internal trade barriers. To put that into perspective, that represents a year's growth in Europe today. SEA (The Single European Act) will change all that—prognosis number three.

(Slide 4)

Listed here are just a few examples of "hidden" trade barriers, and these are just some. Believe me, they are multitudinous in nature. This is today's reality. A reality we've grown up with, and a reality we've organized our activities, built factories, marketing plans, business strategies, and end products around.

(Slide 5)

At the stroke of midnight, 30 December 1992, all of these strategies and plans will be rendered obsolescent. They are all obsolescent now. Companies that are today still acting in a "country" organization structure and defining tactical issues on a local basis are in grave danger of missing the boat. On the 31st December 1992, we will have a have a free domestic market of over 330 million people, very nearly as many people as in the U.S. and Japan combined. Some of today's companies will not make the transition—they will fail to survive in this new competitive environment.

If you would allow me to hypothesize that you accept that this will be the consequence of the SEA—given the drastic consequences it will bring—why then is it so necessary to change in the first place?

(Slide 6)

One of the few things in life that is a given certainty is progress. It is inevitable—I agree that not all progress is necessarily for the best, but nonetheless it happens. In the economic scenario, progress has taken us to a new dawning—one I would like to call "globalization." Joe Duncan, Dun & Bradstreet's corporate economist and chief statistician, points to seven factors that together characterize the new global economy.

- First, trade and the fact that this has become now largely deficit driven. Large regional trade imbalances are no longer politically or commercially an acceptable way of life.

- Second, macroeconomic policy—it ripples around the world. We worry about the size of the U.S. budget deficit, the fact that Germany remains unwilling to stimulate internal demand, and whether or not Japan really will open up its markets.

- Third, currency fluctuations are a real wild card. How do you plan where to build new factories in an environment where an exchange rate variance can render them uncompetitive overnight, even before they have come on stream?

- Fourth, international competition. That situation will continue to intensify.

- Fifth, direct and indirect investment. Do I manufacture or buy the component or service I need? Will this be via an outsourcing agreement or via a joint venture?

- Sixth, foreign capital flows. The excess liquidity at the global level slopping around the world seeking the best interest level or return is 26 times bigger than the total of all world trade put together. It is no longer trade factors that determine exchange rate values today—it is excess liquidity.

- And, finally, information transfer. It is far easier than ever before, since financial transactions etc. are knitted together by instantaneous communications.

I would like now to turn more specifically to your own industry, i.e. semiconductors, and its related fields, and to examine just where this industry is positioned today against the global backdrop I have just painted.

(Slide 7)

The semiconductor industry is currently embarking on a new phase in its evolutionary process. Phase 1 was technology-driven and the U.S. won that round. This was primarily due to the social and political environment at the time, ready access to venture capital, lots of innovation, and a strong military/aerospace industrial driver.

Eventually technological strength alone was not sufficient and the mid-70s saw Phase 2 arrive—manufacturing. That round went to Japan, again due to their social and economic environment at the time, manufacturing science, people discipline, culture, and better economies of scale. That too is no longer sufficient.

The 1980s have brought us to Phase 3—the marketing era. This is opening right now and no clear winners have yet emerged.

(Slide 8)

The implications, though, that it has on our industry have emerged. The winners in the marketing phase will be determined by these companies who today are positioning themselves internationally. And by that I don't just mean selling internationally, I mean sharing internationally: sharing products and technologies; embarking on horizontal and vertical alliances; and restructuring their organizations accordingly. All of this of course must clearly keep the focus on the customer as the priority objective.

Let's now get down to the next level of detail and look first to see how Europe's end equipment industries are faring, and then, the position of Europe's semiconductor industry and its prospects for being among the winners for this next phase of the semiconductor evolution.

(Slide 9)

At the time the SEA becomes law, Dataquest predicts that the European semiconductor market will exceed $10 billion in value, up from our current estimate of the 1987 European market of $6.4 billion. That delta is slightly more the size of the whole of the 1983 European market. I would like to examine now what lies behind this growth rate and at the key industry segments that will impact the growth.

(Slide 10)

The computer segment will continue to have a major impact. With the creation of new emerging standards like UNIX and X OPEN, we expect to see more aggressive postures adopted by equipment vendors for larger market shares. This in turn will impact on price/performance ratios of semiconductors.

It is important to remember when talking about computers nowadays that this industrial segment is no longer dominated by the mainframe computer. That era is fading after 30 years of dominance—the micro is taking command and in this area Europe's manufacturers have an already established strong position.

In 1987, microcomputer revenue surpassed mainframes and there were over 15 million PCs shipped into U.S. offices alone. The balance of power has moved to small systems that didn't even exist 10 years ago. Today's 80386–based machines can be bought for between $5K to $10K and offer the computing potential equivalent to the last generation of mainframes. By 1992, you will have 100 mips of computing power on your desk for the same cost as an 80386–based machine today.

(Slide 11)

Overall, the telecommunications market is not expected to experience rapid growth rates, mostly due to the slowdown in the number of digital lines installed as the system upgrade program reaches maturity, and the fierce PABX competition continues. The picture looks brighter for modems, cellular phones, and local area networks, other areas of European strength. In the wake of the recent consolidation amongst the European industry leaders, the now slimmed-down companies are better equipped to grasp the challenge that these opportunities will provide.

(Slide 12)

The consumer industry is making increasing use of sophisticated semiconductor devices and is responsible for driving some leading-edge products like data conversion and DSP products. Philips and Thomson dominate this market in Europe and together with Amstrad, especially as DSB starts to impact, are well poised to maintain this leadership position.

(Slide 13)

The joint Eurofighter project will have a major impact in Europe as it is not clear which military specification will be used for semiconductor components. This could be either U.S. specifications or the recently adopted CECC specifications. The resounding success that Airbus has had on the civil aircraft market is best measured by the rapid increase in protectionist political lobbying by Boeing in the United States over the past two years.

(Slide 14)

The relative strength of the European currencies over the U.S. dollar has resulted in a slowdown of exports of luxury models to the U.S. market. However the future trends for higher semiconductor contents in the midrange models will make the automotive market one of the most exciting segments for semiconductors.

It is important here to remember that Europe produces more cars (12 million) than either the U.S. or Japan (8 million each), almost comparable with the total production of the U.S. and Japan added together. The problem today is that current "nontariff" trade barriers don't allow this potential economy of scale to be realized—1992 will change all that.

(Slide 15)

Finally, the industrial segment. This remains fragmented, but, for example, the adoption of solid-state electricity-measuring meters will give this area a big boost in semiconductor consumption, as the potential volumes involved are similar to those seen in the video games arena. Last year alone saw 2 million units shipped in field trials.

An even bigger potential market will be that of the smart card, not particularly the financial sector of this market (though I agree that will be significant) but the disposable market, e.g. intelligent (nonforgable) tickets.

What I would like to do now is to examine how Europe's big three semiconductor manufacturers are positioned in these six industrial segments, i.e. Philips, SGS-Thomson, and Siemens.

(Slide 16)

This slide shows the relative market size within the total European market along with the three companies' relative market ranking within the individual sectors. As you can see, apart from data processing and military sector, Europe's big three hold a commanding position. Now let's examine the facts behind these already impressive facts.

First, military. I've already discussed that this is a future high-growth segment, yet apparently Europe's semiconductor manufacturers do not participate strongly? Wrong, the number two supplier is Plessey/Ferranti just slightly behind National/Fairchild and ahead of Texas Instruments at number three. And with SGS-Thomson's total commitment to the European CECC program-I predict this picture will change dramatically over the next five years.

In industrial, ASEA Brown Boveri commands the number five position and in consumer, ITT is number four. Though strictly speaking ITT is in our definition a U.S.-owned company—in reality it is totally European in structure, management, and control. I do not believe I am distorting the facts therefore by including ITT amongst the European manufacturers for the purpose of this analysis.

In the other segment, data processing, we are all well aware that Europe's computer manufacturers conceded defeat to the U.S. in the mainframe market in the 1970s. No wonder, therefore, that the European semiconductor manufacturer's share here is the lowest. As I mentioned before, though, the whole characteristic of the data processing segment has changed—by 1992, therefore, we predict that Europe's semiconductor market share in this segment will increase from its present 24 percent to 35 percent.

(Slide 17)

The overall impact is shown here. Today's reality is that Europe's semiconductor companies control significant market share on a by-segment basis within Europe, from a low of 24 percent in data processing to an impressive high of 65 percent in consumer electronics.

This achievement is the state of play at the entry point of the SEA. It has been achieved from a position of disadvantage brought about by fragmented markets, specification differences, and other operating and marketing inefficiencies. By 1992, those disadvantages will no longer be relevant. The true potential power that these numbers reflect will be capable of being unleashed against Europe's global competitors.

Furthermore, I predict that the market pull will increase dramatically over the same time period, especially as Europe continues to flex its new-found cooperative strength under the banner "united we stand—divided we fall." For example, we are all well aware of the EEC antidumping issues that have affected the electronic printer industry over the last few months. This next slide clearly demonstrates the impact.

(Slide 18)

This year, Japanese production of electronic printers in Europe will reach 1.2 billion units, up from less than 100K units in 1987. Next year, it will rise a further dramatic 40 percent to 1.7 billion units. And with an EEC mandated 40 percent minimum local content, this is a huge shot in the arm; a tremendous marketing opportunity for Europe. There will be many more examples of this kind to follow as Europe starts getting tough in the globalization economic era.

(Slide 19)

Let's now step down one more level to look at the area of semiconductor production in Europe. Approximately 75 percent of the total semiconductor manufacturing base in Europe is European-owned. I predict that this will decrease over the next five years, not in real terms, but as a percent of total, as foreign companies rush to build new factories in Europe. And here I'm not talking about low value-added assembly plants—the semiconductor equivalent of a screwdriver plant. I'm speaking about full-blown wafer manufacturing facilities. Already Japan, led by NEC in Scotland, has gotten this message loud and clear.

I'd like to pause now to reflect on what I've been discussing over the past 30 minutes or so. What I've tried to do is to walk you "top down" through the current economic, political, and social environment, and show you how we see this changing over the next five years; to look at where Europe's end equipment markets are within this context; and the position of Europe's semiconductor industry to support this. I've made several prognostications en route, but so far no conclusions. Before I do that, I'd like to traverse that same route, "bottom up"—the classical analyst's approach to issue solving.

(Slide 20)

Whenever I've shown this slide in the past, it is always the first-level facts that dominate the dialogue. "See how dominant Japan is in its home market—isn't it time we forced them to open their markets?" Another common statement is "Look how small Europe's share of its own market is, compared with that of Japan and the U.S." To me though, the correct analysis is that Europe, far from being the laggard, is actually a perfect representation of the model multinational citizen of the future—build where you sell, buy where you build—emphasis on local value added.

(Slide 21)

In this new model of future excellence, the essence will be focused on a more even balance and sharing internationally. I would remind you of my earlier comments on the factors characterizing the new globalization economic era.

Europe has already achieved this balance. Its downsizing and adjustment process is well down the track. The U.S and Japan are only just beginning on this route and for them, the painful adjustment process that Europe went through in the 1970s and early 1980s lies ahead. I'm sure they will adjust quicker than Europe did, but today Europe has the strategic and tactical advantage.

(Slide 22)

This necessary adjustment to the U.S and Japanese semiconductor domestic supply markets is of course an export opportunity for Europe's semiconductor manufacturers. In past years, poor export performance has been a fundamental characteristic of the so–called European malaise. Not any more I am glad to say.

In 1987, exports accounted for 42 percent of Philips' worldwide revenue, 38 percent of SGS–Thomson's, and even Siemens, with its still essentially parochial marketing approach to semiconductors, achieved a commendable 28 percent figure. With the already strong home base I talked about earlier, the impact 1992 will have will be in making this position even stronger. European companies are positioned with the strongest set of cards than at any time previously in the history of the semiconductor industry.

Let's turn now to the political initiative in the EEC. What chance does the EEC really have of significantly influencing industrial policy after 40 years or so of internal wrangling over such items of global importance as the price of sugar beet, milk quotas, and other agricultural related issues?

(Slide 23)

In the beginning was Esprit, considered at the time as doomed to failure, except perhaps by the more visionary champions.

This slide shows the present status at the end of the first phase of the program. Even the most cynical are now compelled to accept that this initiative has not been a failure. I would agree it is too early to say it has been a resounding success, but I believe it is fair to say that it has exceeded even the most optimistic of expectations at the onset. It also showed that collaborative research could work and it spawned many clones, e.g. Alvey, Eureka, and Jessi as well as specific company collaboratives, e.g. Philips' and Siemens' Megaproject. Moving on from collaborative research and development to manufacturing, I would remind you of a prophecy I made in 1984 that a major restructuring in the world semiconductor industry was imminent.

To succeed in the semiconductor industry you need to have either a sufficiently large market share to be somewhat isolated and protected from the industry's cyclical or tactical issues (that figure is around 4 to 8 percent market share). Or you need to be small enough to exploit a niche market opportunity, either technology or market related, where other factors allow a leadership position to be developed within a narrow field. Only a handful, perhaps 10 or 12 companies, will be in the former position, whereas in the latter position, this is where the bulk of the semiconductor companies will lie. Each will have less than 1 percent market share.

It is in the middle band where the bulk of the industry realignments will occur—companies that are too big to be small and too small to be big. For these companies there is only one of two options. Merge (or be merged) or face extinction.

(Slide 24)

As you are aware, there have been many such examples of mergers in the semiconductor industry over the past 18 months, most noticeable in Europe that of SGS and Thomson, Plessey and Ferranti, and Brown Boveri and ASEA. In all cases, the combined companies are potentially much stronger and better equipped to face the issues of globalization than either part could have done independently.

(Slide 25)

Moving on now to Europe's equipment manufacturers. Here, too, evidence of change is endemic. I'd like to draw your attention to two interesting examples.

First, cellular radio in Scandinavia. As the result of cooperation between the four local manufacturers and their PTTs, Sweden, Norway, Denmark, and Finland have managed to achieve an economy of scale and technological leadership that none could possibly have achieved unilaterally. And that in perhaps the most closeted of all industries—telecommunications.

(Slide 26)

Secondly, the activities of an organization called STACK. In existence now since the early 1970s, STACK is a user group of predominantly European system manufacturers whose role is to exploit the benefits of shared resources. An incredibly visionary decision when first formed and one of Europe's true success stories.

Its early pioneering work has already put in place real programs covering the issues that are today only just beginning to achieve the necessary level of visibility in many other companies.

(Slide 27–29)

These three slides show a sample of some of the programs STACK has already established.

(Slide 30)

If one returns to the changing industry characteristics brought about by the era of global economy, these driving forces at work in the changing supplier/customer relationships show remarkable coincidence to the programs already successfully undertaken by STACK.

(Slide 31)

I mentioned this briefly earlier in my talk, but the implication of the previous slide is that as a result of the changing supplier/manufacturing relationships, foreign companies operating in Europe will progressively move down the so-called "value added" manufacturing chain, from sales, moving rapidly through pure assembly (or screwdriver operations) down to design, development, real local manufacturing, and local

procurement, to eventual export of original European conceived and manufactured products. IBM is probably the best established in this regard at the present time, though other foreign companies, notably Digital and Sony, are catching up fast—the trend is inevitable. Given the 1992 deadline, we expect an acceleration of this trend as foreign companies strive to become good Europeans before the internal trade barriers fall.

(Slide 32)

I polled our internal Dataquest statistics recently to review the five hottest areas in the electronics equipment markets. They are shown here listed in this slide. Europe's electronics manufacturers are already strongly positioned in all of these areas of activity. The SEA and the resultant strength that a consolidated single market will provide gives them a unique opportunity to achieve a world-class position as these industrial segments reach maturity.

I would like now to use my closing minutes to draw some conclusions.

(Slide 33)

First, Europe will become a unified market after 1992. Restrictive trade barriers will be illegal, the market size will truly be 330 million people, and new European standards will emerge, especially in the areas of consumer electronics, telecommunications, and data processing. Companies that fail to recognize this prospective reality are destined for the scrap heap. And no matter how intransigent the problems may appear today, ignoring the inevitable will not help.

The resultant economies of scale will drive down operating costs and Europe will be not only more competitive in its own market, but strategically and tactically positioned to exploit the export opportunities from a position of strength and equality with its other world competitors.

(Slide 34)

Europe will have the necessary semiconductor technology in place. Programs such as Esprit, Eureka, Megaproject, and Jessi will ensure that. It has today a production process capability comparable to the best, e.g. 1.2 micron CMOS, 1.5 micron bipolar, BiCMOS, and state-of-the-art sophisticated packaging techniques.

The EEC initiative will also ensure that multinationals do adopt sound "good citizen" operating principles already discussed, including a high value-added local procurement content, and collaborative research and development, to ensure a strong manufacturing base is maintained. Europe's existing industrial strength will increase significantly.

(Slide 35)

As I speak to you here today, 1992 is only 1,653 days away. The question that remains on the table is whether the progress towards it will be evolutionary or revolutionary. Clearly the methods of managing revolution are different from evolution.

I believe it will be revolutionary—and those companies that act the fastest will be the ones to make the substantial gains in the future. Indeed, I would go even further. I believe that if you haven't today already got a clear plan in place to take account of this effect that the SEA will have when it comes to force an 31st December 1992, it may already be too late.

Now for some tactical advice—how to organize a revolution.

(Slide 36)

For this I've called upon the collective wisdom of prior experts to this field: Marx, Lenin, and Mao.

- Get rid of the old guard
- Build a new team
- Explain the new reality
- Develop a new philosophy and culture
- Implement a new strategy
- Declare a general modularization
- Keep the revolution going

(Slide 37)

To conclude, I believe we do have a picture of 1992; we think we know what it will look like, but the trouble is, it is currently a jigsaw and the pieces are distributed throughout the countries in Europe. For the first time in nearly two decades, the 1990s offer the outlook of a new springboard for economic policy management and for major reductions in chronic European unemployment.

I would like to close by postulating the answer to the following question: What will be the critical success milestones looking back to 1992 in, say, 1998?

The first is really a prerequisite, without which the reality of a single European market will be unattainable—monetary unity and a central European bank. The second is qualitative, a perspective, and that is the feeling that the job is not quite finished yet. And third, the quantitative aspect, that the growth in Europe was higher than it would have been had unity not occurred.

The challenge of a single European market by 1992 is first and foremost a challenge for Europeans. If they respond robustly, they will propel Europe onto the world stage in a position of competitive strength and on an upward trajectory of economic growth lasting into the next century.

Jennifer Berg
Malcolm Penn

(Slide 1)

1992: HAS EUROPE GOT IT?

MALCOLM G. PENN

VICE PRESIDENT

DATAQUEST EUROPE

(Slide 2)

1992

In 1992 the EEC countries form a genuine "Common Market".

"The 31st December 1992 deadline is now enshrined in a single European Act which defines the international market as an area without frontiers in which the free movement of goods, persons, services and capital is insured". "In recent months there has been an upsurge of support from businesses for the grand design implicit in the 1992 deadline".

"The Commission will develop a policy to promote the services market with an eye to completion of the internal market and the growing globalisation of trade".

JACQUES DELORS - EEC PRESIDENT - 20 JANUARY 1988

(Slide 3)

POSTWAR WORLD ECONOMIC RECOVERY

- Market liberalization
- 1920s/'30s trade barriers dismantled
- Government-nurtured cartels broken up
- Controls on direct foreign investment lifted

Since the 1970s there has been
a gradual shift away from market-led forces

The Single European Act will turn the tide

(Slide 4)

TRADE BARRIERS -- EUROPE

- Technical
  - -Standards (TV, telecommunications, power supplies)
  - -Safety
  - -Environmental (RF radiation, automobiles)

- Financial
  - -Standard terms and conditions
  - -Local currency trade
  - -Interest rates and capital sources

- Government and legal
  - -Tariffs and tax rates
  - -Duties
  - -Quotas
  - -Subsidies

(Slide 5)

1992 IMPACT

- This will require a substantial re-think of our marketing strategies
- Can manufacturers continue to have 'Country' organisations defining
  - marketing strategies?
  - sell prices?
  - inventory levels?
  - support?

(Slide 6)

NEW ECONOMIC ERA - GLOBALIZATION

Seven factors on global economy

- Trade
- Macroeconomic policy
- Currency fluctuations
- International competition
- Direct and indirect investment
- Foreign capital flows
- Information transfer

(Slide 7)

THREE PHASES OF SEMICONDUCTOR INDUSTRY

- Phase 1 – Technology
- Phase 2 – Manufacturing
- Phase 3 – Marketing

(Slide 8)

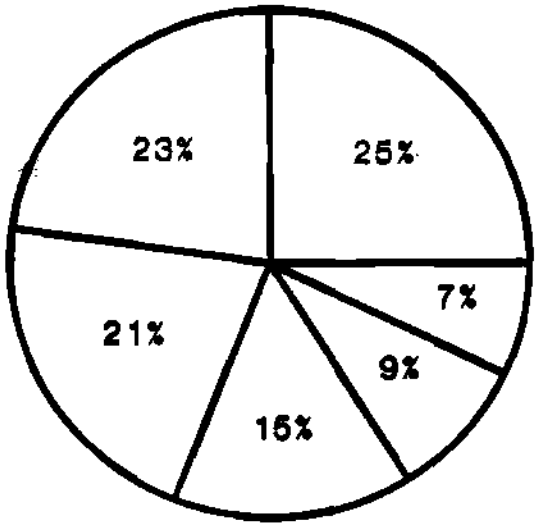
POSITIONING INTERNATIONALLY

Means sharing internationally

- Products and technologies
- Organizational restructuring
- Horizontal and vertical alliances
- Customer-orientated as first objective

(Slide 9)

EUROPEAN SEMICONDUCTOR MARKET BY END-USE SEGEMENT - 1987



Source: Dataquest

(Slide 10)

EUROPEAN COMPONENTS GROUP

Telecommunications

- Merger mania
  - GEC-Plessey
  - Ericsson-Matra
  - Bosch-Schneider
  - Alcatel-ITT

- Growth areas - 1987-1988
  - Modems - $540 million to $611 million - 13.1% growth
  - Central switches - $8.7 billion to $8.9 billion - 2.8% growth
  - Cellular phones - $730 million to $951 million - 30.3% growth
  - LANs - $524 million to $786 million - 49.9% growth

Source: Dataquest

(Slide 11)

EUROPEAN COMPONENTS GROUP

Computers

- Northern Europe takes the lead
  - Amadahl, Apple, Compaq, Digital, IBM, ICL, Wang
- Higher-resolution graphics
- Networking
- 3.5" disk drives

(Slide 12)

EUROPEAN COMPONENTS GROUP

Industrial

- Medical
  - GEC/Philips venture abandoned
- Energy management
  - Solid-state meter trials in U.K. and France successful
  - Enertec, Ferranti, GEC, Sangamo, Siemens

(Slide 13)

EUROPEAN COMPONENTS GROUP

Consumer

- "Professional consumers"
  - Nokia, Philips, Siemens, Thomson
- Compact disks (DSPs, video, RAMs)
- High-definition TVs (DACs, DSPs, ECL)
- Digital audio tape

(Slide 14)

EUROPEAN COMPONENTS GROUP

Military

- Eurofighter project
- Procurement flat in U.K. and France
- Potential growth in German market
- Airbus Industrie

(Slide 15)

EUROPEAN COMPONENTS GROUP

Transportation

- Huge impact due to currency revaluation
- Slow growth in luxury models
- Semiconductor content increasing
- Car production higher in Europe than in U.S. and Japan

(Slide 16)

EUROPEAN END-USE VENDOR RANKINES - 1987

(Millions of US Dollars)

Segement	Philips	SGS-Thomson	Siemens	Market Size
Data processing	4	8	6	23%
Communications	1	3	5	25%
Industrial	1	3	2	21%
Consumer	1	2	3	15%
Military	4	8	N/A	9%
Transportation	6	2	1	7%
Total	1	2	5	100%
Revenues	$930	$537	$475	$6,335

Source: Dataquest

(Slide 17)

EUROPEAN END-USE VENDOR MARKET SHARES - 1987

Segement	% Share
Data processing	24
Communications	40
Industrial	49
Consumer	65
Military	36
Transportation	48
Total	43

TOP 5 EUROPEAN COMPANIES CONTROL 38% OF THE MARKET

Source: Dataquest

(Slide 18)

JAPANESE PRINTER MANUFACTURER SURVEY

Expected Offshore Printer Production (Thousands of Units)

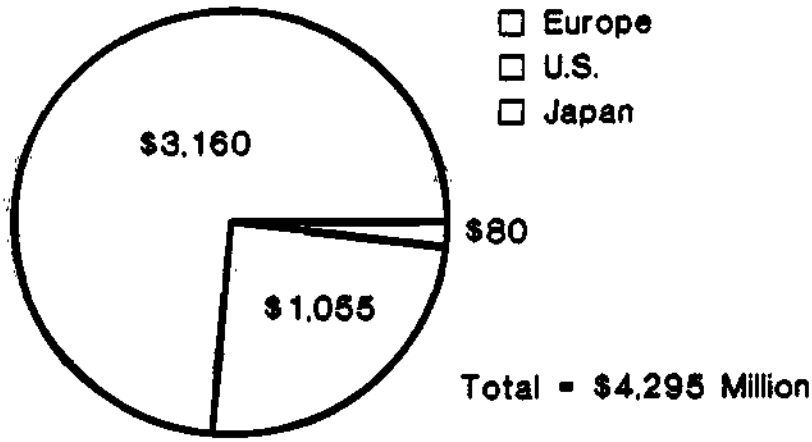
	1987	1988	1990
North America	205	500	850
Western Europe	92	1,245	1,740
Rest of World	3	5	10
Total	300	1,750	2,600

Source: Dataquest

(Slide 19)

ESTIMATED EUROPEAN SEMICONDUCTOR PRODUCTION IN 1987

(Millions of U.S. Dollars)



Source: Dataquest

(Slide 20)

1987 REGIONAL MARKET SHARES

(Billions of US Dollars)

	Europe	US	Japan	ROW	Total
Europe	2.6	0.8	0.1	0.5	4.0
US	2.9	8.7	1.2	1.1	13.9
Japan	0.9	2.0	13.0	1.9	17.8
ROW	0.0	0.2	0.0	0.4	0.6
Total	6.4	11.7	14.3	3.9	36.3

Source: Dataquest

(Slide 21)

1987 EUROPEAN EXPORTS

(Millions of US Dollars)

	Philips	SGS-Thomson	Siemens
Europe	$930	$537	$475
Other	673	322	182
Total	$1,603	$859	$657
% Export	42.0	37.5	27.7

Source: Dataquest

(Slide 22)

IN THE BEGINNING - ESPRIT

Of the 227 projects in first phase

- 143 Industrial significance
- 27 Marketed products
- 44 Products in developments
- 44 Transferred outside esprit
- 28 Contributed to international standards
- 11 Scrapped or merged

(Slide 23)

EUROPEAN SEMICONDUCTOR MERGEOVERS

- Plessey/Ferranti
- Brown Boveri/Asea
- SGS/Thomson

(Slide 24)

CELLULAR RADIO - SCANDINAVIAN EXAMPLE

- Common system throughout Scandinavia
  - Sweden
  - Norway
  - Denmark
  - Finland
- Co-operation between PTT's and local manufacturers

(Slide 25)

STANDARD COMPUTER KOMPONENTEN GmbH

Control Data Corporation
International Computers Limited
The Plessey Company plc
Nixdorf Computer A.G.
Ing. C. Olivetti & C., S.p.A.
British Telecom plc
The General Electric Company plc
Standard Telephones & Cables plc
General Telephone & Electronics Corp.
Honywell Bull Inc.
Italtal S.p.A.
Northern Telecom Limited

(Slide 26)

VENDORS - USERS
CLOSER CO-OPERATION - TO ACHIEVE

- Better Communication
- Improved Quality and Reliability
- Optimum Testing
- Ship to Stock Procedures
- On Time Delivery
- Just in Time Delivery
- Accurate Forecasting
- Shorter Lead Times
- Electronic Data Interchange

(Slide 27)

VENDORS - USERS
CLOSER CO-OPERATION - TO ACHIEVE Cont.

- Standard Packeting for Devices
- Standard Labelling e.g. Bar Codes
- Electronic Data Sheets
- Computerized Device Models
- Realistic ASIC Second Sourcing
- Productive R & D
- Realistic Pricing
- Improved Quality and Realiability
- Lower Cost of Ownership

(Slide 28)

FORMAL MEETINGS

- Technical Policy
- Purchasing – Trend and Techniques
- Test and Correlation
- Purchase Specifications
- Shared Evaluation
- Semi-Custom – USICs
- ASICs
- Failure Analysis Techniques
- Surface Mount Technology
- Surface Mount Dimensions
- Reliability

(Slide 29)

SUPPLIER / CUSTOMER RELATIONSHIP

Closer	Strategy – Technology roadmaps
	Product migration linkage
	Matched quality programmes
	Co-operative programmes
	– Developments
	– Qualifications
	– Tools
	Total data sharing
Longer-fewer	Take time to establish
	Resources to maintain
	Sensitive data transfer
	Win-win requires changes

(Slide 30)

VALUE ADDED MANUFACTURING CHAIN

- Sales
- Assembly
- Manufacturing
- Local procurement
- Design and Development
- Export

(Slide 31)

MULTINATIONAL CITIZEN PROFILE

Buy where we build and sell

- Products
- Services
- Technology
- Jobs
- Export

(Slide 32)

MAJOR MARKET OPPORTUNITIES

Markets	5-Year CAGR*
32-bit PCs	53.0%
Digital TVs	30.0%
Smart Card Electronics	60.0%
Automotive Electronics	10.7%
Personal Communications	26.0%

* Measured in dollars

Source: Dataquest

(Slide 33)

EUROPEAN ELECTRONICS INDUSTRY

Future Trends

- Europe will become a unified market after 1992
- Restrictive trade barriers will disappear
- Size of population will be 330 million
- New European standards will emerge in consumer, telecommunications, computer
- Scale of economy will drive down costs
- Europe will be more competitive in its own market

(Slide 34)

EUROPEAN ELECTRONICS INDUSTRY

Future Trends

- Europe will have state-of-the-art processing capability
  - Esprit, Eureka, Megaproject, Jessi
- European Community will ensure:
  - Multinationals sourcing components locally
  - Collaborative R & D on all fronts
  - Maintaining strong manufacturing base
- Europe
  - Still strong in consumer, automotive
  - Telecommunications will get stronger
  - Stability in military market

(Slide 35)

ARE WE FACING EVOLUTION OR REVOLUTION?

- If we decide the 1992 opportunity will substantially change the "rules" under which we operate – then it must be "revolution".
- The methods of managing revolution are clearly different from evolution!

(Slide 36)

HOW TO ORGANISE A REVOLUTION

1. Get rid of old guard
2. Build a new team
3. Explain the new reality
4. Develop a new philosophy and culture
5. Implement a new strategy
6. Declare a general mobilisation
7. Keep the revolution going!

Source: Marx, Lein, Mao

(Slide 37)

THE 1992 CHALLENGE

HIGH STAKES FOR EUROPE -

THE PRIZE WITHIN THE GRASP

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a company of
The Dun & Bradstreet Corporation

Research Newsletter

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FAR EAST MARKET OVERVIEW

SUMMARY

The year 1987 was full of major changes for Japanese printer manufacturers. The dollar-to-yen exchange rate reached the highest point in history, antidumping pressures from Western Europe became a reality, and Japan was asked to change its export-oriented economic structure.

This newsletter focuses on several topics relating to the Japanese printer industry, including the following:

- Japanese worldwide printer shipments
- The Japanese domestic market
- Trade friction
- Japanese overseas manufacturing trends

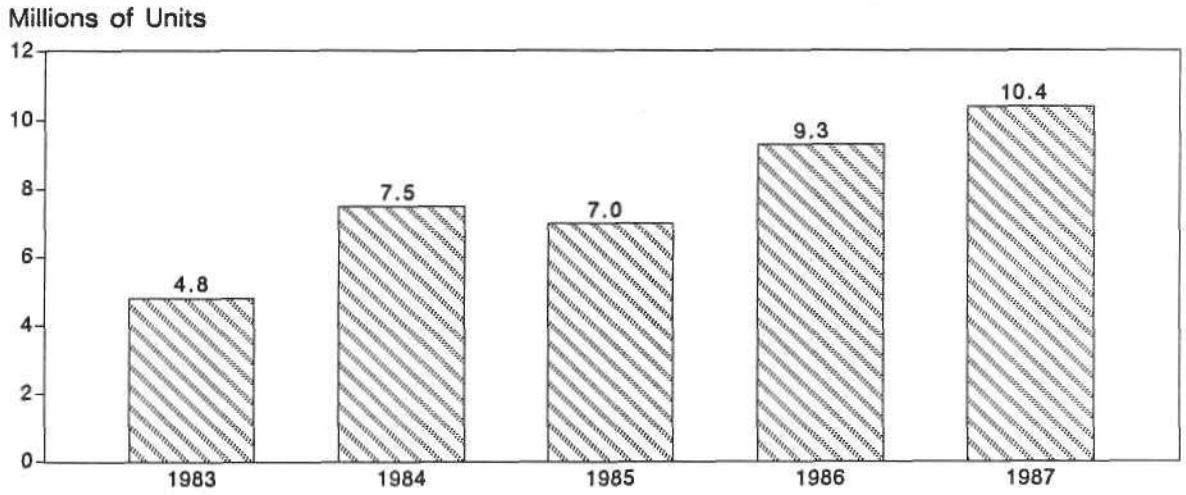
(The material in this newsletter was derived from a presentation given by Kenji Muto, an Industry Analyst at Dataquest Japan. Mr. Muto gave his presentation at Dataquest's thirteenth annual Electronic Printer Industry Conference in April 1988.)

JAPANESE WORLDWIDE PRINTER SHIPMENTS

As shown in Figure 1, Japanese printer shipments for the past five years have grown at a compound annual growth rate (CAGR) of 22 percent. In 1983, 4.8 million units were shipped; in 1987, 10.4 million units were shipped with an export ratio of 90 percent. Dataquest expects that Japanese local printer production will drop below 10 million units in 1988. This expected decline in local Japanese production will result from the production shift to Western Europe due to EEC protectionist actions.

Figure 1

Total Japanese Printer Shipments



Source: Dataquest
June 1988

The 1987 Japanese printer shipments by world region are shown in Figure 2. The 10.4 million units shipped are broken out into the following regions:

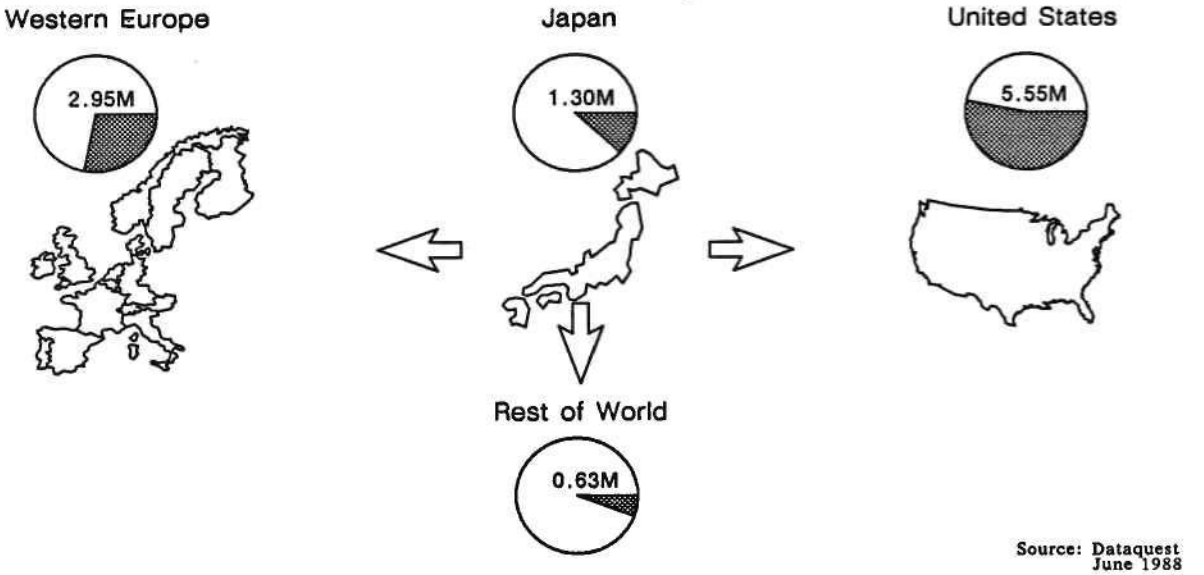
- 5.55 million, 53 percent, shipped to the United States
- 2.95 million, 28 percent, shipped to Western Europe
- 0.63 million, 6 percent, shipped to the Rest of World countries
- 1.30 million, 12.5 percent, remained in the Japanese domestic market

Table 1 illustrates the 1987 Japanese printer shipments for the overseas and domestic markets, by printer technology. For the 1987 overseas market, the combined serial, impact, dot matrix (SIDM) and page, nonimpact, plain paper (PNPP) printers represented more than 90 percent of total units shipped. For the 1987 Japanese domestic market, however, the serial, nonimpact, thermal transfer (SNTT) and serial, impact, dot matrix printers accounted for more than 90 percent of the shipments.

In terms of units, Epson is the world's leading printer shipper with its products under the Epson brand name. The second leading exporter is TEC, which is an OEM–oriented company. Following TEC is Oki. For the Japanese domestic market however, NEC is the leading shipper because of its 40 percent personal computer market share. Total Japanese domestic computer shipments for 1987 were estimated at 1.3 million units, with PCs accounting for 1.2 million units. Following NEC in the domestic printer market are Epson and Oki.

Figure 2

1987 Japanese Printer Shipments by Region



Source: Dataquest
June 1988

Table 1

1987 Japanese Printer Shipments, by Technology

Technology	Overseas Units(M)	Overseas Percent	Domestic Units(M)	Domestic Percent
Serial, Impact, Dot Matrix	7.61	83.5%	0.94	72.1%
Page, Nonimpact, Plain Paper	1.14	12.5	0.03	1.9
Serial, Nonimpact, Thermal Transfer/ Direct Thermal	0.08	0.9	0.27	21.0
Serial, Impact, Fully Formed	0.23	2.5	0	0.1
Serial, Nonimpact, Ink Jet	0.04	0.4	0.02	1.6
Line, Impact, Fully Formed/ Dot Matrix	0.01	0.1	0.03	2.6
Line, Nonimpact, Thermal Transfer/ Direct Thermal	0.01	0.1	0.01	0.7
Total	9.12	100.0%	1.30	100.0%

Source: Dataquest
June 1988

Most of the Japanese firms are quite diversified. Consequently, printer sales are a small portion of their total business. For Epson, TEC, and Oki, 40, 25, and 20 percent of their total sales, respectively, are attributed to printers, and only 4 percent of NEC's sales are attributed to printers.

Japanese Domestic Market

The 1987 Japanese domestic printer market represented 1.3 million units (12.5 percent) of the total worldwide Japanese shipments. Dot matrix printers accounted for 940 thousand units (72.1 percent) and thermal transfer printers accounted for 270 thousand units (21 percent). Shipments of other printer technologies represented rather small shares of the market.

Shipments of the 24–wire, dot matrix printers in Japan accounted for 93 percent of all serial, dot matrix printer shipments, whereas the 18–wire printers accounted for only a few thousand units shipped. This imbalance is a result of the high resolution offered by 24–wire printers, which is needed when printing kanji characters. It is interesting to note that Epson recently introduced a $2,500, 48–wire, 300–dpi dot matrix printer, to the domestic market, the VP–4800.

The previously discussed Japanese domestic printers are those that are connected to computers. In the thermal transfer market, there is another market segment, the built–in Japanese word processor market (JWP). In 1987, more than 2 million JWP units were sold, of which at least 1.5 million were lap–top type printers. The JWP lap–top configuration consists of the following:

- A keyboard
- An LCS 4 x 10–inch display
- A 3.5–inch flexible disk drive
- An 80–column serial, nonimpact, thermal transfer (SNTT) printer

If this shipment segment were counted, the total serial, thermal transfer market would consist of 1.8 million units. In terms of resolution, JWP printers are increasing to 36, 42, and even 56 elements per printhead.

Table 2 shows the Japanese domestic printer market rankings segmented by technology. As noted in the table, NEC is strong in the serial, dot matrix technology. The most popular speed range is 120 to 180 cps, accounting for 40 percent, followed by 181 to 250 cps, accounting for 25 percent. Printing kanji takes approximately one–third to one–half the time required for printing the Japanese alphabet—alphanumeric Kana (ANK).

Table 2

Japanese Domestic Market Share
(Based on Units)

SIDM		SNTT		PNPP	
1. NEC	49%	1. NEC	80%	1. Canon	90%
2. Epson		2. Epson		2. TEC	
3. Oki		3. Hitachi		3. NEC	

Source: Dataquest
June 1988

For the serial, thermal transfer technology, NEC is again the top market participant. The personal computer market affects this segment because the printers used are for the low-end PCs. The top three participants hold 80 percent of the market and offer speeds of less than 120 cps.

In 1987, Japanese page printers were in the introductory stage, and only 28 thousand units were shipped to the domestic market. However, we expect the Japanese domestic page printer market to soar in 1988. The desktop publishing market is also expected to grow in the third quarter of 1988.

TRADE ISSUES

Our trade friction analysis is based on our Japanese printer manufacturer survey in the first quarter last year. The survey results are based on 27 of the major Japanese printer manufacturers. Seventeen companies responded to the survey. Our survey covered the following topics:

- The movement of overseas production and its related problems
- The exchange rate issue and its effect on overseas production
- The Japanese printer manufacturers' response to trading difficulties

As previously stated, the major Japanese printer production technology is serial, dot matrix. The survey respondents accounted for over 70 percent of the entire serial, dot matrix production. We believe that this percentage qualifies the validity of the survey results.

Table 3 illustrates the respondents' offshore printer production plans. As shown for 1987, the actual production was 300 thousand units, of which 200 thousand were produced in North America and 92 thousand were produced in Western Europe. We project that in 1988, production units will increase to 500 thousand for North America and 1.25 million for Western Europe.

Table 3

Japanese Printer Manufacturers' Projections for
Estimated Offshore Printer Production
(Thousands of Units)

	1987	1988	1990
Western Europe	92	1,245	1,740
North America	205	500	850
Rest of World	3	5	10
Total	300	1,750	2,600

Source: Dataquest
June 1988

MOVE TO WESTERN EUROPE

The primary reason for Western Europe's production growth stems from the expected EEC antidumping duty expected to be levied on serial, dot matrix printers. In 1987, Japanese printer exports to Western Europe were 2.9 million units and both serial dot matrix and fully formed printers were produced in Western Europe by Japanese companies. We expect that in 1988, 38 percent of the Western European market shipments will be produced locally by Japanese firms. Page printers will also be manufactured in Western Europe. By 1990, the number of locally produced units is predicted to increase to 1.74 million units.

The situation is different for Japanese production in North America, however. Production growth is moderate in North America compared with Western Europe.

The locations of Japanese printer factories in Western Europe are shown in Figure 3. These factories have commenced operations within the last 15 months and should expand production this year. We believe that the expected monthly run rate will reach 160 thousand units. The average factory size is anticipated to be 8,000 square meters with 1,200 total employees for this factory expansion.

Figure 3

Location of Japanese Printer Manufacturers in Western Europe

1.	Brother	Wrexham
2.	Citizen	Scunthorpe
3.	Epson	Telford
4.	Star	Tredagar
5.	NEC	Tekfird
6.	Oki	Glasgow
7.	Panasonic	Newport
8.	Canon	Littre
9.	Epson	Paris
10.	Canon	Aglie
11.	Fujitsu	Malagre
12.	TEC	Braunschweig

Source: Dataquest
June 1988

Local Content

In June 1987, the EEC passed legislation to control local content of new factories set up by companies with products subject to EEC antidumping duties. Essentially, the law states that products assembled in the EEC to escape antidumping duties must have 40 percent local content. The EEC group investigating local content in European factories has recently completed its investigation of electronic typewriter factories, and it is currently evaluating local content in copier factories. The investigation of SIDM factories will begin in the fall of 1988.

How soon can Japanese printer manufacturers meet with local content requirements? Table 4 focuses on this issue. As shown, within the next two years, a 50 percent local content goal is possible, but it will pose a challenge for manufacturers.

Table 4

Japanese Printer Manufacturers' Projections for Meeting Local Content Requirements (Western Europe)

Number of Years	% Content	Part	
0.5	22	Case Mechanism	Electronic, PWB
1.0	41	Case PCB	Manual Book
1.5	45	Motor PCB	Mechanism, Electronic
2.0	50	PCB	

Source: Dataquest
June 1988

Japanese manufacturers indicated that it would take twice as long to reach a 50 percent goal, compared with 40 percent, which is the requirement mandated by the EEC. Table 5 illustrates the key concerns of Japanese manufacturers regarding overseas production in both North America and Western Europe. The three primary problems for Japanese companies manufacturing overseas are:

- Parts procurement
- Quality control
- Production costs

In the past, these problems were advantageous for Japanese manufacturers, however, but now, production and local content requirements are making overseas production disadvantageous. Production cost is a key element in manufacturing.

Table 5

Japanese Printer Manufacturers'
Key Concerns in Overseas Production

Concern	Points*
Parts Procurement	91
Quality Control	82
Production Cost	71
Delivery	40
Worker Education	36
Local Government	35
Domestic Employment	31
Research and Development	23

*Maximum points possible = 100

Source: Dataquest
June 1988

This year, Japanese manufacturers have projected the dollar–to–yen exchange rate as $1 to ¥123.8. The projected range is relatively small: between ¥120 and ¥130. If the yen rises to 100, the expected overseas production ratio increases by nearly 50 percent. Changes in the dollar–to–yen exchange rate will primarily affect overseas production in North America.

Table 6 illustrates the Japanese printer manufacturers' projected actions toward government dumping charges. The top three answers to our survey question were factory set up, joint ventures with local manufacturers, and rationalization of production. In the case of Western Europe, factory set up has already taken place due to the European community movement.

One–half of the survey respondents said they believe that some sort of trade restriction action will be taken by the U.S. government. The reasons they gave dealt with inconclusive trade laws and the U.S. manufacturers' appeal regarding dumping of serial, dot matrix printers.

Regarding the high yen exchange rate, the respondents said they believe that a decrease in sales will occur. To maintain revenue, either price or volume will have to increase, resulting in either a value–added product or low–cost, high–volume production. Japanese manufacturers indicate they will focus on the following value–added areas, by technology:

- PNPP—Higher functionality, dependability, software, controller, and color
- SIDM—Paper handling, increased copies and speed, lower noise level, and special paper capabilities
- SNIJ and SNTT—Regular paper, color, and high resolution

Table 6

Japanese Printer Manufacturers'
Projected Actions from Government Dumping Charges

Activity	North America*	Western Europe*
Factory Set Up	90	89
Change Export Item	31	32
Lobby Japanese Government	46	50
Withdraw from Market	17	20
Local Joint Venture	72	83
Lobby Local Government	39	37
Rationalize Production	73	71
Review Marketing Channel	42	55

*Maximum points possible = 100

Source: Dataquest
June 1988

The characteristics of the Japanese manufacturers in the printer business include the following:

- No Japanese company manufactures printers exclusively.
- Diversification of business is the mission for Japanese manufacturers.
- Capturing market share is a prime strategy. Adequate market share, low-cost, and mass-quality production can provide enough investment return.

Even among Japanese manufacturers, these characteristics lead to highly competitive environments. On the other hand, both Western Europe and the U.S. SIDM producers' governments are focused on local production and niche markets.

DATAQUEST ANALYSIS

We expect 15 percent of Japan's 1988 production capacity to move overseas. This trend is likely to continue because Japanese players are not only questioning the world economy, they are also realizing that cooperation and peaceful coexistence is imperative in order to maintain their prior levels of success. Thus many Japanese manufacturers are now seeking new ways of becoming recognized international companies by adding value to their products and contributing to the local economy.

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Jennifer Berg
Robert Fennell

Dataquest
a company of
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FAX MARKET SURGES AHEAD; JAPAN LEADS THE PACK

SUMMARY

The year 1987 proved to be another period of major growth for the worldwide facsimile market. In regional terms, the European market grew the fastest, with a compound annual growth rate (CAGR) of 110 percent (1987 versus 1986). The Japanese market, which is more mature, increased at a CAGR of 49 percent, while the U.S. market grew by a significant CAGR of 102 percent.

In terms of unit shipments, the Japanese still led in 1987 with 1.1 million units. The number of European shipments (421,000 units) was slightly higher than U.S. shipments (417,000 units) for the second year running (see Table 1).

Table 1

Estimated Worldwide Facsimile Shipments
(Thousands of Units)

	1986	1987	1991	CAGR 1987-1991
Asia	40	60	329	53.0%
Europe	199	420	1,876	46.0%
France	21	45	256	54.5%
Italy	21	60	211	37.0%
Sweden	11	20	64	34.0%
United Kingdom	50	100	340	35.8%
West Germany	24	60	340	54.3%
Rest of Europe	72	135	665	49.5%
Japan	738	1,100	2,280	22.0%
North America	227	456	1,500	34.5%
United States	206	417	1,380	35.0%
Canada	21	39	120	34.0%
Rest of World	25	45	136	32.0%
Total	1,229	2,081	6,121	31.0%

Source: Dataquest
May 1988

All this activity is of great interest to Japan, where 98 percent of the world fax manufacturing is currently taking place.

In this newsletter, we will review the present fax market and the Japanese manufacturing phenomena. In addition, we will look at some development factors affecting the market into the 1990s.

MARKET OVERVIEW

A facsimile (fax) machine is a telecommunications product that must meet the stringent and often restrictive requirements of local PTTs and operating companies in order to receive approval for connection to the public switched telephone network (PSTN). Given that fact, it is a remarkable phenomenon that, in 1987, more than 98 percent of the approved fax machines were of Japanese origin. Furthermore, as the market continues to grow, Dataquest expects the proportion of Japanese fax machines to exceed 99 percent in 1988. The following factors contribute to this situation:

- Although the fax machine was initially developed in Europe by Muirhead and in the United States by Xerox, these western manufacturers were unable to maintain high volumes of commercially attractive products; they had stopped manufacturing fax machines by 1975.

- The fax machine was then found to fulfill a major user requirement in the Japanese market as a mean of communicating kanji characters. Consequently, the Japanese domestic fax market grew rapidly; local production became firmly established, helped by this strong internal demand.

- The fax machine proved to be a product ideally matching Japan's skills in high-volume electronic production, based on the country's abilities in improved productivity and electronic miniaturization.

- By 1987, Alcatel of France was the only non-Japanese manufacturer producing its own fax equipment (sold under the brand name Thomfax).

  - Alcatel had trouble manufacturing products to the same price margins as the Japanese, however. Consequently, during 1987, Alcatel made an agreement to manufacture equipment in France under license from Toshiba.

  - Alcatel will continue to manufacture the high-end "feature machines" but will only partly manufacture and assemble Toshiba products for the low end of its product portfolio.

- Sagem, another French manufacturer, has reached a similar agreement with Murata of Japan. However, under this agreement, Murata will supply all the products of the Sagem portfolio.

- These two agreements permit continued fax manufacturing in France and an increased dependence on Japan as the low-end fax product market share continues to increase.

- Dataquest believes that as Japanese manufacturers proceed further along the learning curve of high-volume fax production, it will become much more difficult for any other country to successfully compete in the production of facsimile equipment.

Tariffs and Import Restrictions

Having noted the domination of the fax market by Japanese manufacturers, we must also consider the issue of trade barriers. Similar situations of overwhelming Japanese production superiority have developed in both the copier and the electronic printer industries. A review of these industries may help to explain the international reaction.

During the last 12 months, action has been taken by the European Commission and a number of individual countries to impose severe penalties on products that are not at least assembled within relevant trade zones such as Europe or America. In the case of fax products, the issue of PTT approval further complicates free access to a market.

Dataquest believes that the Japanese manufacturers should take note of this international trend to require local manufacturing and should make appropriate plans. In fact, a number of Japanese manufacturers have already positioned themselves to meet such market restrictions. Most notable is Canon, which has reached a marketing and manufacturing agreement with Olivetti in Italy and has established its own fax manufacturing facilities in France.

Ricoh with Kalle Infotec, NEC, and Toshiba also have local manufacturing facilities that could commence fax operations, if required.

The 1987 Fax Market

Table 1 presents the initial Dataquest estimates of worldwide facsimile shipments for 1986, 1987, and 1991.

Table 2 shows the initial Dataquest market share estimates for the top suppliers in the European facsimile market for 1987.

Table 3 provides a breakdown of 1987 shipments into the major European countries.

Table 2

European Facsimile Market Share by Supplier (Actual Units)

Supplier	Units	Percent Share
Panasonic	70,800	16.8%
NEC	45,274	10.7%
Canon	73,900	17.5%
Infotec	38,727	9.2%
Alcatel	39,200	9.3%
Toshiba	31,650	7.5%
Oki	39,995	9.5%
Sharp	20,670	4.9%
Xerox	8,610	2.0%
Murata	17,765	4.2%
Hitachi	13,604	3.2%
Fujitsu	10,013	2.4%
Pitney Bowes	4,750	1.1%
Others	6,905	1.7%
Total	421,863	100.0%

Table 3

Estimated 1987 European Facsimile Placements (Actual Units)

Country	Units	Percent Share
United Kingdom	102,951	24.4%
France	45,032	10.7%
West Germany	59,294	14.1%
Italy	57,391	13.6%
The Netherlands	21,593	5.1%
Norway	17,392	4.1%
Sweden	21,530	5.1%
Switzerland	16,727	4.0%
Belgium	18,393	4.4%
Greece	1,839	0.4%
Finland	7,784	1.8%
Denmark	15,577	3.7%
Spain	18,827	4.5%
Turkey	3,755	0.9%
Ireland	3,030	0.7%
Austria	6,582	1.6%
Portugal	2,725	0.6%
Others	1,449	0.3%
Total	421,871	100.0%

Source: Dataquest
May 1988

Market Analysis and Forecast

From 1984 through 1986, most facsimile shipments in Europe and in the United States were aimed at businesses' communication rooms, in which the fax machine typically stood next to the telex machine. In 1986 and 1987, the low-end facsimile products began to penetrate smaller business organizations and started to find their way into department-level applications.

Dataquest believes that shipments through 1992 will show the greatest growth in the low-end product sectors. The low-end products are becoming increasingly popular in Japan; now they are becoming known by the alternative name, "personal fax." Using innovative production techniques, the Japanese manufacturers are making these products even more compact, progressively decreasing the footprint size, and integrating a telephone handset with the box.

Personal faxes are beginning to penetrate very small businesses now, in addition to being targeted for executive desktops. As the average selling price (ASP) of these machines continues to decline, two questions arise:

- What proportion of desktops and homes of business executives will become populated by faxes? In other words, what is the personal fax total available market (TAM)?
- What channels of distribution should be used for these products as the cost of sales becomes a proportionally more significant factor in the product price?

The Japanese fax market, which is one to two years ahead of the European and U.S. markets in maturity, is already beginning to face these issues. Retail channels are being tried, and Dataquest recently noted personal fax machines on sale in Tokyo stores for as little as ¥79,000 ($640).

Focusing on retail channels, however, ignores the issue that the fax machine remains, in principal, a business tool with the need for effective supplier provisions and maintenance contracts. Thus, the retail channel is less attractive to the business purchaser. Home, door-to-door salespeople are finding resistance for similar reasons.

Dataquest speculates whether improved advertising techniques, combined with toll-free call facilities for more accurate prospective customer identification prior to sales calls, would reduce direct sales costs (i.e., through achieving a higher percentage sales close rate). Other low-cost sales channels may exist, including office-related electronics retail stores and mail order sales.

TECHNOLOGY TRENDS

Personal Fax Machines

Personal fax machines that are compatible with CCITT Group III standards certainly show much growth potential in the short to medium term.

Color Facsimile Machines

The Japanese, however, are also working on new facsimile developments, and one specialized development is color facsimile. NEC recently demonstrated a prototype of such a machine; however, the technology is still very expensive at this time. We believe that color facsimile certainly could become a very successful niche market sector in the future. Two-color-image (red and black on white) faxes are also becoming available, and Ricoh recently demonstrated a prototype of such a product. These machines are likely to be used in editing applications such as highlighting or making corrections to areas of text and graphics.

Group III Facsimile Machines

High-end Group III fax machines with store-and-forward capabilities, although currently representing only 5 percent of all fax units sold, are expected to show strong growth, with a 70 percent CAGR through 1992. This segment is less price sensitive and is aimed at placements within the headquarters of large companies. Consequently, we believe that many extra new functions and technology advancements will be seen in this area. Other capabilities that we expect to become available with machines in this segment are fax networking and switching functions.

A further advancement that is currently receiving a lot of research and development attention is error correction for secure transmission. The CCITT has put together a preliminary specification for such a facility, and a number of manufacturers are working to have this feature available with their products by the end of 1988.

Plain Paper Facsimile Machines

Much effort continues in the area of plain paper facsimile (PPF) machines. At this stage, these machines are at least twice as expensive as thermal paper machines. Such a high price effectively makes PPF products unacceptable in a market where the user usually has a plain paper copier not far from the fax machine, which means that if required, a PPF copy can be produced easily and at minimal extra cost. The Japanese are currently working on technologies that may eventually drop the price of a PPF machine much nearer to that of a thermal machine. If such a price reduction is achieved, Dataquest expects the PPF market to open up quite rapidly.

Group IV Facsimile Machines

Looking forward, the big question is about Group IV facsimile machines. These products will require an ISDN or compatible 64K digital network to operate. We do not believe that they will be widely available before 1995, even in countries with advanced telecommunications infrastructures. Although Group IV faxes will be capable of sending messages at approximately 3 seconds per page, this capability is already being achieved through improved Group III coding techniques such as Modified Modified Read (MMR), which currently has reduced the transmission time from about 20 seconds to 9 seconds. Further transmission improvements are under development. The recent advancements of Group III clearly reduce the advantage of Group IV. Furthermore, the fax machine became attractive as a text-transmission medium only once a solid user base had been established. The same problem will be encountered by Group IV machines until they gain acceptance and establish a worldwide user base.

Although Group IV will certainly establish its market niche, particularly within large internal network applications, we do not expect it to take a dominant position over Group III in terms of shipments until well into the 21st century.

JAPANESE MANUFACTURING

Japan's success in the realm of facsimile is due to the country's formidable record of achieving economy of scale in electronic manufacturing techniques. Although one South Korean manufacturer has recently entered the facsimile market, its product is comparatively much lower in quality. We believe that this product will need considerable improvement before it becomes a serious contender against Japanese products in world markets.

Factory Automation

Meanwhile, Japan continues to improve its electronic production techniques through advances in semiconductor technology as well as increasingly sophisticated production robots, such as pick-and-place semiconductor component assembly systems.

The Oki Honjo (North of Tokyo) is one of the most modern automated facsimile assembly facilities in Japan. Following a recent refurbishment program, it uses 300 assembly and quality-inspection robots linked to a fully computerized stores-and-supplies system in what is known as an FA (factory automation) environment. Nevertheless, the facility still employs 900 direct workers involved in the fax manufacturing area, as well as a number of subcontractor companies that deliver completed and tested subassemblies and other components to the plant at least twice daily.

Oki insists that all the subcontractors are in the area, close to the Honjo plant to ensure secure product delivery. The subcontractors themselves all work in a typically Japanese manner, with timely deliveries of high-quality products. The stores area is thus minimized, and the reject rate is extremely low. Subassembly and other partly finished components are shuttled around the facility on computerized delivery vehicles that beep and flash warning lights whenever humans cross their paths.

In order to address new target markets, Japanese manufacturers also plan to design fax products with an ever-decreasing footprint size. One of the factors contributing to this effort is a new and extremely compact image-scanning system.

To achieve this smaller footprint, Oki, like a number of other Japanese manufacturers, has recently introduced the direct-contact technology for the image-scanning mechanism. Although not particularly less expensive than the older charged couple device (CCD) technology, it is able to achieve a significant reduction in the equipment size. This size reduction results in an implied saving in material cost, as well as a machine with a more attractive user footprint.

A second route to achieving smaller product size is through the ever-increasing miniaturization of electronic components. For example, a number of manufacturers have started using the new Rockwell single-chip modem, replacing the four IC chips used in previous generations of facsimile modems.

Productivity Race

The facsimile output capacity of the Honjo plant is currently 460 units per day. The final assembly is done on two parallel lines, each with an indicator of the daily production target and a second counter to show performance against the target. As each finished machine comes off the assembly lines, the daily tally is incremented and the performance counter adjusted. The two production-line staffs essentially race against each other, as much for the honor of being ahead as for the small bonus that they can win at the end of the month.

Even the computerized delivery vehicles seem to be in an hurry, competing with one another to raise the daily production quota. At 460 fax units per day, the Honjo plant output is running at approximately $1.5 million daily. This output is far from the plant's ultimate capacity. The factory management anticipates easily reaching more than 700 units daily through shift work at the current facilities. Management further claims that even higher output could be reached through additional improvement in production techniques.

Such increased production capacity will be critical to Harris/3M, Oki's largest worldwide OEM customer. Indeed, in 1987, Harris/3M ramped up its production requirement with Oki by more than 168 percent against its 1986 shipments and is now responsible for more than 55 percent of Oki's total worldwide facsimile output.

Clearly, any restrictions applied on facsimile imports into Europe would have a major impact on Oki and its OEM partners alike. Should such restrictions be applied, however, Oki does have a European manufacturing facility in Scotland and would be able to move fax production there within six months.

DATAQUEST ANALYSIS

Dataquest anticipates that the worldwide fax market will remain one of the fastest-growing telecommunications market segments over the next few years. In terms of unit shipments, we estimate that the worldwide fax market will increase by a 30 percent CAGR from 1988 through 1993. In telecommunications, only the cellular radio handset market is expected to grow as rapidly during this period. Here, again, the Japanese have significant presence.

Dataquest believes that Japanese manufacturing skills, combined with a closely affiliated semiconductor technology and the current level of R&D spending to maintain technical innovation, will make Japanese manufacturers a tough team to beat. This will be particularly true in product areas where production volumes are high and the software content is low. A typical product of this kind is the facsimile machine. Central office switching technology, however, is an example of a product requiring specialized software. In the case of central office switching, we do not expect the Japanese to make a significant market impact in Europe.

Dataquest anticipates that with the continuation of worldwide telecommunications market deregulation, governments and PTT authorities in many countries will be assessing the increasing impact of Japanese products on their markets. We believe that Japan does have an excellent chance for success in the U.S. and European markets with its current and future products in areas such as facsimile. However, we also believe that Japanese manufacturers should seriously consider strategies that would give them a local manufacturing presence in the U.S. and European markets. Dataquest considers such a capacity to be an essential requirement for Japanese facsimile manufacturers hoping to avoid the imposition of future punitive trade restrictions.

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YEAR-END EUROPEAN PROCUREMENT SURVEY: THE ISSUES ARE AVAILABILITY, PRICING, AND SUPPLY

INTRODUCTION

This newsletter presents the results of our second European Semiconductor Application Markets (ESAM) procurement survey conducted across a wide range of major Europe-based electronic equipment manufacturers in the fourth quarter of 1987. The first European purchasing survey, conducted during the second quarter of 1987, revealed the then global concern of pricing. Since then, the emphasis has moved away from the issue of pricing and toward that of the availability of components.

The object of the survey was to determine the major concerns of semiconductor buyers in Europe. One major concern is the resulting shortage of memory parts that is due to the export license requirements imposed by MITI on Japanese suppliers. Other issues that were important to buyers included possible price increases on selected products in short supply, increasing demand, and longer lead times.

Table 1 shows the primary concerns emphasized by our respondents.

Table 1

Semiconductor Buyer Concerns

Concern	Percent of Respondents
Availability	20.4%
Pricing	16.3
Supply	12.2
Quality	12.2
Lead Times	12.1
Tariffs	10.3
Surface-Mount Technology	6.1
ASICs	4.1
Memory	4.1
Currency Exchange Rates	2.2
Total Respondents	100.0%

Source: Dataquest
March 1988

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SURVEY STRUCTURE

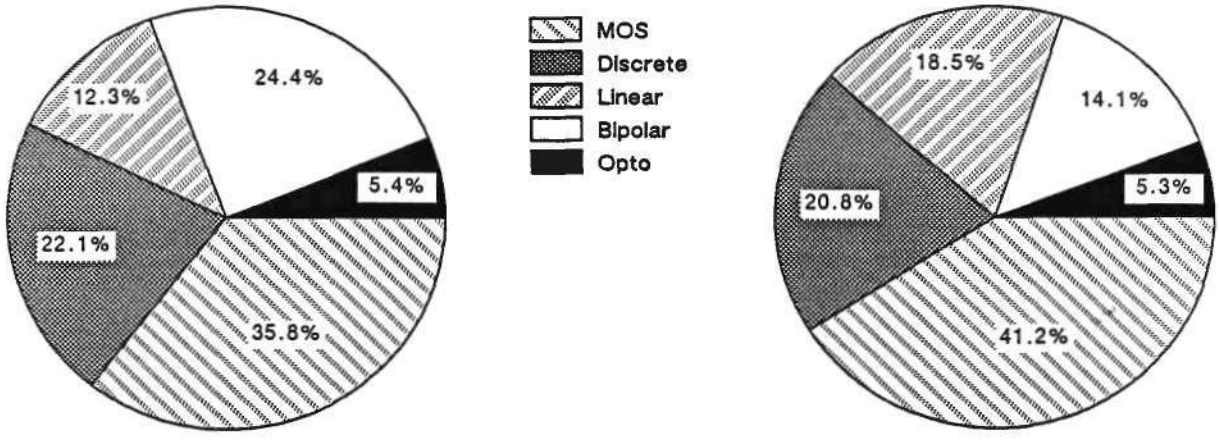
Dataquest selected survey participants from the top electronics manufacturers in Europe, successfully repolling the majority of manufacturers that participated in our first data- and trends-gathering project. We surveyed manufacturers that are actively purchasing semiconductors for electronic systems and subassemblies, interviewing individuals who are purchasing managers and directors, or who are involved in material or corporate contract management.

Subsequently, we compared our survey data on the semiconductor purchase mix with our 1986 European estimates; Figure 1 shows how closely they correspond. The survey results show a higher percentage of bipolar logic purchases than Dataquest's market share estimate of this segment. In the MOS market, however, the situation is reversed, with purchases lower than expected. Overall, the survey results demonstrate that our sample of purchasers closely reflects the total European demand.

Figure 2 shows the geographic distribution of our survey respondents. Although we tried to achieve an even distribution of respondents throughout Europe, the results show that there was a bias toward the United Kingdom. This bias was probably due to the fact that the survey was conducted from the United Kingdom; however, we do not believe that it detracts from the validity of our analysis.

Figure 1

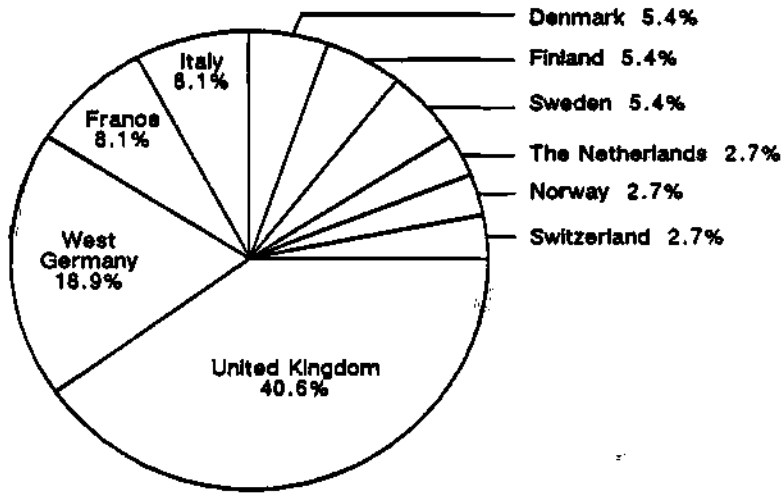
Semiconductor Purchase Mix
Survey Results Compared with 1986 Estimates
(Percent of U.S. Dollars)



Source: Dataquest
March 1988

Figure 2

Geographic Distribution of Survey Respondents
(Percent of Respondents' Regional Base)



Source: Dataquest
March 1988

The survey centered around factors influencing and driving semiconductor purchasers. It focused on the types of products that these purchasers manufacture and the semiconductor quantities/value they bought in 1987. We further asked questions about the sources of their semiconductor purchases on a regional basis. The survey reveals that the majority of manufacturers' purchasing was influenced by price, quality, and availability, in that order. Comparing this survey with the previous one conducted in the second quarter of 1987, a trend emerges showing that buyers are moving away from Europe-based suppliers and toward Japan-based suppliers. The survey results indicate that the purchasing community perceives that a good number of European and U.S. suppliers have difficulty matching Japanese vendors in price and quality on MOS ASIC, microprocessor, and memory product lines.

EUROPEAN MARKET TRENDS

Overall, Dataquest believes that distribution-channel purchases are increasing in Europe as a percent of total semiconductor purchases for two reasons. First, the movement from electromechanical industries to electronic systems implies that more companies are entering the market with relatively modest requirements for semiconductor purchases; these companies are best served by distributors. Second, semiconductor vendors are moving to regulate and minimize sales costs by limiting the number of companies with which they deal directly. By servicing some of these companies through their franchised distributors, the vendors can increase their overall efficiency.

Table 2 shows the currently perceived worldwide shift in supplier base compared with our previous survey's results.

Table 2

Worldwide Shift in Supplier Base

Supplier Base	Q2 1987 Survey Results	Q4 1987 Survey Results
Europe	32.9%	32.0%
United States	50.0	46.0
Japan	14.9	18.9
ROW	2.2	3.1
Total	100.0%	100.0%

Source: Dataquest
March 1988

Figures 1 and 2 indicate a shift in the buying patterns of these equipment manufacturers. Most of the surveyed companies would prefer to buy locally manufactured semiconductor devices. Unfortunately, local suppliers still have to go some way in order to deliver the breadth and depth of the required product range. The increase in Japanese preference for procurement was partially due to a switch to higher-density memories, but it also was moderated by the effects of the U.S.-Japan Semiconductor Trade Arrangement.

The survey also confirmed the penetration of rest of world (ROW) suppliers (such as those based in Korea, Taiwan, and Singapore), with some equipment manufacturers relying on up to 10 percent of their semiconductor requirements from these suppliers.

ASSESSING INVENTORY LEVELS

Dataquest clients have frequently asked us to assess inventory levels. However, it is very difficult to estimate inventory levels because of the varied product mix for discrete, linear, memory, and logic. Table 3 shows our respondents' estimates of their inventories relative to target. Overall, 42.4 percent reported that their inventories were above target. Only 12.1 percent indicated below-target levels. The trend that began two years ago to reduce the excessive levels of 1984 has continued, and we believe that inventories have now reached stable levels. The majority of respondents indicated that their inventories are expected to increase from an average of 6 weeks to 8 to 10 weeks, as the expected demand and growth will create temporary shortages in key areas such as DRAMs and some 32-bit microprocessors.

Table 3

Semiconductor Inventories Relative to Target
(Percent of Total Respondents)

Inventory Level	Percent of Respondents
Extremely Low	3.0%
Somewhat Low	9.1
On Target	45.5
Above Target	39.4
In Significant Excess of Target	3.0
Total	100.0%

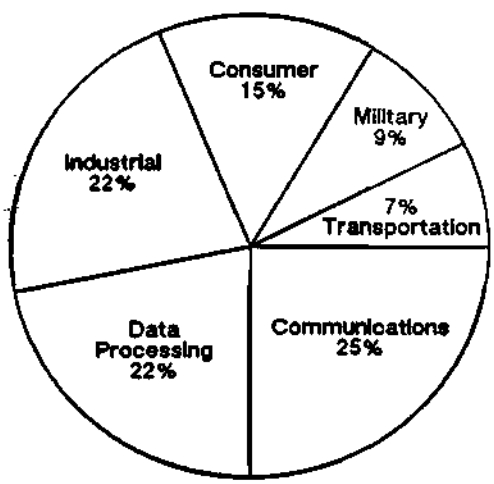
Source: Dataquest
March 1988

PROCUREMENT TRENDS BY SEMICONDUCTOR APPLICATION SEGMENT

Figure 3 shows Dataquest's estimates for 1986 European electronic equipment production by application.

Figure 3

Electronic Equipment Production by Application Segment
(Percent of U.S. Dollars)
1986



Source: Dataquest
March 1988

Consumer Application Market

The purchasing pattern in the consumer segment still favors the Europe-based supplier. This segment is a relatively large user of discrete and optoelectronics devices, a market of which Europe-based suppliers have a substantial share.

Most buyers expect these discrete devices to be customized to achieve better price/performance integration, and for this they require close, long-term relationships with local suppliers. They also expect the number of ICs used in consumer products to be substantially reduced in favor of a semicustom/custom approach, which will require a major shift toward surface-mount devices.

Surprisingly, major consumer manufacturers are purchasing up to 30 percent of their requirements from offshore sites rather than from the local sales offices of these offshore suppliers. This situation could be explained by the consumer market requiring close links with the supplier manufacturing site to interface on all levels—design, test, quality, shipping, and logistics.

Major Japanese consumer manufacturers in Europe have started to procure locally, especially with discrete and opto devices. Most of these manufacturers complain that local suppliers do not have the right manufacturing technology to supply their special needs. However, they face increasing pressure from the EEC to source more components locally.

Overall, consumer manufacturers in Europe reported a healthy growth in 1987 compared with 1986, but indicated that they expect to further reduce inventory levels and start engaging more JIT (just-in-time) programs with their suppliers.

Automotive Application Market

Purchasing managers in the automotive segment responded very positively about their inventory levels, as most of them have ongoing JIT programs that have passed the learning-curve period. They reported that suppliers failing to meet their specification and delivery commitments do not win future contracts for supply.

Major concern is still shown over the long-term reliability of semiconductor devices, fault coverage, and incoming test correlation. Very few suppliers are able to meet more than 80 percent of these purchasers' requirements. The suppliers' concern is amplified when dealing with the purchasers' ASIC requirements. Among the major European automotive electronic equipment manufacturers, preference is shown toward Europe-based suppliers or foreign suppliers with a manufacturing base in Europe.

In general, the automotive market anticipates greater IC use in the future as more features are added to standard models.

Military Application Market

Purchasers in the military segment are prepared to hold relatively large inventories for parts that are prohibitively expensive at low volumes. This segment shows heavy reliance on the semiconductor distribution network for standard military-grade parts. Most purchasers indicate above-average inventory levels. North American suppliers are

heavily used over their European counterparts, except for ASIC requirements. Major military contractors prefer in-house suppliers for ASICs because of the complex nature of meeting as yet undefined military-standard specifications for these parts.

Major concern was shown about U.S. versus European military specification issues and specifications for surface-mount devices.

Computer Application Market

This segment showed the most volatility, with purchasing managers expressing much concern about the availability of 256K and 1-Mbit DRAMS and the impact of MITI export licensing requirements. This segment is heavily dependent on Japanese suppliers for its memory devices. The supply shortage of these devices, coupled with price rises, is starting to hurt some manufacturers, with the exception of those manufacturers with steady in-house supplies.

Most U.S. multinationals based in Europe procure, on average, 30 percent from European manufacturing sites, including U.S. suppliers manufacturing in Europe.

We believe that 1988 will be a big year for surface-mount devices, as most purchasers reported substantial increases in their purchases of these devices.

Inventory levels of computer manufacturers are, on average, down to 6 weeks, but most manufacturers expect this time to increase to 8 to 10 weeks as a result of shortages of leading-edge products such as 1-Mbit DRAMs and 32-bit processors.

The computer segment also showed a substantial increase in the use of gate arrays and programmable logic. Most purchasers indicated requirements for higher-speed PALs and high-density gate arrays.

Regional preference in this group is still for U.S. suppliers because of the large presence of U.S.-based computer manufacturers in Europe. CMOS now accounts for more than 50 percent of total purchases in the computer segment.

Telecommunications Application Market

Most purchasing managers in the telecommunications segment indicated healthy growth in the amount of semiconductor purchases when expressed in U.S. dollars, but showed a virtually flat pattern when the purchases were expressed in local currency. They expect prices to decrease with the increasing volumes. The use of surface-mount devices is somewhat erratic: Some major manufacturers use surface-mount devices up to 10 percent, while others, at 2 percent, barely use them.

Most purchasers reported inventories on target, but they also expected to further reduce their levels. Some purchasers in this segment have started JIT programs, and many others are moving in this direction.

Purchasers expressed uncertainty about recent mergers in the telecommunications industry, focusing on the issues of plant location, products, and personnel rationalization.

It appears that the telecommunications segment, like the other industry segments, has been unable to reduce the number of its suppliers because of the diverse range of semiconductor devices required. A supplier with a broad product line and the right telecommunications products stands a better chance than one with a narrow product line.

The major concerns shown in this segment are procurement logistics and management of ASIC supplies.

DATAQUEST CONCLUSIONS

The buyers' responses to Dataquest's second European procurement survey primarily indicate concern over availability and cost-related issues. The emphasis on availability, pricing, supply, and quality leads us to believe that this concern is indeed a positive signal for steady growth in the industry. Quality was not at all mentioned in our second quarter 1987 survey; however, this issue ranks high on the list of concerns generated by our latest survey. European semiconductor buyers' mindfulness of ASICs and surface-mount technology reflects the fact that these two product areas are now impacting the marketplace with their cost-competitive and overall system design advantages.

We believe that there is a pressing need for semiconductor vendors to better educate the purchasing community on changing technology and product trends. A large proportion of the respondents indicated that they were swamped with product specifications; however, the information from maunufacturers concerning key areas of interest, such as packaging, quality, and cost benefits, was insufficient.

Bipin Parmar
Mike Williams

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IS THERE A TRANSPUTER IN YOUR FUTURE?

INTRODUCTION

In the last few years, both Intel and Motorola have introduced microprocessors that have changed the face of the PC industry. However, a third company, Inmos Corporation, has introduced the transputer, a microprocessor designed to bring the power of a supercomputer to desktop computing.

This newsletter examines some of the products utilizing transputer technology and discusses the implications of the transputer for the personal computer industry.

BACKGROUND

In November 1986, Inmos Corporation, a subsidiary of United Kingdom-based Thorn EMI, introduced the T800 transputer, a 32-bit microprocessor capable of achieving performance ratings of 10 to 12 mips. Since this announcement, the T800 transputer and its predecessors, the T212 and T414, have been catching the eye of many computer product manufacturers.

The transputer is not a coprocessor. The T800 transputer combines a 32-bit CPU; standard IEEE, 64-bit, floating-point processor; 4KB of fast RAM; and four communications links that are used to connect transputers into networks.

The transputer is designed for high-performance single-microprocessor applications; however, the real power of the transputer is in its capability to be linked with other transputers to provide ultrahigh-performance multiprocessor applications ranging from PC workstation accelerators to supercomputers.

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The Inmos T800 competes directly with microprocessors manufactured by Intel and Motorola. The Inmos T800 is the first microprocessor to offer a processor and a floating-point processor on a single VLSI device. This combination is ideal for applications such as high-end graphics and artificial intelligence.

TRANSPUTER APPLICATIONS

The Atari Abaq

At the fall Comdex, Atari Corporation demonstrated a prototype of the Abaq, a 32-bit transputer-based workstation. The Abaq uses the Inmos T800 and is capable of operating at 10 to 12 mips. This level of performance would give the Abaq the ability to operate at speeds 10 times greater than the IBM AT. The Abaq is equipped with 4MB of RAM and 1MB of display RAM. The Abaq supports four graphics modes: 1,280 x 768 pixels in 16 colors or monochrome; 1,024 x 768 pixels in 256 colors; 640 x 480 pixels in 256 colors with two screens; and 512 x 480 pixels in 16 million colors plus overlay.

Perihelion Software is currently developing Helios, a UNIX-like operating system for the Abaq. In addition, an MS-DOS emulator is currently being developed for the Abaq by a third-party developer.

Apple Macintosh Enhancement

Levco has announced an add-on board for the Macintosh II and Macintosh SE, based on the Inmos T800 transputer. The Levco TransLink transputer card will range in price from $2,000 to $12,000, depending on the number of transputers installed on the board and the amount of memory allocated to each transputer. A transputer card with four T800 processors, C compiler and assembler, and 1MB of RAM dedicated to each processor will provide 20 times the performance of the Mac II. Pricing for this configuration will range from $11,000 to $12,000.

Microport V/TT System

Microport Inc., a supplier of UNIX software, recently announced the Microport V/TT System, a UNIX-based implementation of the Inmos T800 transputer.

The system runs on an IBM AT and is equipped with the Inmos B008 transputer module board. The B008 board utilizes four T800 transputers, and it is claimed that this combination can deliver 50 times the power of UNIX running on the IBM PC AT itself.

DATAQUEST ANALYSIS

Prior to the introduction of the PC, users were forced to share the same processor. With the advent of the PC, users now have their own dedicated processors. Transputers linked within a network take the one person/one processor concept a step further by providing a user with access to several processors at a time. Application tasks are distributed among the processors in order to optimize the total application performance.

The problem facing vendors of transputer technology is that very few software applications have been written with the capability of utilizing multiple processors. In order for this technology to gain a foothold in the PC marketplace, we believe that Inmos must persuade software developers to adapt their applications to a multiprocessor environment.

Parallel processing is not a new concept in the computer industry as a whole; however, for the PC industry, it represents the ultimate solution for power-intensive applications. It opens the door to having mainframe computing power on the desktop and is the next logical step for the PC of the future. The embodiment of this capability in IBM's Micro Channel and Apple's Nubus is a reaffirmation of this philosophy.

Although multitasking is the current topic of conversation in the PC industry, we believe that multiprocessing will have a significant impact on the future of the PC industry. How significant an impact the Inmos transputers will have in the area of multiprocessing will ultimately be decided by software developers.

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Jennifer Berg
Bill Lempesis

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Research Newsletter

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ERICSSON GETS LEANER WHILE NOKIA CONTINUES ACQUISITIONS

SUMMARY

Ericsson's pending sale of its Data System Division to Nokia will put Nokia in a commanding position as the number two European supplier of computer terminals after Olivetti.

This event is of major significance in the European telecommunications market, as it reverses the trend of the early 1980s when telecommunications companies created and/or acquired computer companies due to the pending fusion of communication and information technologies. In the majority of these cases, the ventures have been major drains in financial and management resources.

ERICSSON

The newly acquired Data System Division manufactures terminals, personal computers, minicomputers, and banking and business systems, and has a turnover of SKr 4 billion (US$631 million.) It will be merged with Nokia's existing Information Division, Nokia Data. The merged division will have a turnover of SKr 7 billion (US$1.1 billion).

Ericsson's strategy has been to offload business units that do not form part of its core business, i.e., telecommunications. In October 1987, Ericsson sold off its Office Equipment Division, which manufactures typewriters and office furniture, to Design Funktion of Norway.

Ericsson's sale of its Data System Division and its Office Equipment Division will stem the flow of red ink that has plagued its Information Division since its inception. This division reported a loss of SKr 284 million (US$45 million) on a turnover of SKr 10 billion (US$1.6 billion) in 1986.

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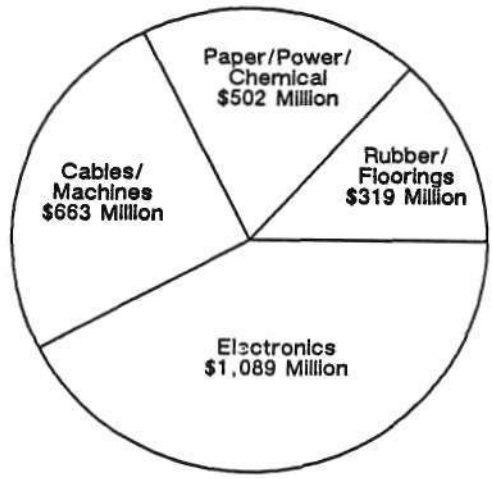
NOKIA

As shown in Figure 1, the Nokia Group of companies' total 1986 sales were Fmk 12 billion (US$2.5 billion), with almost 60 percent coming from the export market. The group's 1986 profit was Fmk 675 million (US$141 million), or 5.6 percent of sales. The Electronics Group represented 43 percent of the Nokia Group's net sales in 1986, before its recent acquisition of Ericsson's Data System Division and the consumer division of Alcatel N.V. (formerly the consumer division of ITT).

Figure 1

Nokia Group Major Activities
Net Sales by Division



1986 Net Sales = $2.5 Billion

Source: Nokia Corp.
Dataquest
February 1988

Electronics Group Activities—1986

The group achieved net sales of Fmk 3.7 billion ($843 million) in the first eight months of 1987, compared with Fmk 2.9 billion ($572 million) in the corresponding period in 1986, and represented a local currency growth of 27 percent (47 percent growth in U.S. dollars).

Information Systems

This division represented Fmk 1.6 billion ($334 million) of the company's 1986 sales. The division consisted of a Data Processing Systems Unit (computer systems and equipment), Data Transmission Unit (modems and multiplexers), Business Communications Unit (digital PABX and key telephone systems), Components Unit (thick film hybrids and PCBs), and a Control and Instrumentation Unit (automation equipment in wood pulping and energy sectors).

Telecommunications

Net sales for this division totaled Fmk 939 million ($196 million) in 1986. The division consisted of a Transmission Systems Unit (PCM equipment and radio relay links), Dedicated Networks Unit (for energy and railway sectors), and Telenokia Ltd. (digital PABXs).

Nokia–Mobira

This division's net sales totaled Fmk 847 million ($177 million) in 1986. The division consisted of an NMT Unit (Nordic Mobile Telephones for the 450– and 900–MHz system) and a USA Unit (mobile telephones for the U.S. Advanced Mobile Phone System (AMPS), and the Tandy Mobira Corp. (TMC) joint venture with sales via Radio Shack). There was also a Euro Unit (mobile telephones for the Total Access Communications System (TACS), R200, and Netz–C networks), an Oulu Unit (base stations for cellular and paging networks), and a PMR (Private Mobile Radio) Unit.

Salora–Luxor

Net sales for this division totaled Fmk 2.1 billion ($439 million) in 1986. The Group consisted of a Consumer Electronics Unit (TV and video recorders), Monitors Unit (color and high resolution), Components Unit (hybrids, TV tuners and power supplies), Satellite Systems Unit (receivers and transmitters, plus cable and pay TV), and an Industrial Electronics Unit (customer–specific components for the automotive, engineering, and plastics industries).

Electronics Group Restructuring—1987

Information Systems

This division is a combination of the former Information Systems Division and the Telecommunications Division. It comprises the Data Processing Systems Unit, the Data Transmission Unit, the Business Communications Unit, the Public Telecommunications Networks Unit, the Dedicated Networks Unit, Nokia Cellular Systems, and Telenokia. Net sales from this division for the first eight months of 1987 amounted to Fmk 1.1 billion ($250 million), a growth in local currency of 19 percent compared with the same period in 1986 (37 percent growth in U.S. dollars). This growth can be attributed to increased sales, particularly in Sweden and West Germany, and deliveries of electronic point–of–sales systems to retailers in Finland.

Consumer Electronics

This division was mainly created from the former Salora–Luxor Division, and comprises the Video/Audio Unit, the Monitors Unit, the Components Unit (formerly the Information Systems Division and the Salora–Luxor Division), and the Industrial Electronics Unit.

Net sales from this division for the first eight months of 1987 amounted to Fmk 1.4 billion ($319 million), a growth in local currency of 17 percent compared with the same period in 1986 (35 percent growth in U.S. dollars). This growth can be attributed to the company's successful penetration of the French consumer electronics market, where it holds a 10 percent market share, and its continuing leadership in Scandinavia as a supplier of color television sets and video recorders. The recent purchase of Oceanic S.A., a French consumer electronics manufacturer (part of the Swedish Electrolux Group), has given Nokia two more recognized brand names, Oceanic and Sonolor. The division has significantly enhanced Nokia's position in the European Economic Community.

Nokia–Mobira

This division is restructured internally, and now comprises the NMT Unit, the AMPS/TACS Unit, the Euro Unit, the Paging Equipment Unit, and the Cordless Unit.

Net sales from this division for the first eight months of 1987 amounted to Fmk 613 million (US$140 million), a growth in local currency of 22 percent compared with the same period in 1986 (41 percent growth in U.S. dollars). Operations overseas accounted for 75 percent of 1987 sales, and included the acquisition of Diversicom in the United States (the only nationwide long-range paging service for the U.S. market). Agreements also were made with McCaw Cellular Equipment (which owns and operates 40 mobile telephone networks in the United States), Mobile Telephone Systems (based in Kuwait), and Shaye Communications (based in the United Kingdom).

DATAQUEST ANALYSIS

Nokia's recent acquisition of the Consumer Electronics Division of Alcatel (formerly ITT) makes Nokia the third-biggest consumer electronics manufacturer in Europe after Philips and Thomson. This will allow Nokia to consolidate and rationalize its European manufacturing and marketing base and allow it to gain further market share while competing effectively against Japanese suppliers. The recent rise in the value of the Japanese yen, together with Nokia's manufacturing synergy with computer monitors and its number two position in the corporate microcomputer market, will allow the company to raise its value-added contribution in these markets. Another significant factor is that Nokia will now be able to make inroads into the European Community through its new acquisitions, as Finland is a nonmember of the EEC.

Dataquest estimates that Nokia-Mobira was number one in the rapidly expanding European cellular radio market in 1987, although the five different standards for cellular radio used in Europe has hindered its growth. Nokia will be able to leverage its number one position when the new GSM (Group Speciale Mobile) European Cellular Network Standard is established, which should be by 1991. Nokia has already taken steps to address the base station market by forming a consortium with Alcatel and AEG, in which Nokia has a 35 percent share.

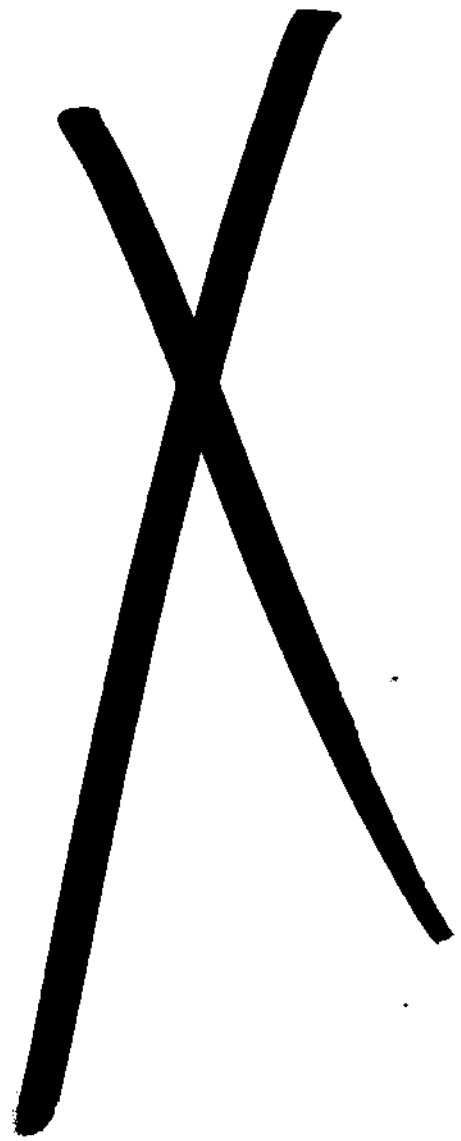
Together with its strength in cellular subscriber equipment and base station equipment, Nokia will become a commanding force in the European cellular radio market, estimated to reach $3.5 billion by 1995.

Nokia was already the largest manufacturer of microcomputers in Scandinavia prior to its acquisition of Ericsson Data System. These combined forces put Nokia in the number two position in Europe after Olivetti. The relatively successful market penetration in the United Kingdom and the United States of the Ericsson Data System's banking terminals, together with Nokia's microcomputer and digital PABX technologies, will allow Nokia to leverage itself into the lucrative market for fully integrated information systems. Nokia already has an agreement with the Honeywell–Bull–NEC consortium in the midrange computer market.

Although the European market for systems integration already has numerous participants, the biggest potential for growth lies in the North American market. It is not obvious how Nokia will consolidate its position in this important market; but, it already has a head start with its joint venture with the Tandy Corporation and its numerous sales outlets via Radio Shack.

Dataquest believes that because of its leading position in consumer, cellular radio, and business microcomputer markets, which require highly automated volume manufacturing and continuous technological advances, Nokia will become a significant participant in the European market and will join the ranks of Philips, Siemens, and Thomson. This represents a new challenge and potential for the suppliers of semiconductors that previously considered Nokia a small niche player.

Byron Harding
Bipin Parmar
Anne Barbancon



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EUROPEAN CD MARKET SYNOPSIS

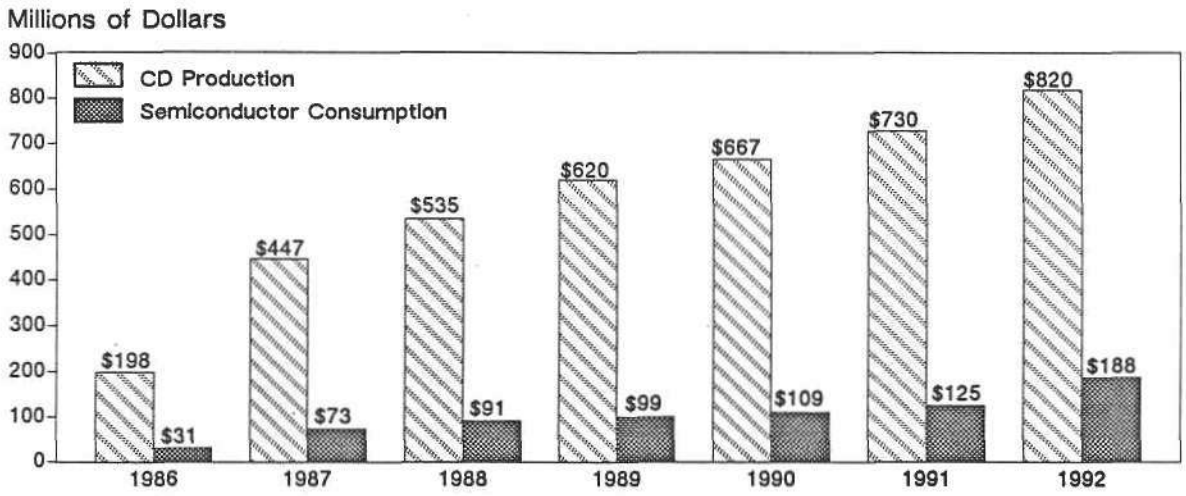
INTRODUCTION

For a number of years, optical storage has been regarded as the mass memory storage technology of the future. One product, the compact disk (CD), has emerged as the technology driver, gaining mass acceptance with devotees of hi-fi sound. Compact disks and players became the darlings of the European audio world in 1986. In this watershed year, CDs gained broad acceptance by music lovers as the medium of choice for the enjoyment of jazz, rock, and classics. Approximately 5 percent of householders in Europe owned CD players in 1986. Half of the current CD players owned were purchased in 1986.

Dataquest's European semiconductor analysts have researched the production and marketing of CD players in Europe between 1984 and 1992, and have estimated the semiconductor content of the players produced in 1987. As indicated in Figure 1, we believe that 1987's European CD market will reach $447 million, a 226 percent increase over 1986. We estimate that this represents a $73 million semiconductor opportunity for 1987 alone.

Figure 1

ESTIMATED EUROPEAN CD PLAYER PRODUCTION



Source: Dataquest
June 1987

BACKGROUND

Developed jointly by Philips of the Netherlands and the Sony Corporation of Japan, compact disk players were the first commercially available digital audio systems to offer far more accurate sound reproduction than conventional analog systems. CD players were introduced to Europe in February 1983 and quickly caught the consumer's attention because of their compact size, easy handling, and superior sound reproduction. However, initial sales were slow because of the CD player's high retail price compared with that of its analog counterpart.

COMPACT DISK PLAYER PRODUCTION IN EUROPE

CD player production is highly competitive in Europe. In order to avoid large import tariffs (19 percent) placed on the goods, many Japanese manufacturers have set up production facilities here. Table 1 lists the major manufacturers, which we believe account for approximately 100 percent of the total CD player production.

Table 1

CD PLAYER MANUFACTURERS IN EUROPE

Country	Company
West Germany	Dual (Thomson subsidiary)*
	Grundig*
France	Aiwa
	Akai
	JVC
	Pioneer
	Sony
United Kingdom	Aiwa
Italy	Pioneer
	Autovox**
Belgium	Philips
Denmark	Bang and Olufsen*
Switzerland	Studer-Revox
Turkey	Crown**

*Assembly only
**Production to start in 1987

Source: Dataquest
June 1987

SEMICONDUCTOR CONTENT

We have examined a medium-scale CD player and its components and have estimated the semiconductor value as shown in Table 2. The component values, based on contract-volume prices, result in an input-output ratio (semiconductor value as a percentage of equipment average selling price) of 16.3 percent.

Table 2

ESTIMATED SEMICONDUCTOR CONTENT OF A COMPACT DISK PLAYER

Components	Quantity	Cost
Integrated Circuits	13	
Standard Logic (SSI/MSI)	1	
Microcontroller (8-bit)	1	
D/A Converter (16-bit)	1	
Digital Filter	1	
Signal Conditioner	1	
Servo Control Unit	1	
Subtotal	19	$24.50
Optoelectronic		
Laser Diode	1	
Optical Sensor	1	
LED Lamp	1	
Subtotal	3	$17.50
Discrete Components	25	$ 3.00
Total	47	$45.00

$$\frac{\text{Semiconductor Value}}{\text{Retail Value}} = \frac{\$\ 45.00}{\$276.00} = 0.163 = 16.3\%$$

Source: Dataquest
June 1987

CD TECHNOLOGY AS A CATALYST

Consumer acceptance of CD players will act as a catalyst in the development of other optoelectronic products. CD-ROM technology is virtually the same as that found in audio CD players, with the exception of more stringent error-correcting demands for data applications. Potential applications for CD technology include the following:

- Computer data storage
- Video disks
- Publishing

- Road map directories in automobile dashboards
- Medical records
- Laser smart cards

The potential applications for CD technology represent numerous attractive markets. They could all gain widespread use by the consumer, in part because of the enthusiastic acceptance of CD players.

DATAQUEST ANALYSIS

Digital audio disks offer better sound than conventional records and tapes and put an end to noise and signal degradation over time. This is because a laser pickup eliminates direct contact with the disk surface; hence, disk wear is avoided. Using error-detection and -correction circuitry together with software, the conventional analog filtering techniques are eliminated. This provides audio that is free of noise and that has concert hall dynamic range. Digital audio tapes (DAT) and DAT players also offer perfect sound reproduction with virtually no deterioration regardless of the number of times the tape is played.

The supply of integrated circuits to CD or DAT player manufacturers is a significant market opportunity for semiconductor manufacturers in the late 1980s and early 1990s. Dataquest believes that as prices for players, CDs, and DATs come down, and as older music systems wear out, owners will replace their combination LP/cassette music libraries with CDs and DATs.

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Research Newsletter

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TELECOMMUNICATIONS--SNAPSHOT OF '87

SUMMARY

Dataquest forecasts that the European Communications Equipment marketplace will increase from $17,871 million in 1986 to $19,914 million in 1987, representing an increase of 11.4 percent (see Table 1). The European semiconductor consumption for communications equipment is forecast to increase from $1,411 million in 1986 to $1,700 million in 1987. The purpose of this newsletter is to provide our summary outlook for customer premise equipment in 1987 (see Tables 2 and 3). We estimate that customer premise equipment sales accounted for $7,084 million in revenue and represented 39.6 percent of European communications equipment sales in 1986.

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Table 1

EUROPEAN COMMUNICATIONS EQUIPMENT MARKET FORECAST
(Millions of Dollars)

Equipment	1984	1985	1986	1987	1988
Customer Premise	$ 5,391	$ 5,860	$ 7,085	$ 7,850	$ 8,482
Public Telecommunications	5,125	5,571	5,292	5,960	6,504
Radio	1,790	1,946	2,594	2,882	3,178
Broadcast and Studio	1,305	1,418	1,891	2,101	2,319
Other	693	753	1,009	1,121	1,284
Total	$14,304	$15,548	$17,871	$19,914	$21,767

Equipment	1989	1990	1991	1992
Customer Premise	$ 9,088	$10,187	$11,562	$12,524
Public Telecommunications	6,965	7,649	8,245	8,442
Radio	3,425	3,806	4,165	4,205
Broadcast and Studio	2,480	2,747	3,150	3,157
Other	1,411	1,561	1,705	1,776
Total	$23,369	$25,950	$28,827	$30,104

Source: Dataquest
June 1987
Ref. 0587-05

Table 2

1987 EUROPEAN CUSTOMER PREMISES EQUIPMENT FORECAST
(Millions of Dollars)

Equipment Type	1987
Terminal Equipment	$3,680
Single-Line Telephones	2,019
Integrated Voice/Data Wkstn.	7
Facsimile Machines	470
Telex Machines	477
Teletex Terminals	139
Videotex Terminals	314
Other	254
Data Communications Equipment	$ 992
Modems	580
Statistical Multiplexers	72
TDM Multiplexers	196
Data Network Control Systems	43
Data PBX	4
Packet Switching Networks	55
Local Area Networks	42
Business Communication Systems	$3,156
Key Telephone Systems	1,073
PBX	1,948
Centrex	1
Automatic Call Distributors	134
Attached Network Functions	$ 22
Voice Messaging	11
Call Accounting	3
Video Teleconferencing	8
Total	$7,850

Source: Dataquest
June 1987
Ref. 0587-05

Table 3

EUROPEAN CUSTOMER PREMISE APPLICATION SUMMARY

Application	End Equipment Percentage Growth Rate 1976-1987	1987 Market Estimate ($M)	European Market Outlook
Telex	(6.3%)	$ 477	The market up to present has been characterized by its stability. A modest decline will be experienced during 1987 as the reduction in standalone terminals is not quite compensated for by the increased production of PC telex adapter cards produced by Hasler, (Germany), DCE, (U.K.)
Teletex	57.9%	$ 139	Growth will be mainly confined to Germany. Production is by Siemens and Triumph-Adler.
Videotex	9.0%	$ 314	The product has not gained acceptance in the mass market. Except for France, it is confined to use by the business user groups such as the financial markets and travel agents. Within France, it is enjoying success in the form of Minitel terminals supplied free to PTT subscribers in some regions. Minitel production is running at 1.5 million sets per year. Production is by Alcatel and Matra.
Facsimile	63.7%	$ 470	This is a fast-growing market where supply is dominated by Japanese vendors, NEC and Canon. European production is confined to France where Alcatel Thomson produced 20,000 sets during 1986.

(Continued)

Table 3 (Continued)

EUROPEAN CUSTOMER PREMISE APPLICATION SUMMARY

Application	End Equipment Percentage Growth Rate 1976-1987	1987 Market Estimate ($M)	European Market Outlook
Single-Line Telephones	15.2%	$2,019	Despite the increasing number of Far Eastern imports, European manufacturers continue to dominate production and supply of the standard device. Major manufacturers include Autophon, Comdial, Ericsson, HPF, ITT, Matra, Siemens, and Televerket.
PBX	2.6%	$1,948	Low-end PBX L100 lines are becoming commodity items. Dataquest estimates that 85 percent of the 1986 market in Europe is supplied by local industry: <100 lines = 5.1 million >100 lines = 1.8 million
Modems/ Multiplexers	16.9%	$ 580	The major proportion of growth during 1987 will be accounted for by PC modems. These are manufactured by companies such as Racal, Doughty, and Dacom. The growth area in the multiplexer marketplace is in the installation of private and megabit multiplexers for large companies. Timeplex, (Ireland) and CASE, (England) manufacture for this marketplace.
Local Area Networks	55.6%	$ 42	The market is still in an early growth phase. At present, it is dominated by U.S. manufacturers supplying Europe through distribution. Producers in Europe include Siemens, (Germany), and Philips, (Holland).

Source: Dataquest
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Ref. 0587-05

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Research Newsletter

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EUROPEAN CONSUMER EQUIPMENT--SEMICONDUCTOR MARKET ANALYSIS

INTRODUCTION

As the range of semiconductor applications continues to become increasingly complex, so too has the task of examining and forecasting semiconductor consumption from an electronic equipment perspective.

Dataquest European Semiconductor Division (ESD) has developed a new module called European Semiconductor Application Markets (ESAM) that provides a complete analysis of semiconductor consumption by application market segment. This product is intended to assist decision makers who must take a tactical or strategic approach in their analysis of the semiconductor market, from either an application, demand-side, or end-use perspective.

This newsletter provides ESAM clients with a brief look at the methodology and offers an example of the research and analyses that can be found in this new module.

METHODOLOGY

Market Segmentation

Dataquest's European Semiconductor Industry Service has traditionally broken its end-use analysis into six market segments:

- Automotive
- Computer
- Consumer

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- Industrial
- Government and military
- Telecommunications

The ESAM module uses a slightly different market segmentation, splitting the electronic equipment into the following markets:

- Data processing
- Communications
- Industrial
- Consumer
- Military
- Transportation

Data processing comprises all equipment whose main function is flexible information processing. Included in this segment are all personal computers, regardless of price, distribution, or use in the office, education, or home environments.

Within the communications market, Dataquest classifies telecommunications as a subsegment that consists of customer premises and public telecommunications equipment. The other communications categories include radio, studio, and broadcast equipment.

The industrial segment comprises all manufacturing-related equipment, including scientific, medical, and dedicated systems.

The consumer segment comprises equipment that is designed primarily for home or personal use and whose primary function is not flexible information processing. Audio and video equipment and appliances are typical examples of equipment that is classified in the consumer application market.

Military equipment is primarily defense-oriented electronic equipment and is classified by major budget area. It does not include all electronic equipment procured by the government because such a breakout would double-count equipment that logically belongs in other market segments.

Finally, transportation consists mainly of automotive and light truck electronics. This designation leaves room to analyze other markets, such as off-highway equipment, that are potentially large users of semiconductors.

Full definitions of these segments are included in the ESAM binder.

Research

Depth of research includes:

- Information on electronic equipment manufacturers in Europe, including revenue and semiconductor consumption
- European electronic equipment forecasts by application market, including equipment type and year
- European semiconductor consumption forecasts by application market: by product, technology, and region
- Detailed service sections covering market trends and semiconductor analyses within each of the major application markets

ANALYSIS

The following section is an example of the type of information that is available as part of the ESAM module.

Table 1 shows Dataquest's forecast for the European consumer equipment market. The appliance market is the largest portion of the European consumer segment. Dataquest estimates that the European market for appliance equipment will reach $13,546 million by 1991, declining slightly at a compound annual growth rate (CAGR) of negative 0.6 percent for 1987 through 1991.

Table 2 shows Dataquest's forecast for European semiconductor consumption for consumer equipment. The consumer semiconductor market is estimated to grow at a CAGR of approximately 2.1 percent between 1987 and 1991. This is lower than the overall semiconductor market, which Dataquest estimates to be growing at a CAGR of 12.3 percent between 1987 and 1991.

Table 3 shows Dataquest's forecast for European input/output (I/O) ratios for consumer equipment. The I/O ratio represents the value of the semiconductors divided by the value of the electronic equipment and expressed as a percentage.

Table 4 shows Dataquest's estimates for the European appliance market. The European home appliance industry (manufacturing such items as refrigerators, washers, dryers, dishwashers, and microwave ovens) is currently severely depressed and has been so for several years. The saturation point has been reached for several products. Notable exceptions to this are microwave ovens, ranges, ovens, dishwashers, and disposals.

Table 1

EUROPEAN CONSUMER EQUIPMENT PRODUCTION
(Millions of Dollars)

	1985	1986	1987	1988	1989	1990	1991
Audio	$ 791	$ 897	$ 1,166	$ 1,101	$ 1,295	$ 1,338	$ 1,485
Video	3,746	3,910	4,280	4,047	5,069	5,256	5,540
Personal Electronics	1,190	1,220	1,284	1,213	1,581	1,742	1,828
Appliances	10,648	11,803	13,880	13,115	12,770	13,011	13,546
Other	227	222	232	219	260	257	285
Total	$16,602	$18,052	$20,842	$19,695	$20,975	$21,604	$22,684

Source: Dataquest
June 1987
Ref. 0587

Table 2

EUROPEAN SEMICONDUCTOR CONSUMPTION
CONSUMER
(Millions of Dollars)

	1985	1986	1987	1988	1989	1990	1991
Audio	$ 68	$ 87	$133	$ 133	$ 134	$ 142	$ 157
Video	426	448	529	584	588	592	641
Personal Electronics	33	34	39	46	49	49	54
Appliances	201	238	230	274	271	270	303
Other	5	6	7	7	7	7	8
Total	$733	$812	$938	$1,044	$1,049	$1,059	$1,163

Source: Dataquest
June 1987
Ref. 0587

Table 3

EUROPEAN INPUT/OUTPUT RATIOS
CONSUMER
(Percent Based on Dollar Values)

	1985	1986	1987	1988	1989	1990	1991
Audio	8.6%	9.7%	11.4%	12.1%	10.3%	10.6%	10.6%
Video	11.4%	11.5%	12.4%	14.4%	11.6%	11.3%	11.6%
Personal Electronics	2.8%	2.8%	3.0%	3.8%	3.1%	2.8%	3.0%
Appliances	1.9%	2.0%	1.7%	2.1%	2.1%	2.1%	2.2%
Other	2.4%	2.5%	3.0%	3.2%	2.6%	2.7%	2.8%
Average I/O Ratio	4.4%	4.5%	4.5%	5.3%	5.0%	4.9%	5.1%

Source: Dataquest
June 1987
Ref. 0587

Table 4

ESTIMATED EUROPEAN APPLIANCE MARKET
(Millions of Dollars)

	1985	1986	1987	1988	1989	1990	1991
Air Conditioners	$ 192	$ 196	$ 219	$ 207	$ 181	$ 184	$ 192
Microwave Ovens	8	60	138	130	162	165	171
Washers and Dryers	2,793	3,044	3,556	3,360	3,100	3,158	3,288
Refrigerators	1,737	1,862	2,139	2,021	1,774	1,808	1,882
Dishwashers and Disposals	599	702	845	798	1,052	1,072	1,116
Ranges & Ovens	1,933	2,175	2,581	2,439	2,461	2,509	2,613
Vacuum Cleaners	1,029	1,134	1,325	1,252	1,099	1,120	1,165
Food Processors	1,162	1,278	1,492	1,410	1,239	1,262	1,314
Heaters	870	963	1,117	1,056	927	943	822
Total	$10,648	$11,803	$13,880	$13,115	$12,770	$13,011	$13,546

Source: Dataquest
June 1987
Ref. 0587

The full advantage of the methodology detailed above is realized by applying I/O ratios to these appliance estimates. This demonstrates that the estimated semiconductor consumption of European appliances will grow from $230 million in 1987 to $303 million in 1991, a CAGR of 7.1 percent. In the appliance market, Europe's leading producers are now stepping up their development of electronic controls and timers, although only for more sophisticated machines. However, Dataquest believes that it will be necessary for them to display a faster rate of innovation in order to avoid being overtaken by the new Japanese products that should be available on the market in the next five years.

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A WORLDWIDE SMART CARD OUTLOOK: EUROPE PIONEERS PRODUCTION

The most dramatic change in the smart card market over the last year is that the market appears more application-driven and likely to grow from a demand-pull. For years the smart card has been a great concept in search of a market--a technology push. Today, smart card technology is able to provide solutions to many problems. This newsletter highlights recent worldwide smart card market activities, Dataquest's current unit production projections, and key developments occurring across the globe.

EUROPE--THE BACKDROP FOR MARKET ACTIVITY

The IC credit card or smart card was pioneered in 1976 by French citizen, Ronald Moreno. Three years later, in 1977, the concept became a reality as a result of collaborative work between Cii Honeywell Bull and Motorola Semiconductors (Europe). Initial production started in 1981 using a single-chip 8-bit microcontroller with 1,026 bytes of EPROM. Today, 10 years on from the first development work, IC cards are running in volume production in Europe in addition to undergoing numerous field trials in a variety of applications.

Table 1 lists Dataquest's world unit production estimates for 1987: nearly 50 million units. Of this 50 million, we expect 45 million or 90 percent of the production to take place in Europe. We estimate that this 45 million will comprise 22 million units of the financial card CP8 and 23 million units of the telephone E^2PROM card being marketed by the French PTT.

Production of the telephone card is exclusively by Thomson Semiconductors and takes place in its Rousset Plant, Southern France. Thomson recently moved a number of MOS processes from the Grenoble Plant to Rousset in order to focus key MOS process development in one center. The development of E^2, EPROM, and HCMOS processes at this site allows the company to rationalize the production and development resources associated with the telephone and

CP8 cards. Dataquest estimates that Thomson will supply approximately 20 percent of worldwide demand on CP8 (8.8 million units) during 1987. The other participants during 1987 are Motorola (Scotland) and Philips (RTC France) with 40 percent and 20 percent of the worldwide production, respectively.

Dataquest expects that the present E^2PROM telephone credit card will be phased out during 1987/1988 to be replaced by a variant of CP8. By 1992, Dataquest estimates that worldwide IC card production will be 525 million units, Europe accounting for 35 percent of the TAM.

Table 1

ESTIMATED WORLDWIDE SMART CARD PRODUCTION*
(Millions of Units)

	1985	1986	1987	1988	1990	1991	1992
Financial	1	7	25	45	70	135	155
Telephone	3	10	22	50	95	185	260
Other	N/A	N/A	3	7	30	55	110
Total	4	17	50	102	195	375	525

*Assumes financial cards have a life cycle of approximately two years. Other cards have a life cycle of six years. Telephone card life cycle is three months.

N/A = Not Available

Source: Dataquest
May 1987

U.S. SMART CARD MARKET ACTIVITY

In the United States the smart card market has centered around entrepreneurial activity and alternative technologies such as that of Datakey, Inc., a Minnesota company focusing on nonfinancial smart card applications. The much-touted financial arena (the most traditionally thought of application for smart cards) had too many barriers to entry--namely ISO packaging requirements and smart card cost. (Other ISO standards activities for the smart card, for example, communications protocols, are still emerging.) Some confuse the unclear standards as a major market barrier. While smart card standards are more complex than for the mag stripe, it is encouraging to note that it took seven years before standards

for mag stripe technology were adopted; today nearly a decade later, over 1 billion mag stripe cards are in circulation--for financial transactions alone.

In the past, Dataquest has noted that nonfinancial applications would be the driving force behind smart card development, particularly in the United States because nonfinancial applications:

- Would not be restricted by ISO packaging and communication standards for plastic cards
- Would not be limited by the current infrastructure and manner in which business is currently performed (i.e., working around the already heavy investment in automatic teller machines)

MasterCard International and Visa International, both with very different philosophies, strategies, and approaches to the market, have begun to change this. The nonfinancial market legitimized the technology to a certain extent and acted as a proving ground for smart card technology. Just as Dataquest originally expected, these applications appear to have inspired the financial community to analyze smart card technology with a view toward applications within the financial arena.

MasterCard--Leading the Way

Things changed in 1985 when MasterCard International formally announced its market test, setting off a flurry of interest including a smart card approach announced shortly thereafter by Visa International. Both MasterCard and Visa are outspoken about their approaches to smart card solutions.

We believe that MasterCard has been actively qualifying and discussing vendor participation and we expect an announcement in the first half of 1987 as to who will be the program's major participants and how the program will expand. We believe that MasterCard has been working with as many as six IC manufacturers including NEC and Motorola whose chips are in the cards currently being tested. We believe Motorola is the only U.S. IC manufacturer among the six or so companies. Requirements for multiple sourcing and MasterCard's requirement for state-of-the-art technology are fostering numerous discussions. Another potential boon to semiconductor manufacturers is that MasterCard is considering the testing of biometric identification as a less cumbersome solution than PIN codes. Proposed methods include digitized signatures or finger characteristics.

We believe that MasterCard will begin testing and using a production IC card by the second or third quarter of 1987. MasterCard views the semiconductor industry as a vital support link, necessary to effectively implement the technology. Unconfirmed estimates place MasterCard IC card use at the low hundreds of thousands by mid-1987, the low millions by 1988, and high volume in the late 1989 to early 1990 time frame.

The Visa Approach

Visa International's strategy for smart cards is quite different from that of its counterpart. Visa believes that the current need for the technology comes from improving current bankcard services and providing new services that can produce incremental income. They believe that the current system works and that operating costs and losses through fraud can be reduced. Visa believes that current services are highly profitable and it disagrees with MasterCard that today's bankcard business can justify smart card technology. MasterCard justifies implementation based on reducing losses and authorization costs.

Visa believes that in order to take advantage of new technologies and new services and improve existing services there must be an increase in terminal penetration because different terminals accept different cards. Therefore, by putting the terminal on the card, the industry has a readable card that also becomes the delivery system--no need for a variety of terminals, especially with a single vendor that accepts more than one card.

For the financial community this is truly forward thinking, because the history of banking holds that authority lies in more than one place--to use the analogy of the safety deposit box, the customer brings a key, the banker brings a key, and together they unlock the box. Visa believes that the key and the lock do not have to be in two different places. MasterCard, on the other hand, is approaching the system from a traditional banking operation perspective. In short, Visa views the concept as pocket banking as compared to controlled banking.

Visa's different perspective, namely its cost justification, view toward providing new services, and pocket banking concept has thrust it toward development of the next generation of smart card technology--a card utilizing E^2 technology, which Visa refers to as a super card and which falls at the high end of the card evolution spectrum.

Visa is currently testing a small number of cards developed by Smart Card International and manufactured by General Instrument's Microelectronics Division. The main purpose is to evaluate users' needs and attitudes toward the technology. Meanwhile, Visa has commissioned Toshiba to make a production version of the card with the charter of putting the technology on a card that meets ISO standards of 30 mils in thickness. The time frame for completion is the fall of 1987 to spring of 1988.

We applaud Visa's strategy to seek "a gradual transition to the smarter cards of the future while supporting the coexistence of several technologies," and we believe that E^2 technology is the long-term answer to most future smart card applications. MasterCard, however, is taking a more realistic approach in its attempt to use current technology within the current financial infrastructure.

E^2 technology for financial applications is still not as technically feasible. MasterCard's testing of the technology in a large-scale pilot is a manageable approach to making the technology realistically meet the needs of today's bankcard environment. We believe that smart cards can work in the

financial community today, without having to wait for E^2 technology in the late 1980s time frame. Testing the system as it exists appears most feasible from a smart card market perspective. MasterCard is chartering U.S. market development in financial applications.

JAPAN'S FOCUS ON SMART CARDS

There has been a surge in Japanese smart card activity over the last year. Dataquest's semiconductor market analysts in Japan have kept abreast of smart card market trends and we believe that there is no question that this market is being assessed and targeted very seriously by many sectors of the Japanese economy--much of this activity appears coordinated and orchestrated at a government level. The development of the smart card market is a lesson in Japanese industrial policy at work; competition is said to be fierce. There are as many as 50 to 75 small tests actively being observed. Applications are numerous and a myriad of technologies are being used. Consensus holds that a large number of small tests will provide the best window on market opportunities.

The most striking aspect of Japan's involvement has been the pace with which the Japanese have taken an active interest in the market. In terms of manufacturing technology, smart cards are similar to calculators and digital watches. Smart cards lend themselves to assembly and production by Japan's large electronic watch and calculator manufacturers.

In Japan, partnerships and alliances appear integral to the market's early development. Manufacturers are aligning with users to secure volume sales of products that conform to a worldwide or manufacturer's standard. This is all part of the coordination and cooperation that is being brought to bear on the Japanese focus on this market.

CONCLUSIONS

We are encouraged by smart card activity overall, and in particular the surge of activity seen in 1986. We believe 1987 will bring continued market opportunities and growth as the market begins its early shift into high gear. Market participants should be positioning themselves now; waiting much longer may mean that the market will be closed just as it begins to ramp up. There are opportunities for many types of IC manufacturers because the market has needs in large scale, high-volume applications as well as within the niches. The smart card market will not be only for those who are capable of withstanding the tremendous competition of commodity markets.

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Research Newsletter

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EUROPEAN MANUFACTURING AUTOMATION STATUS--SUMMER 1987

OVERVIEW

Development and installation of manufacturing automation in Europe is continuing on an aggressive scale relative to the rest of the world. Key factors that are sustaining investments in industrial plant modernization include:

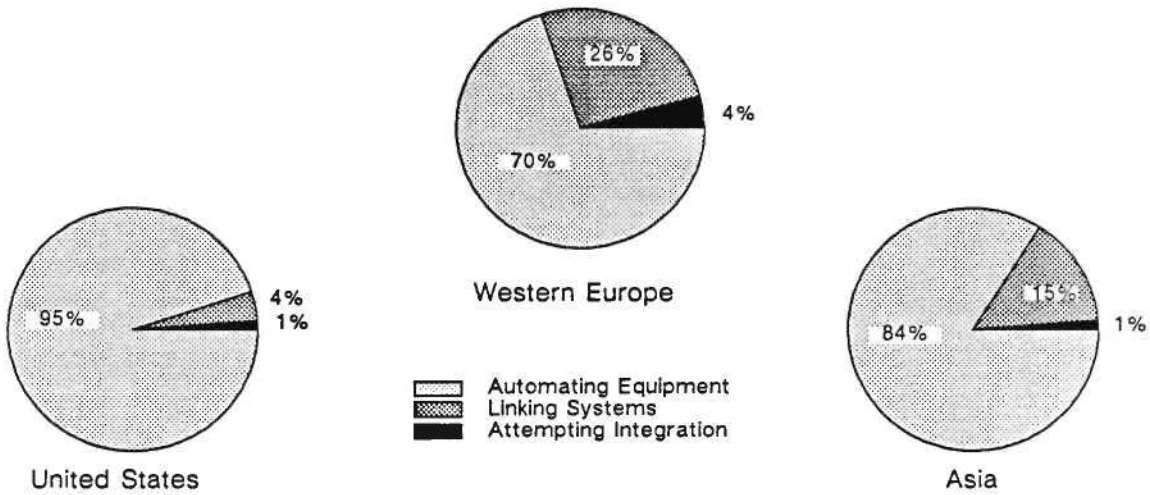
- Pressure to reduce manufacturing costs as local currencies rise in comparison with the U.S. dollar
- Rising confidence in the value of automation based upon results of pioneering efforts of innovative industry leaders
- Cooperative programs between governments, universities, and individual companies for investments in technology development
- Focus of management upon strategic manufacturing as a vital element for European economic strength in a global economy

Dataquest believes that Europe is currently leading the rest of the world in implementation of automated work cells. Figure 1 shows the relative positions of Western Europe, Asia, and the United States as of early 1987. The growth of strategic partnerships between European companies both within and across national borders is enabling this technology to spread rapidly.

The 1987 world market for manufacturing automation, excluding design automation and automation services, is estimated to be US$35.0 billion. Europe is expected to purchase US$7.2 billion, or 22.5 percent of the world total. Figure 2 shows the relative shares of the European total that Dataquest estimates will be consumed by individual European countries in 1987.

Figure 1

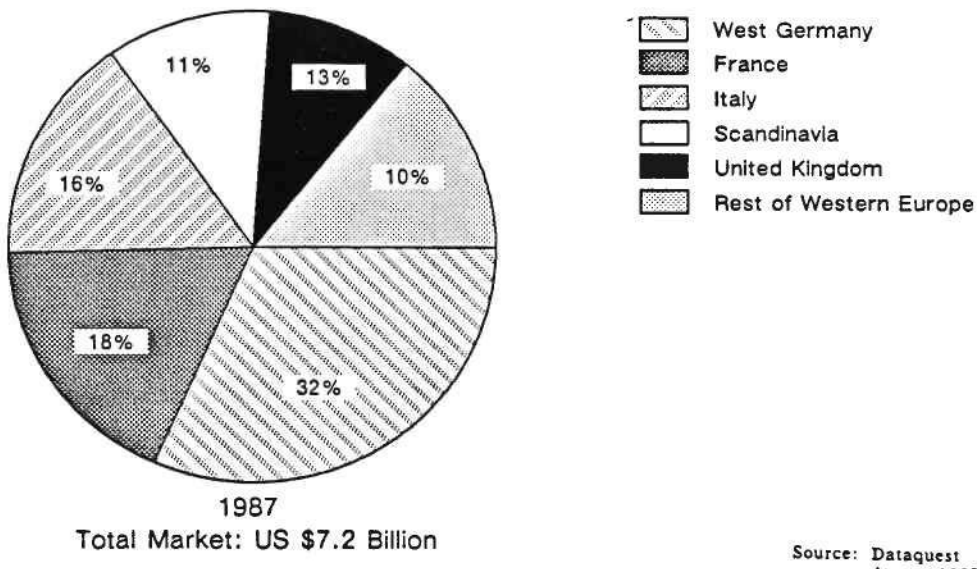
MANUFACTURING AUTOMATION IMPLEMENTATION
Early 1987



Source: Dataquest
August 1987

Figure 2

ESTIMATED WESTERN EUROPEAN MANUFACTURING
AUTOMATION MARKET SEGMENTS BY COUNTRY
1987



1987
Total Market: US $7.2 Billion

Source: Dataquest
August 1987

WESTERN EUROPEAN MANUFACTURING DEVELOPMENT TRENDS

During the spring of 1987, Dataquest toured four of the major industrial countries in Western Europe and attended the Hannover Industrial Fair in West Germany and the SICOB and Convention Automatique Productique exhibits in Paris. Dataquest visited factories of both automation users and vendors, and held press conferences with members of the technical press in London and Hannover regarding the status of manufacturing automation developments and trends for the immediate future.

The Hannover Industrial Fair is a massive display. Taking place in buildings encompassing a total of 380,000-square-meters with more than 6,000 companies, universities, and research institutes from 50 countries exhibiting, it attracted nearly half a million attendees.

Although the Fair had a strong West German vendor flavor, the signs of European unity were clearly discernible from the opening address by the vice-president of the European Economic Communities (EEC) commission. Examples of this unity were programs such as ESPRIT (European Strategic Program for Research and Development in Information Technology) and joint exhibits such as the "Initiatives for the Factory of the Future." The latter consisted of 194 individual stands, encompassing 10,000 square meters, that presented production-related automation technology in an overall, integrated context.

Dataquest believes that a major industrial trend in Western Europe is the emergence of a European community that is replacing the old internecine wars and conflicts that characterize much of European history. According to the Treaty of Rome, signed in 1957, a large common European market and technological community is expected to emerge by 1992. The primary objective is to create a market size for European industry that is comparable to what exists for North American and Japanese firms. The market area is expected to result from the planned dismantling of all trade, monetary, and technology barriers between members of the EEC.

The concept of a united Europe has a high acceptance level, according to surveys that have been taken by members of the community. There is a broad awareness of changing international circumstances and a consequent change in priorities for responding to the new international environment. Manufacturing automation development and implementation is high on the list of priorities.

Governments already are pooling funds in technology development and research via such projects as ESPRIT. The EEC has spent $120 million since 1982 developing ideas for the factory of the future. It is now proposed that $1.2 billion be spent on computer-integrated manufacturing (CIM) research over the next 5 years. In addition, the EEC expects to invest over $900 million in communications research with the Race program and $140 million for the Brite program on industrial technologies.

Manufacturing automation protocol (MAP) is well on the way towards development with a distinctly European flavor. Standards are viewed as a means for widening market opportunities for European automation systems vendors. For example, instead of producing machine tools with Italian

standards to serve the Italian market, machine tool builders can address world markets if their machines conform to international standards. European users are involved in the MAP development through the ESPRIT program and through membership in EMUG, the European MAP Users Group.

Another trend is toward joint ventures, strategic alliances, and mergers across borders. An example is the agreement between France's Thomson Semiconducteurs and Italy's SGS Semiconductors. This merger will involve the creation of a Netherlands-based company, owned 50 percent by Thomson-CSF and 50 percent by STET, the Italian group. Other examples of noteworthy cooperative efforts include a joint R&D effort for digital switches by France's CIT-Alcatel, Italy's Italtel, Plessey of Britain, and West Germany's Siemens AG; ICL, Siemens, and Bull cooperating on technology for the next generation of computers; and Philips and Siemens working together to develop megabit chips.

The mood of the European manufacturing automation vendors at the Hannover Fair was one of optimism. The same attitude was expressed by both vendors and end users of automation systems during Dataquest visits to factory sites in Europe. Manufacturing competitiveness on a global scale is viewed as a major factor in the economic well-being of European society. Automation is seen as a key element in the ability of manufacturers to sell products on a worldwide basis.

Installation of automated systems and processes in Europe has progressed to a greater extent than might be realized. Experience with successful automation projects has tended to make both systems vendors and end users highly receptive to further investments in manufacturing systems. Dataquest further believes that the Western European region is taking a back seat to no one in such areas as work cell integration, use of expert systems in manufacturing, robotics, automated material handling systems, and factory floor simulation software.

WEST GERMANY

West Germany leads the world in per capita exports, with 60 percent of its gross national manufactured products exported. This level is twice as high as Japan's and four times that of the United States. German manufacturing managers tend to be technically trained with factory operations experience. These executives view manufacturing operation efficiency as one of the key elements to maintaining worldwide competitiveness. Thus, investments in manufacturing technology are strong.

The recent rise in the value of the deutsche mark relative to the dollar has added additional incentive toward investments in manufacturing automation. Since the United States often represents 30 percent or more of the West German market, every attempt to hold product prices down in the United States is being made. Because the price must be lowered to counter the rising mark value, profit margins can be retained only if product costs are reduced. How is this being accomplished? Through increased automation, say German representatives.

Interviews with West German manufacturing executives reveal that the annual rate of automation systems investments will grow between 15 and 20 percent per year for at least the next two years. This rate is the highest in Europe. Particularly strong are purchases of robotics, material handling automation, and industrial sensors. West Germany has more flexible manufacturing systems (FMS) installations than any other country in the world, with approximately 100 such installations as of the end of 1986.

West German industry has close cooperation with universities. Dataquest saw at least 12 universities that exhibited their state-of-the-art technology developments at the Hannover Fair. In contrast to the U.S. students, the highly motivated West German students were looking forward to careers in manufacturing operations or research in manufacturing technology development.

FRANCE

France is the second-largest market for manufacturing automation systems in Europe, with an estimated total of nearly $1.3 billion to be spent in 1987, as shown in Figure 2. Applications of automation are concentrated in the largest companies. The market has been slow in developing for the following reasons:

- Necessity of retrofitting old factories
- Lack of experience and need for extensive training
- Insufficient resources in the majority of small companies
- Wide product and process diversities
- Disappointments with overly ambitious projects that have not met expectations

Emphasis has been on elimination of unprofitable operations and the discontinuance of poorly performing product lines, such as consumer electronics.

The current strategy of many French companies is to consolidate in order to gain benefits from greater pools of resources and also to eliminate duplications. An example of this strategy is the merger of the Peugeot and Citroen automotive firms.

The automotive, aerospace, and appliance industries lead in French manufacturing automation implementation and developments. Some large firms such as Renault have taken advantage of their internal manufacturing expertise to develop products and services for new business developments. Renault Automation has successfully participated on a worldwide basis as a turnkey supplier of systems integration services and as a supplier of robotic and material handling systems.

In an alliance with EMUG, 30 French companies have been working since June 1986 on development of a factory network standard called Factory Information Protocol (FIP). This network is intended to be implemented at the equipment and workstation level below the factory MAP network. The objective of this standard is to provide analog, nondedicated, low-cost communications at the lowest levels in the factory. FIP would be connected to the MAP network via bridges.

Dataquest attended both the Convention Automatique Productique and the SICOB computer fair in Paris. In conjunction with SICOB, Bull held a separate show where it exhibited its capabilities in both design and process automation. All of these events, while not on the scale of the Hannover Fair, were well attended. The French are determined not to be left behind in the European surge toward manufacturing automation developments. They place particular emphasis on software development, modeling of automated structures and organizations, design automation, and workstation scheduling and control innovations.

Concerted efforts are being made to ensure that workers and executives alike are well trained in the developments that are occurring in manufacturing. For example, Peugeot/Citroen advertises that 3.5 percent of the annual turnover of the combined companies is spent on employee training.

ITALY

Italy is currently experiencing the best economic environment that it has seen in a decade. Always strong in engineering capabilities, Italy is at the forefront of European manufacturing automation technology development. There is a new emphasis on worldwide business alliances and product development. An important example of this trend is Olivetti, which has formed alliances with AT&T in the United States, and with European and Asian firms. In addition, Olivetti is actively pursuing its role as a leading vendor of manufacturing information systems development on a worldwide basis. Comau's acquisition of three French machine tool companies is another example of Italian expansion into European markets.

The automotive, apparel, and appliance industries have gained significant penetration into global markets. According to the Italian Economic Study Office, the export-import balance of trade for machine tools has climbed steadily upward since 1975 to an estimated positive level of nearly 1,000 million liras in 1986. Exports of machine tools exceed domestic consumption by nearly 400 million liras. Nineteen eighty-six machine tool revenue increased by 17 percent over 1985. Italy is the world's fifth largest producer of this class of automation systems.

Turnkey plant installations by Italian firms lead the rest of Europe, with 80 percent of their turnover coming from installations outside Italy, according to the chairman of Italimpianti. Evidence of Italian manufacturing technology prowess can be seen from recent contract awards to Italian firms. For example, Mitsubishi has signed an agreement to market rolling mill technology developed by Pomini Farrel throughout Asia. For the Soviet

government's ZAZ towncar, Geico of Milan will provide design and construction of the entire painting structure, including pretreatment, catphoresis, and robotized lines for primer and final coats for vehicle interior and exterior bodywork. This car will be produced and marketed throughout the USSR beginning in 1990.

There are 70 robot manufacturers in Italy. The majority of these are simple pick-and-place devices that do not qualify as robots under the Dataquest or Robotics Industry Association (RIA) definition. For example, in 1985, Italy had an installed base of 5,000 industrial and 15,000 additional pick-and-place machines. Dataquest estimates that robot use in Italy is growing at 25 to 30 percent per year. Major suppliers include Comau, DEA, and Olivetti. Major users include Fiat and its newly acquired subsidiary, Alpha Romeo, and Olivetti--which supplies 90 percent of its robots itself.

UNITED KINGDOM

The weakest link in an otherwise upbeat European manufacturing automation market appears to be the United Kingdom. The London Financial Times has reported that in 1987, Italy's GNP is expected to surpass that of the United Kingdom for the first time in modern history. The United Kingdom will be last in terms of GNP size of the major EEC countries.

Even so, Dataquest believes that there are some signs of encouragement for the future of U.K. manufacturing developments. For example, some 50 Japanese companies have set up factories in Britain, putting it neck-and-neck with West Germany as the European nation of choice for Japanese enterprises. Currently, Japanese firms such as Nissan, Sony, NEC, Hitachi, Komatsu, Sumitomo, and Ricoh employ about 13,000 workers.

At the $650 million Nissan plant in Sunderland, evidence of changes to England's class-ridden industrial past are reported to have resulted in a steady increase in output levels, with quality reportedly equal to that of cars produced in Japan. Further, there have been no union grievances to date. A just-in-time system of scheduling the arrival of parts, the utilization of groups of spot-welding robots, and the emphasis of employee teamwork are fundamental changes in British industrial style.

Other areas of British leadership in European manufacturing automation development are that the chairman of EMUG, Colin Hoptroff, is an executive at Jaguar, and that British Aerospace is the prime contractor for CNMA (Communications Network for Manufacturing Applications). CNMA, a parallel to MAP, is a European initiative funded by EEC as one of the ESPRIT developments. MAP and CNMA have the same objective, which is to get suppliers and users of automation systems to use the open network communications standards as defined by the ISO (International Standards Organization).

In spite of these bright spots, Dataquest believes that the United Kingdom lacks the intensity of development that is occurring elsewhere in Europe. Too many developments appear to be academic, with low levels of acceptance in the mainstream of manufacturing industries. The recent reelection of the Thatcher government is more likely to produce a continuation of the present level of development than it is to produce any revolutionary changes in British industry.

DATAQUEST ANALYSIS

In summary, Dataquest finds the status of European manufacturing automation to be as follows:

- European business is generally good and growing for most manufacturers. Exports to the United States continue in spite of the falling U.S. dollar.

- Technology development is being emphasized throughout Europe, especially in applications software and the integration of programmable equipment into automated work cells.

- Dataquest estimates that Europe is spending 25 percent of its total investment in manufacturing automation for integration of equipment into work cells, 4 percent for integrating entire factory systems, and 71 percent for automating individual pieces of equipment. The level of work cell integration is the highest as a percent of the total automation investment in the entire world.

- Generally, European governmental support for manufacturing automation development is clearly evident. Although governments may not be as enthusiastic about the formation of a single European economic community as is industry, Dataquest believes that developments to this end may well occur at a faster pace than is currently anticipated, both within and outside Europe; this will be particularly true if the United States appears to begin to reduce its Western European military support after 1988.

- Worldwide alliances, as well as intra-European alliances, joint ventures, the pruning of unprofitable products and factories, and the implementation of automation in manufacturing, are well under way in Europe.

- Manufacturing competitiveness is a high-priority item in Europe. There is no debate about becoming a service economy or a post-industrial society. Europe intends to continue to be very much a world industrial power.

- Since exports represent a high percentage of the GNP of European manufacturers, the increase in their currency values relative to the U.S. dollar provides additional impetus to reduce the cost of goods sold. Automation is seen as a major element in meeting this objective.

- Europe enjoys good academic support for technical developments in manufacturing automation. Universities are providing a source of highly qualified and motivated human resources for long-term growth in European manufacturing technologies.

- Dataquest's contacts with European manufacturers confirm that most companies throughout Europe intend to focus on specific market niches rather than expand across broad market areas. They are in the process of strategic consolidation and streamlining of their internal organizations in order to become experts in particular areas with products focused upon global market needs.

- The European industrial leaders are solidly behind the development of world standards, such as MAP. However, Europeans are also intent upon improving standards that are developed in the United States. Dataquest estimates that implementation of the MAP standard in Europe will parallel U.S. efforts.

(This newsletter is reprinted with the permission of Dataquest's Manufacturing Automation Service.)

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NIXDORF COMPUTER AG--REACHING FOR THE WORLD

INTRODUCTION

Nixdorf Computer AG has long been one of the most successful computer companies in Europe, particularly in its native Germany. However, the company's success in other important markets in the world, particularly in the United States, has been less than spectacular. In 1987 we may see a positive change in the company's worldwide sales picture as management rededicates itself to the original company goal: to provide standard and tailored vertical programs for small- and medium-size companies in a variety of markets.

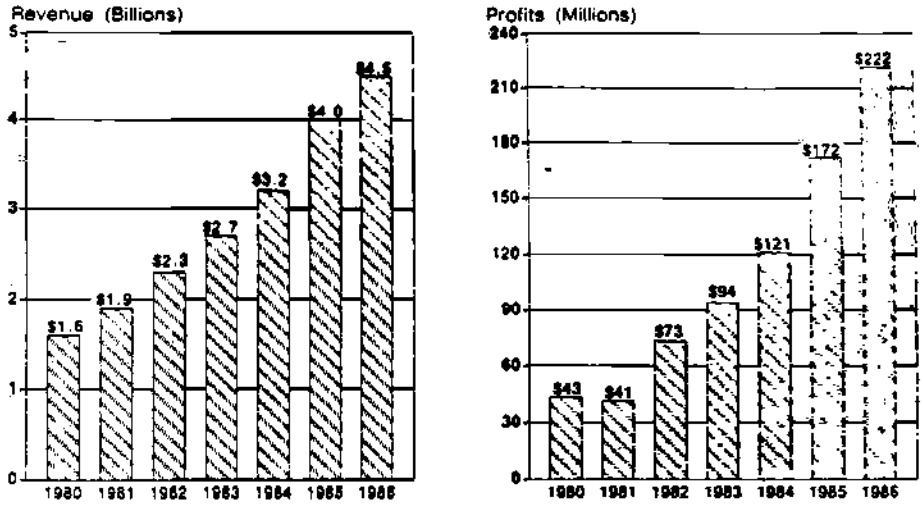
This newsletter discusses Nixdorf's growth, examines its overall product line and its position as a vendor of integrated office systems, and evaluates its marketing strategy in the light of changing end-user requirements.

COMPANY HISTORY

The rise of Nixdorf Computer AG can be considered a success story by any standard. The company was founded in Germany in 1952 by Heinz Nixdorf, and today is represented in more than 44 countries with over 600 branches and service organizations. As shown in Figure 1, revenue has increased steadily by approximately 20 percent per year to DM 4.51 billion (or $2.1 billion) in 1986. More than 89 percent of this revenue is from Europe, the rest from international markets (the United States and Asia). Profits climbed 29 percent in 1986.

Figure 1

Revenue and Profit--1980 to 1986



Source: Nixdorf Computer AG

But Nixdorf measures its success based upon more than just the bottom line. The company takes its social responsibility seriously and regards people and innovative technology as important as an increase in profits. At press and stockholder meetings, Nixdorf always emphasizes two points:

- The size of its research and development budget, which has consistently remained at approximately 10 percent of revenue
- The number of additional people that the company employs each year. In 1986, for example, Nixdorf added 2,300 positions. This increased worldwide personnel to 25,600 people, with approximately 17,000 of them working in Germany.

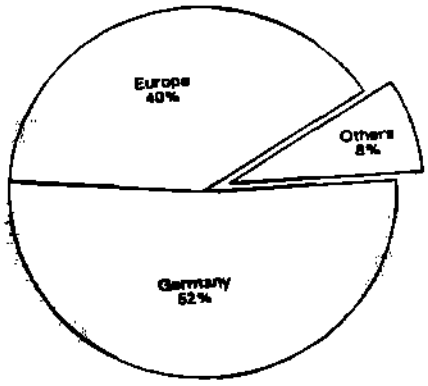
Mr. Nixdorf died prematurely in 1986 at the age of 60. Mr. Klaus Luft, the Vice Chairman of the Board, assumed the position of Chairman of the Board, and Mr. Arno Bohn took the position of Vice Chairman. No other management changes were made. The company continues to be run by the seven board members, five of whom have been with Nixdorf since 1970.

Foreign Markets

As represented in Figure 2, approximately 52 percent of total revenue comes from sales within West Germany, 40 percent from the rest of Europe, and 8 percent from other countries. Excluding Germany, Nixdorf is represented in 325 cities in 17 countries in Europe. Outside of its native Germany, Nixdorf has been most successful in England, France, and Spain. In England, for example, Nixdorf has an 8 percent market share in the retail industry and an 11 percent market share in the banking industry. In addition to Europe and the United States, Nixdorf is represented in 54 cities in 24 countries in South America and Asia.

Figure 2

Revenue by Region



Source: Nixdorf Computer AG

In the United States, Nixdorf has established subsidiaries and service organizations in 110 cities. However, penetrating the U.S. market has proved to be a formidable task. Although Nixdorf is the largest non-American computer business in the United States, its market share after 19 years is 1 percent of midrange computer sales. But several large orders in 1986 (Montgomery Ward, for example) indicate that the trend may be reversing now that Nixdorf has switched from a product-oriented to a solution-oriented approach, the strategy to which it owes its success in Europe.

In its continuing push into international markets, Nixdorf has established software centers in Holland, Ireland, Japan, the United States, and Singapore to develop application programs appropriate to local market requirements. Production facilities have been established in the United States, Ireland, Spain, and Singapore.

Corporate Objectives

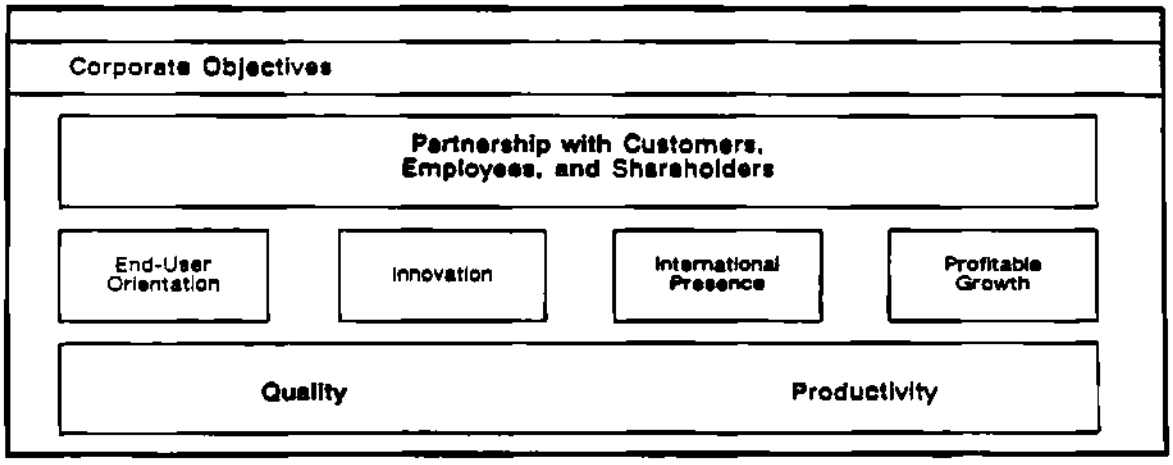
Until his death in 1986, Heinz Nixdorf "was" Nixdorf Computer AG to the public and one of the most prominent personalities in the European computer industry. Yet, when he died unexpectedly in Hannover, the transition to new leadership was untroubled and smooth, largely due to Mr. Nixdorf's vision and long-range planning. Corporate policies had always been set by Mr. Nixdorf in conjunction with the board of directors, and so no changes in corporate strategy were considered necessary.

This includes Nixdorf's determination to remain independent rather than merge with another company. Equity capital is now more than 60 percent, and all voting shares remain in the hands of the Nixdorf family.

Nixdorf's approach to domestic and international business is perhaps best exemplified by the company's traditional corporate objectives as outlined in Figure 3. Nixdorf has always emphasized (and has built its success on) its role as a partner to its customers, its employees, and its shareholders. In its role as partner, Nixdorf has paid primary attention to end-user needs and to the necessary innovation in developing programs for its domestic and international customers.

Figure 3

Corporate Objectives

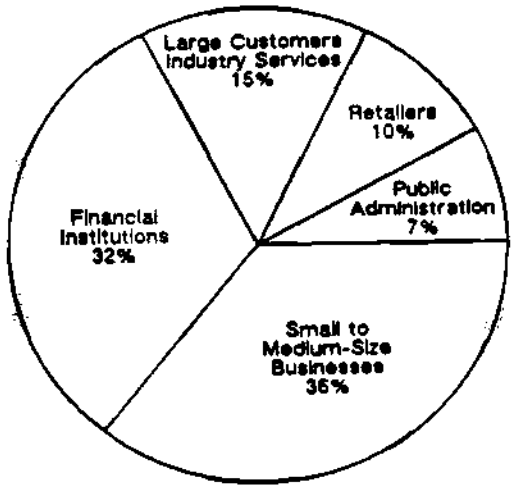


Source: Nixdorf Computer AG

To achieve these objectives, Nixdorf's main strategy has been to penetrate small- and medium-size companies by providing them with tailor-made vertical application programs for solving specific problems. Nixdorf was one of the first to address the needs of vertical markets. In order to produce the numerous tailored, solution-oriented applications, the company established its own 3,500-person software development staff and formed strong alliances with numerous software and system houses. As a result, approximately 36 percent of Nixdorf's revenue comes from sales to small- and medium-size companies as outlined in Figure 4.

Figure 4

Worldwide Revenue by Customer Group



Source: Nixdorf Computer AG

Strategic Changes

Although Nixdorf's basic tenets have not changed over the years, there have been several shifts in the company's strategy that should improve its appeal to multinational companies and international markets. The first shift is in its attitude toward IBM; the second is its attitude toward office automation, reflecting the recent shift from standalone business application solutions to an emphasis on integrated solutions, which include office applications.

Nixdorf initially believed that it could continue to provide its own proprietary hardware and tailored software solutions. Over time, Nixdorf realized that it could be more successful if its products were compatible with IBM and other vendors from large hosts to personal computers. After initial hesitation, Nixdorf added IBM-compatible PCs to its product line. The company's strong support of DISOSS on its primary products (the 8860, the 8890 and the TARGON Series) is additional proof of this change in strategy.

Initially, Nixdorf also viewed office systems as closed solutions appropriate for specific departments of an organization. With its support of the 88BK system, the company paid a high price to recognize that this approach did not work. Nixdorf now believes that office applications are needed throughout an organization and that these products can be cohesive elements tying together the entire organization. If implemented, this approach should make Nixdorf more competitive with other integrated office system vendors such as Digital Equipment, Data General, and Wang.

The shift from standalone, tailored business applications solutions to a more integrated approach has resulted in what Nixdorf calls the Computer Integrated Office (CIO) and Computer Integrated Manufacturing (CIM). CIO consists of three areas: telecommunication, text processing, and data processing/business applications. The three components can be found in each Nixdorf product line, and they are developed to maximize the capabilities of each product family. CIO will be described more fully later on in this newsletter.

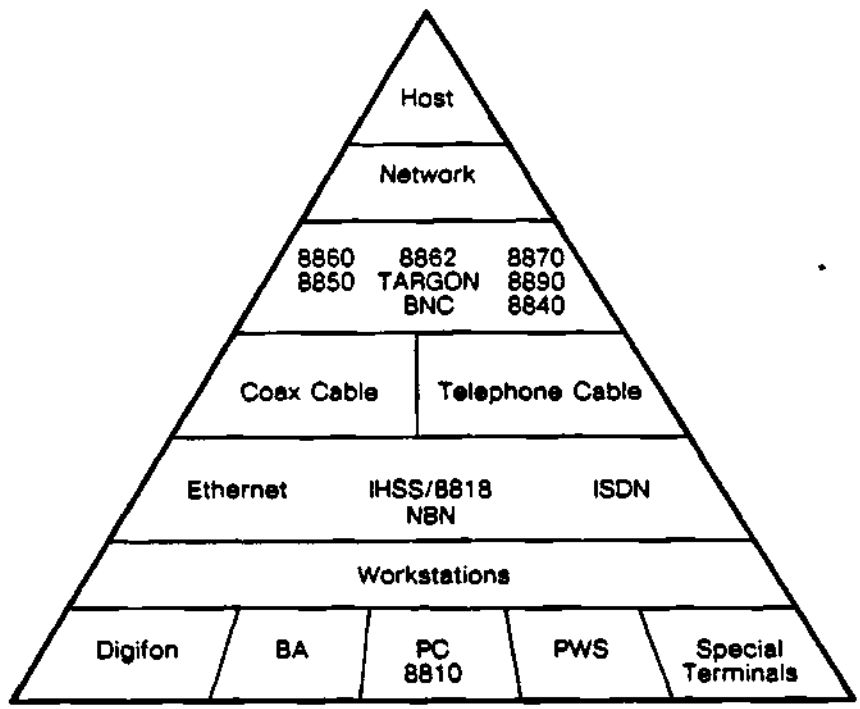
Nixdorf is also a proponent of international standards and continues to work with organizations such as the X/Open Group (UNIX standards); CCITT to promote the X.400 electronic mail standards; X.21 and X.25, with ISO/OSI, ANSI, ECMA, IEEE (Ethernet and Nixdorf Broadband Network) and others.

THE NIXDORF PRODUCT LINE

A brief overview of the product line may be helpful in providing perspective to Nixdorf's offerings. With the exception of large hosts, Nixdorf Computer AG offers an array of hardware and software products for every type of user and application: small- and mid-range computers, personal computers, local area networks, videoconferencing systems, digital PBX systems, image scanners, laser printers, videotex systems, point-of-sales systems, and automatic cash dispensers. Figure 5 outlines Nixdorf's products for the office automation environment.

Figure 5

Pyramid of Products



Source: Nixdorf Computer AG

Terminals

Nixdorf supports character-oriented data processing (DAP) terminals, the personal computer, and the Professional Workstation (PWS). Both PCs and PWS systems function either as standalone workstations or as intelligent workstations to most Nixdorf systems. Through a set of soft keys, the unintelligent DAP 4 terminals offer a user interface similar to the PWS systems.

The Nixdorf 8810 Personal Computer Product Family

Nixdorf models 8810 M 25 and 8810 M 35 IBM compatibles can function as standalone personal computers or they can be attached to other Nixdorf products as workstations. All personal computer models support standard industry software, including the Window Manager from Microsoft and GSX graphics. The 8810/55 is an AT compatible with specific Nixdorf enhancements that is likely to function as Nixdorf's primary desktop publishing system using Page software from Island Graphics.

Professional Workstation (PWS)

The PWS is Nixdorf's primary strategic office workstation. It is a high-resolution (820 x 615 pixels), multifunction workstation with programmable soft keys for use as a videotex terminal, PC, data processing terminal, teletext system, or intelligent workstation to the Series 8840, 8850, 8860, 8862, 8864 BNC (Banking Network Computer), 8870, and 8870 Quattro. Nixdorf markets several models of the PWS: the PWS WP, a low-cost, intelligent, but diskless word processing system terminal; the PWS-D, with diskette; and the PWS-E, the expandable Tower version. The PWS is modular and supports external and internal communications, as well as emulation of the 8840, 8850, 8860, 8870, TARGON, and a variety of host systems from other vendors. It is deeply integrated into each Nixdorf server system for file transfer and remote file access. It supports a wide range of peripherals. Its eight windows permit several applications to run simultaneously, for example MS-DOS (2.11 and 3.2) as well as AT or UNIX software. The PWS can be connected directly, or through the PABX 8818, Ethernet, or the Nixdorf Broadband Network (NBN).

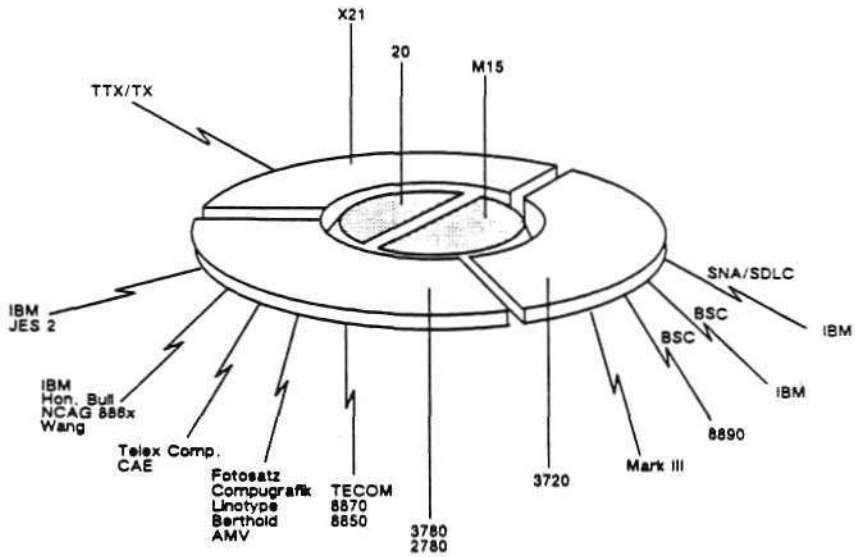
The Nixdorf 8840

Nixdorf's traditional standalone (8840/3) or shared logic (8840/5 to 8840/45) word processing system is expandable to 512K of main memory and 264Mb storage capacity) and supports up to 14 workstations (including personal computers and PWS systems) and 8 printers. The 8840 is designed to handle the integration of text (unstructured) and data (structured) as well as paragraph assembly. The 8840 text software includes mathematical capabilities, teletext capabilities, and communication to a variety of hosts.

Nixdorf has expanded the capabilities of the traditional 8840 text system by providing numerous communication capabilities as outlined in Figure 6. This includes access to the vertical business application capabilities of the larger 8860, 8870, and 8870 Quattro systems. It is also possible for 8840 users to integrate information from the 8870 proprietary data base into the 8840 text program. Editable document exchange is already available between the 8840 and the 8860 text program. Document conversion with the 8870 and the 8870 Quattro text software is planned for 1987.

Figure 6

Communication Capabilities of the Nixdorf 8840



Source: Nixdorf Computer AG

The Nixdorf 8850

The 8850 is a 16-bit decentralized data acquisition and distributed data processing system that is sold primarily to commercial markets. It supports the operating system DIDOS (Distributed Data Processing Operating System), up to 32 workstations including PCs, and a workstation for the blind. The 8850 supports teletext and DETAS (Decentralized Textverarbeitung am Sachplatz), a simple text processing program that merges structured data with addresses and text for mass mailings. The 8850 is able to transfer data and files to the traditional 8840 text system for integration into the more complex text editing programs.

The Nixdorf 8860

The 8860 with Models 60 (industry and public administration), 62 (hotels and wholesale organizations), and 64 BNC (banking systems) is one of Nixdorf's most important and successful products. In the past it was used primarily for distributed data processing applications such as order processing, inventory control, time recording, and recording of production data, and competed with the old IBM 8100. In contrast to the 8870 with its many standard applications, the 8860 fits into environments where tailored systems are needed or where the user develops vertical software.

With the addition of NIOS-TOP at the end of 1986, the 8860 has moved into the office environment and competes against IBM's low-end S/370 line. More than 40,000 processors have been installed: 30,000 in main offices and branches of financial institutions (8864 BNC) and 10,000 (Models 60 and 62) in factories or large organizations as a centralized and distributed information processing system, and more recently, also with terminals for business and office applications. In West Germany, the 8864 is the market share leader in financial institutions.

The 16-bit 8860 with a Nixdorf proprietary operating system consists of modular hardware that provides a user with upgradable systems from standalone micros to MCS, the Multi-Computer System 886X with up to 100 terminals.

The 8860 Multi-Computer System

The MCS was introduced in January 1987 as the most powerful version of the 8860 family. An MCS consists of up to eight autonomous processors coupled with an extremely fast MCS-Bus. Each processor has its own operating system and a copy of the application programs, and each MCS can function as either application or file server. Several Multi-Computer Systems 8860 can be clustered using Ethernet as a local area network. All 8860 software is compatible with the new family.

The application and file server concept of the MCS system provides 8860 users with unlimited growth, and positions Nixdorf to compete directly in the market for major accounts, particularly in the office environment.

The most versatile workstation for the 8860 in an office environment is the Professional Workstation (PWS). Because of its multifunction and windowing capabilities, the PWS can support 8860 emulation in one window, MS-DOS or UNIX software in another, and the NIOS text program (loaded from the 8860) in yet another.

In the office environment, the 8860 supports NIOS-TOP, the Nixdorf Integrated Office Software. NIOS-TOP Word is similar to Quadratron's Q-Office software, and consists of text processing software (including the integration of data processing information), communication (electronic mail, teletext, videotex, and telex), information (calendar, directory, calculator), and document management (filing, retrieval). NIOS-TOP also supports SNA, NCN (Nixdorf Communication Network, and Ethernet, as well as DISOSS DCA/DIA.

The Nixdorf 8870

The 8870 product family is more than 10 years old and has an installed base of more than 50,000 units worldwide. It and the 8860 family are considered by Nixdorf as its "bread and butter" products. The system is primarily sold with standard application programs into small and medium-size organizations as well as into branch offices of large companies.

The Nixdorf 8870 Quattro

The 8870 Quattro family was introduced in early 1987 and offers twice the performance of the 8870 while retaining software compatibility with all 8870 programs. The increased power of the 8870 Quattro is due to the new operating system NIROS 7.0 and its parallel processor architecture with a maximum of four processors. Approximately 50 programs can be run at the same time.

The Micro 7 is the smallest model with two workstations; the high-end Quattro/75 supports up to 30 workstations and 15 printers.

Both the 8870 and the 8870 Quattro support hundreds of standard software programs (bookkeeping, accounting, and so forth) for specific markets under the generic name COMET. As part of Nixdorf's Computer Integrated Office (CIO) approach, the company developed COMET TOP Word, which consists of word processing, filing, archiving, and document creation, as well as COMET data base, telebox, teletext and videotex. COMET TOP Word and COMET Calc can be accessed from all other COMET vertical applications such as bookkeeping, inventory, and so on.

The 8870 and the 8870 Quattro can be networked through the 8818, Nixdorf's digital PABX. Personal computers can be attached through COMET PC-LINK and can support file transfer of business applications information into personal computer programs such as Open Access or Symphony.

The Nixdorf 8890 Product Family

This Nixdorf product competes directly with the IBM 9370 announced in 1986. The Series 8890 (models 32, 13, 18, 23, and 28) is Nixdorf's largest system and ranges from 0.25 mips to 2.8 mips. Together with the 8870 and the 8870 Quattro, it offers a complete modular range, from standalone systems up to the 64-workstation model of the 8890 under VM-Basic. Nixdorf's own PCs, as well as other IBM-compatible PCs, can be attached as intelligent workstations through Ethernet and either in-house or telecommunication lines.

In addition to business application software specific to the 8890, the system supports 8870 and 8870 Quattro compatible COMET TOP commercial software. For the office environment, the 8890 supports COMET TOP Word text processing, electronic mail, resource scheduling (meeting rooms, meeting times, etc.), and meeting facility (videoconferencing). Nixdorf also provides its own relational data base, Reflex.

Reflex is compatible with IBM's Structured Query Language (SQL), a standard set by IBM for its data base products. SQL is portable, independent of application environments, and exchangable. For Nixdorf customers, this means that programs developed under SQL are supported by Reflex. At present, Reflex is available on the 8860, the 8890, and the TARGON systems under Nixdorf's own operating system DIPOS, as well as DOS, VM, and UNIX. Nixdorf is developing Reflex versions for IBM (MVS) and Digital (VMS).

The 8890 systems support IBM's S/370 Office as well as a DISOSS gateway for final-form and revisable-form document exchange.

The Nixdorf TARGON Product Family

Nixdorf has long been a supporter of UNIX V as the standard UNIX implementation. TARGON supports UNIX V, and Nixdorf regards this system as a strategic product, particularly in the public sector. Nixdorf recently received the largest order in its history for more than DM 300 million ($150 million) in TARGON systems from the Bundesanstalt fuer Arbeit (Federal Unemployment Agency). This organization uses Reflex as a distributed data base for its unemployment records and TARGON-Office with teletext and word processing.

The TARGON systems consist of a standalone, the PWS-X (Figure 7) with graphics capabilities, the TARGON/31 M 10 30/50 based on the 86020 processor (8 to 32 users), the TARGON/35 RISC system Models 30 and 50 with 12 mips (32 to 200 users), and the fault-tolerant TARGON/32 (16 to 250 users). PCs and the versatile PWS systems function as workstations to the TARGON system.

Figure 7

PHOTO OF PWS-X

Source: Nixdorf Computer AG

In addition to numerous business applications, TARGON supports TARGON Office software. TARGON Office is the Q-Office program from Quadratron, but it has been enhanced by Nixdorf with soft keys and includes integration of graphics and image. TARGON Office consists of text processing (word processing, text/business applications), notebook, calendar, telephone directory, electronic mail, data base, and calculator. TARGON Calc will be released in 1987. In addition, Nixdorf's TARGON Office supports X.400-Mail, the relational data base Oracle, SQL, and Nixdorf's own data base Reflex in a UNIX coprocessor. TARGON Office also permits access to hosts and networks.

The Nixdorf 8818 PBX

In 1982, Nixdorf launched Germany's first digital PABX, the 8818, a vitally important module in the company's integrated office strategy. According to Nixdorf, the PABX is already being marketed in eleven countries and more than 3000 systems (30 to 3000 users) have been shipped. The 8818 can be integrated into data processing systems to support applications relating to factory data capture (building security, energy management, time recording), charge recording, and wholesale applications. The 8818 also transmits data, text, voice, and graphics within office applications, and will be connected to all Nixdorf products.

All Nixdorf terminals can be attached to the 8818, including the BT01 videotex terminals and the Digifon, a digital telephone used for data switching and telephony. The 8818 permits switching of data from the PC/PWS to personal computers and to midrange computers, as well as from terminals with teletext capabilities to midrange computers.

Voice Box

Nixdorf's Voice Box is a voice store-and-forward system based on 80186 and 80286 Intel microprocessors with the RMX operating system. Voice messages are integrated into electronic mail and appear in the electronic mail directory. Table 1 shows the worldwide installed processor units of the major Nixdorf systems as of the end of 1986:

Table 1

WORLDWIDE INSTALLATIONS OF NIXDORF SYSTEMS

Nixdorf 8840	4,500
Nixdorf 8850	14,500
Nixdorf 8860	40,000
Nixdorf 8870	50,000
Nixdorf 8870 Quattro	released 1987
Nixdorf 8890	700
Nixdorf TARGON	500
Nixdorf 8818 PABX	3,000

Source: Nixdorf Computer AG

CIO, THE COMPUTER-INTEGRATED OFFICE

The CIO concept was developed almost two years ago. To Nixdorf, CIO represents the "informative infrastructure" of an organization, while CIM represents the "productive infrastructure." The CIO concept encompasses all of Nixdorf's hardware products and all data, text, and communication software capabilities, including the digital PBX 8818, Ethernet, and the Nixdorf Broadband Network (NBN).

With CIO, Nixdorf pledges to combine both hardware and software in a number of ways to support managers, secretaries, and knowledge workers in a variety of environments. Through the CIO concept, Nixdorf hopes to show its existing customers that they are already participating in office automation. At the same time, Nixdorf wants to assure them that the investments they have made in Nixdorf products will always be upgradable to state-of-the-art technology without loss of hardware or stored information, and without having to perform duplicate work.

Under the CIO concept, Nixdorf intends to integrate its products according to specific in-house and international standards, perhaps similar to IBM's System Application Architecture that was announced in 1987. In a statement of direction, Nixdorf has formulated rules for each of six main areas:

- Communication with the host
  Rules: RJE (remote job entry), 3270, 8160, SNA, DISOSS/DIA

- Communication between Nixdorf products
  Rules: IHSS in-house communication; remote connection/public networks; Ethernet for server connections; ISDN for workstation connections
  Rules: Ethernet and ISDN

- External postal services:
  Data services: dedicated lines and switched networks; Datex L; Datex P
  Information services: telex, videotex, teletext, telefax, telebox, all according to ISDN standards

- Internal postal services:
  electronic mail according to X.400 and the CCITT standards
  Rules: ISDN standards

- Information management: business applications, word processing, integrated word and business applications, filing and archiving, personal computing, including voice, image and graphics
  Rules: Uniform Information Management (internal Nixdorf standards for uniform integration and user interface)

- Application integration: file transfer, dialog access, multifunctionality (dp + wp + pc + host access and postal services)
  Rules: Multifunctional solutions using standardized interfaces

Dataquest's View of an Integrated System

Dataquest defines an integrated office system as a composite of computer hardware and integrated software that supports and enhances the productivity of work groups. The core functions that have evolved over the years are document management, administrative support, decision support, end-user computing tools, and gateways to other systems.

Vendors must provide for integration, particularly in the area of text, data, image, and voice, and must form them into one compound document. The following capabilities should be available in a tightly integrated system.

- Move data from one application to another without exiting the program or using a conversion utility.

- Move data between applications and files without losing the character of the information (e.g., spreadsheet data inserted into a word processing document retains its spreadsheet identity); when data are changed in one application, the same change is automatically reflected in the second application.

- Store different types of data (such as in compound documents) in one filing system.

- Present a consistent user interface across all applications.
- Run the same software on all proprietary hardware products.

The Nixdorf View of an Integrated System

Nixdorf holds two views of an integrated system. The first one is called CIO, the Computer Integrated Office. CIO champions global integration of data processing, office, and communication applications. This view includes the addition of office and communication capabilities (electronic mail, teletex) to application programs in specific vertical markets, for example, or the addition of those capabilities to already existing installations. Nixdorf has committed to provide this level of integration for all of its products, and is able to deliver many of these capabilities today. For example, many vertical programs access text processing or electronic mail capabilities, or are able to integrate structured data from business applications.

The second view of integration is that of information media: text, voice, graphics, and data. This level of integration provides for the close integration of individual programs in the classical Dataquest definition. Since Nixdorf has never committed to develop a pure integrated office system in the classical sense of Digital's All-in-1 or Wang Office, it must now work to bring its NIOS and COMET office software to the level of these systems. For example, in most Nixdorf systems, spreadsheet information can be integrated into the text program in print mode, but graphic and image data are still stored separately and indicated through a pointer.

However, at the same time, Digital, Data General, and Wang have recognized the need for vertical programs and are working to integrate their office systems software with vertical applications. But even here Nixdorf is more application-oriented and provides this level of integration where its is indicated by customer need and where it provides an enhancement to the existing system.

DATAQUEST ANALYSIS

Nixdorf in the Office Environment

In order to evaluate its office system approach, Nixdorf insists that one must always remember that the company is foremost one that sells into business environments with specifically tailored business applications. This approach has been the primary reason for Nixdorf's success: the ability to give small- and medium-size companies the numerous hardware and software products that solve specific industry-related problems.

The business orientation continues today. Neither in Europe nor internationally does Nixdorf market its systems primarily as office systems. However, in order to compete with companies offering both business and office applications, Nixdorf has added office systems software to most of its systems. In addition, Nixdorf continues to provide its traditional 8840 word processing system in Europe:

- The Series 8860 with NIOS TOP office software
- The Series 8870, 8870 Quattro, and 8890 with COMET TOP office software
- The TARGON Series with TARGON Office

When viewed simply in an office context (a market in which Nixdorf traditionally has not competed), several drawbacks are apparent:

- For Nixdorf, office applications have always been an add-on to business applications. As a result, neither NIOS TOP nor the COMET TOP components are comparable in their depth of integration to the integrated solutions offered by Digital, Data General, Wang, and other competitors.

  However, Nixdorf's strength lies in the numerous specific vertical software programs that the company offers for particular industries. For example, the 8860 is sold primarily into the operating areas of financial and insurance industries, and the office system companies compete primarily in the administrative departments of these organizations. Although NIOS TOP office applications are not as feature-rich or as integrated among themselves as those of its competitors, they can be accessed from NIOS TOP business applications. European customers often prefer this level of integration to office software that is richer in functionality but that lacks integration into business applications.

- The office software programs vary in their ease of use and degree of integration, and some product families consist of incompatible hardware and business applications. This may force users to choose between a strong business application or a strong office application.

- Editable document exchange is possible only from the 8840 to the 8860 and from the 8860 to TARGON. COMET TOP Word is available on the 8870, 8870 Quattro, and 8890, but there is no bridge to the other systems. The document exchange between other products is possible only through teletext.

- The older DAP 4 terminals support only DETAS, an older text processing program well integrated into numerous vertical applications. The newer DAP 4X terminals support COMET TOP Word, but there is no document conversion from DETAS to Word. All new installations are sold only with DAP 4X, leaving DETAS as island applications in specific vertical markets.

However, end-user requirements everywhere have been changing from specific feature/function orientation to an overall systems approach, and from general office solutions to specific vertical applications. In a solution-oriented market, Nixdorf's drawbacks are balanced by an equal number of advantages:

- By positioning itself as the present and future provider of integrated information, Nixdorf has its special emphasis on the integration of business applications, office technology, and communication of all of its products. This means that Nixdorf users can expect continued development of integration capabilities between its major commercial and office software products.

- Nixdorf provides both a digital PABX and computer systems, and intends to integrate them with future ISDN orientation.

- Nixdorf already has strong internal and external communication capabilities and is a strong supporter of international communication standards. These international communication standards are outlined in Nixdorf's statement of direction.

- The company's emphasis on solution-oriented software provides users with a large number of business programs not easily matched by other companies.

- Nixdorf's commitment to software compatibility should assure customers of the longevity of its software programs and company data.

- The TARGON systems now provide Nixdorf with a product that will support truly integrated programs. Nixdorf intends to build on existing programs and to develop an office system that will compete in the office systems market, for example in organizations that already use the 8860 for business applications.

- Nixdorf has announced DISOSS, MAP, and TOP support for the TARGON systems, as well as SNA host functionality and a new 24-mips TARGON system. This expands the TARGON line even farther and positions it as one of Nixdorf's major products.

- Nixdorf intends to exploit the strengths of its PWS systems for all product families and to position it as the workstation of choice. Nixdorf expects to provide the PWS with the more powerful 80386 Intel processor to increase speed and performance.

International Markets

Europe is Nixdorf's primary market. In Germany and in the rest of Europe, Nixdorf's products are well established and will continue to be readily accepted. However, much remains to be done to assure their international competitiveness, primarily in the office systems market. A prime factor aiding Nixdorf in its renewed push into international markets is an increasing emphasis worldwide on vertical applications and solution-oriented software, rather than on the traditional generalized office systems approach.

In order to compete in emerging Asian markets, Nixdorf is busy adapting and translating its COMET TOP vertical software into Japanese, Chinese, and Korean.

One of the largest international markets for Nixdorf could be the United States. However, the office world there is dominated by IBM, Digital, Data General, and Wang; NCR will be a formidable opponent in the vertical application and cash register market.

Several years ago, Nixdorf attempted to compete in the office market with its Nixdorf 8840, designed for predominantly German-oriented integrated text and data applications (for example, merging client addresses resident in a data base with an offer letter originated in word processing, and automatically calculating unit prices). The 8840 was not successful in the United States, and the system was discontinued.

Nixdorf is making another assault on the U.S. marketplace with its 8870, and in particular with its TARGON systems. However, as a pure office systems vendor, Nixdorf at present cannot compete with available integrated office systems from Wang, Digital, and others. Although Nixdorf has rededicated itself to doing what it does best--provide vertical programs for specific U.S. markets--the company is aware that it must continue to deepen the integration level of its office software. In addition, Nixdorf must provide gateways to other vendors and integrate competitors' office software into Nixdorf's vertical business applications.

This is no small task, but Nixdorf is in this business for the duration and realizes that revenue cannot be improved in the short term. Now that the company has moved from a product to a solution approach in the United States, first successes are becoming apparent in the banking, insurance, and retail markets. Nixdorf expects major orders from large companies in 1987, similar to the $100 million order it received from Montgomery Ward & Co.

One of Nixdorf's long-range plans is to bring its ISDN-based products, the 8818 PBX and its Digifone, into the United States. This will put the company not only in direct competition with U.S. vendors of PBX systems, but also with European companies like Philips and Ericsson who intend to garner a share of that market. The 8818 PBX is already sold in Germany, Austria, Belgium, Ireland, Switzerland, Italy, Greece, Portugal, Japan, China, Hong Kong, and Turkey; telephone systems now account for 10 percent of all new orders. In this market, Nixdorf also offers particular vertical applications for hospitals (patient status) and hotels (automatic wake-up calls). Just recently, Nixdorf supplied the renovated Queen Elizabeth II with 1500 digital telephones, to be followed shortly by cash registers connected to the hotel computer 8862 Rio and the 8818 PBX. Again, Nixdorf competed successfully because of its vertical hotel application.

Mr. Luft expects revenue to reach DM 9 billion in five years. As long as Nixdorf retains its market-driven focus (expressed in vertical applications for specific market niches and excellent customer care) Dataquest believes that the company will continue to perform as one of the consistently successful computer companies in Europe and to gain market share in the United States.

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Hilde Uhler

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CONVERGENCE AND CONNECTIVITY IN EUROPE: THE RACE HEATS UP

Now that many desktop computing devices in Europe have achieved significant market penetration, the focus is changing to making these devices communicate. It is widely accepted that desktop devices are more useful when connected than when used as standalone units.

Dataquest has combined the resources of several of its European industry programs to focus on the issues of work group computing. This research provides our clients with a context in which to consider how all these pieces of the information processing puzzle interrelate. (Appendices A and B define the terminal types and connection technologies referred to in this analysis.)

Tables 1 through 6 show the estimated installed base of terminals in Europe for 1986, 1987, and 1991, and their connection methods. Tables 1 through 3 show the actual numbers for each connection method, and Tables 4 through 6 show the percentage of use of each connection method.

This newsletter has the following objectives:

- To define the installed base of desktop terminals
- To identify the important connection technologies employed and analyze the trends in types of connection from 1986 to 1991
- To outline the implications for suppliers

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Table 1

Dataquest Connection Matrix—1986 Estimated Units
(Thousands of Units)

Type of Desktop Device	Installed Base at Year End	Units Connected Via: LAN	PBX	Data PBX	Hard-Wired	Remote	Not Connected	Total
Display Terminal	6,630.5	379.3	33.2	186.8	4,918.6	1,112.6	0.0	6,630.5
Word Processor	295.3	29.2	0.3	7.1	77.1	17.4	164.2	295.3
IVDT	15.7	0.0	11.8	0.0	0.0	3.9	0.0	15.7
Electronic Typewriter	140.1	0.0	0.0	0.0	0.7	2.1	137.3	140.1
Personal Computer	4,325.7	298.5	1.7	110.4	558.0	372.0	2,985.0	4,325.7
CAD/CAM	100.4	10.0	0.0	0.0	40.2	5.0	45.2	100.4
Telex	772.4	0.0	0.0	0.0	0.0	772.4	0.0	772.4
Teletex	41.8	0.0	0.0	0.0	0.0	41.8	0.0	41.8
Facsimile	344.1	0.0	0.0	0.0	0.0	344.1	0.0	344.1
Videotex	2,986.2	0.0	0.0	0.0	149.3	2,836.9	0.0	2,986.2
Total	15,652.2	717.0	47.0	304.3	5,743.9	5,508.3	3,331.8	15,652.2

Source: Dataquest
October 1987

Table 2

Dataquest Connection Matrix—1987 Estimated Units
(Thousands of Units)

Type of Desktop Device	Installed Base at Year End	Units Connected Via: LAN	PBX	Data PBX	Hard-Wired	Remote	Not Connected	Total
Display Terminal	7,268.6	567.0	94.5	225.3	4,753.7	1,628.1	0.0	7,268.6
Word Processor	306.8	36.8	2.8	8.0	83.1	18.1	157.9	306.8
IVDT	25.4	0.0	19.1	0.0	0.0	6.4	0.0	25.4
Electronic Typewriter	203.4	0.0	0.0	0.0	1.0	3.1	199.3	203.4
Personal Computer	6,000.2	534.0	36.0	155.5	978.0	606.0	3,690.6	6,000.2
CAD/CAM	179.8	18.0	0.0	0.0	71.9	9.0	80.9	179.8
Telex	811.1	0.0	0.0	0.0	0.0	811.1	0.0	811.1
Teletex	73.9	0.0	0.0	0.0	0.0	73.9	0.0	73.9
Facsimile	658.4	0.0	0.0	0.0	0.0	658.4	0.0	658.4
Videotex	4,571.1	0.0	0.0	0.0	228.6	4,342.5	0.0	4,571.1
Total	20,098.7	1,155.8	152.3	388.8	6,116.4	8,156.6	4,128.9	20,098.7

Source: Dataquest
October 1987

Table 3

Dataquest Connection Matrix—1991 Estimated Units

Type of Desktop Device	Installed Base at Year End	Units Connected Via: LAN	PBX	Data PBX	Hard-Wired	Remote	Not Connected	Total
Display Terminal	9,667.9	2,030.3	290.0	290.0	5,259.4	1,798.2	0.0	9,667.9
Word Processor	251.7	42.7	3.8	6.2	167.9	20.7	10.4	251.7
IVDT	107.6	0.0	80.7	0.0	0.0	26.9	0.0	107.6
Electronic Typewriter	655.1	0.0	0.0	0.0	3.3	9.8	642.0	655.1
Personal Computer	12,814.6	1,922.2	76.9	291.8	2,703.9	1,671.0	6,148.8	12,814.6
CAD/CAM	776.1	77.6	0.0	0.0	310.4	38.8	349.2	776.1
Telex	946.8	0.0	0.0	0.0	0.0	946.8	0.0	946.8
Teletex	376.2	0.0	0.0	0.0	0.0	376.2	0.0	376.2
Facsimile	3,073.5	0.0	0.0	0.0	0.0	3,073.5	0.0	3,073.5
Videotex	10,752.5	0.0	0.0	0.0	537.6	10,214.9	0.0	10,752.5
Total	39,422.0	4,062.8	451.4	588.0	8,885.3	18,284.0	7,150.5	39,422.0

Source: Dataquest
October 1987

Table 4

Dataquest Connection Matrix—1986 Estimated Percentages

Type of Desktop Device	Installed Base at Year End	Percentage Connected Via: LAN	PBX	Data PBX	Hard-Wired	Remote	Not Connected	Total
Display Terminal	6,630.5	5.7%	0.5%	2.8%	74.2%	16.8%	0.0%	100.0%
Word Processor	295.3	9.9%	0.1%	2.4%	26.1%	5.9%	55.6%	100.0%
IVDT	15.7	0.0%	75.0%	0.0%	0.0%	25.0%	0.0%	100.0%
Electronic Typewriter	140.1	0.0%	0.0%	0.0%	0.5%	1.5%	98.0%	100.0%
Personal Computer	4,325.7	6.9%	0.0%	2.6%	12.9%	8.6%	69.0%	100.0%
CAD/CAM	100.4	10.0%	0.0%	0.0%	40.0%	5.0%	45.0%	100.0%
Telex	772.4	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
Teletex	41.8	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
Facsimile	344.1	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
Videotex	2,986.2	0.0%	0.0%	0.0%	5.0%	95.0%	0.0%	100.0%
Total	15,652.2	4.6%	0.3%	1.9%	36.7%	35.2%	21.3%	100.0%

Source: Dataquest
October 1987

Table 5

Dataquest Connection Matrix—1987 Estimated Percentages

Type of Desktop Device	Installed Base at Year End	Percentage Connected Via						
		LAN	PBX	Data PBX	Hard-Wired	Remote	Not Connected	Total
Display Terminal	7,268.7	7.8%	1.3%	3.1%	65.4%	22.4%	0.0%	100.0%
Word Processor	306.8	12.0%	0.9%	2.6%	27.1%	5.9%	51.5%	100.0%
IVDT	25.4	0.0%	75.0%	0.0%	0.0%	25.0%	0.0%	100.0%
Electronic Typewriter	203.4	0.0%	0.0%	0.0%	0.5%	1.5%	98.0%	100.0%
Personal Computer	6,000.2	8.9%	0.6%	2.6%	16.3%	10.1%	61.5%	100.0%
CAD/CAM	179.8	10.0%	0.0%	0.0%	40.0%	5.0%	45.0%	100.0%
Telex	811.1	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
Teletex	73.9	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
Facsimile	658.4	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
Videotex	4,571.1	0.0%	0.0%	0.0%	5.0%	95.0%	0.0%	100.0%
Total	20,098.8	5.8%	0.8%	1.9%	30.4%	40.6%	20.5%	100.0%

Source: Dataquest
October 1987

Table 6

Dataquest Connection Matrix—1991 Estimated Percentages

Type of Desktop Device	Installed Base at Year End	Percentage Connected Via						
		LAN	PBX	Data PBX	Hard-Wired	Remote	Not Connected	Total
Display Terminal	9,668.0	21.0%	3.0%	3.0%	54.4%	18.6%	0.0%	100.0%
Word Processor	251.7	17.0%	1.5%	2.5%	66.7%	8.2%	4.1%	100.0%
IVDT	107.6	0.0%	75.0%	0.0%	0.0%	25.0%	0.0%	100.0%
Electronic Typewriter	655.1	0.0%	0.0%	0.0%	0.5%	1.5%	98.0%	100.0%
Personal Computer	12,814.6	15.0%	0.6%	2.3%	21.1%	13.0%	48.0%	100.0%
CAD/CAM	776.1	10.0%	0.0%	0.0%	40.0%	5.0%	45.0%	100.0%
Telex	946.8	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
Teletex	376.2	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
Facsimile	3,073.5	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
Videotex	10,752.5	0.0%	0.0%	0.0%	5.0%	95.0%	0.0%	100.0%
Total	39,422.1	10.3%	1.1%	1.5%	22.5%	46.4%	18.1%	100.0%

Source: Dataquest
October 1987

INSTALLED BASE OF DESKTOP TERMINALS

Figures 1 and 2 show the estimated installed base of terminals for 1986 and 1991 in Europe. The trends are reviewed below:

- While the number of terminals is growing at a 26.1 percent compound annual growth rate (CAGR), the number of potential desks is estimated to grow at only a 3 percent CAGR. Suppliers will have to fight hard for greater penetration into the existing installed base of desktops.

- The replacement market is expected to be low because many users do not discard desktop devices. They simply pass them on to someone else.

- Many suppliers are expected to move toward offering desktop systems (for example, 3Com, which offers LAN connections as well as terminals). Digital Equipment and IBM have been doing this for some years already.

Personal Computers and Display Terminals

- The wide availability of personal computers (PCs) at prices similar to display terminals will obviously have an impact on the sale of display terminals. The installed base of PCs will have overtaken that of display terminals by the end of 1988.

- The launch of IBM's PS/2 range of PCs will lead to a further decline in the price of PCs. Also, the differences between applications supported by PCs and display terminals is fast eroding. The success of PC plug-in terminal emulation boards such as the IRMA board from DCA is leading this trend.

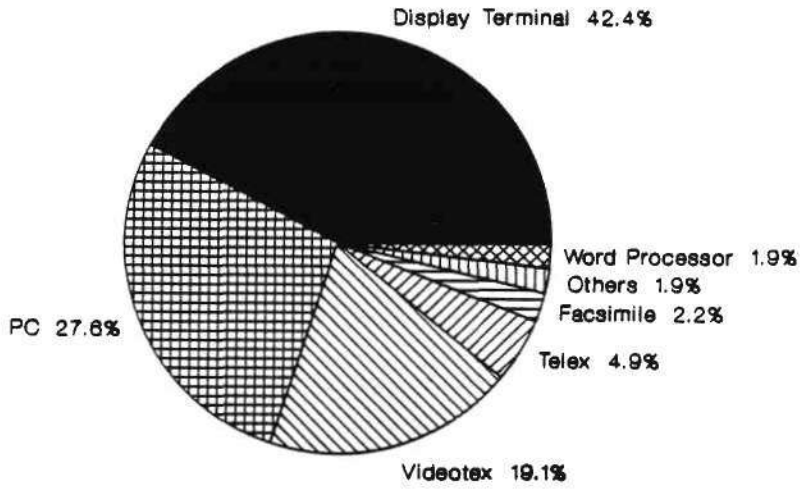
Integrated Voice/Data Terminals

- Dataquest expects the integrated voice/data terminal (IVDT) to have a limited penetration in the European market. These products are often not standards sold as compatible and sold as part of PBX. The Siemens Hicom PBX with its proprietary IVDT is a typical example.

- IVDTs are generally relatively expensive and, being proprietary, are a less flexible solution. Since IVDTs are rarely compatible with PCs, they consequently are limited in the number of application programs they can run.

Figure 1

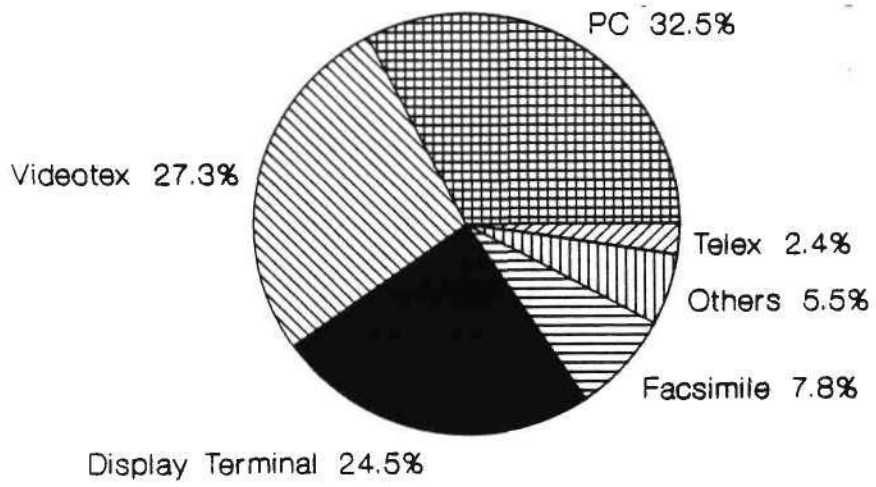
European Desktop Terminal Population—1986 Estimate



Source: Dataquest
October 1987

Figure 2

European Desktop Terminal Population—1991 Estimate



Source: Dataquest
October 1987

Word Processors

Shipments of standalone word processors will quickly decline. Dedicated minicomputer-based word processor systems are experiencing little growth. Dataquest expects these products to be overtaken by "office systems" that, in addition to text processing, will encompass various levels of voice, data, and graphics integration.

The differences between applications supported by PCs and traditional word processors, like those between word processors and display terminals, are also eroding.

CONNECTION TECHNOLOGIES

This section describes how the installed base of terminals connects. Figure 3 shows the spread of connection technologies for all terminals. The trend is clearly toward greater connectivity, using more than one of the connection methods in Table 1.

A standalone PC today may be connected to a local area network (LAN) soon, which will extend to a remote gateway (e.g., a modem) through a wide area network, an international link, and then to another LAN across the world. In consequence, the percentage of standalone terminals will drop to 18.1 percent of terminals in use by 1991. The main beneficiaries will be LANs and remote connection technologies. Data PBX, voice/data PBX, and hard-wired connections will not make significant gains. Figures 4, 5, and 6 show the spread of connection technologies for PCs, dumb terminals, and word processors in 1986, 1987, and 1991.

LAN

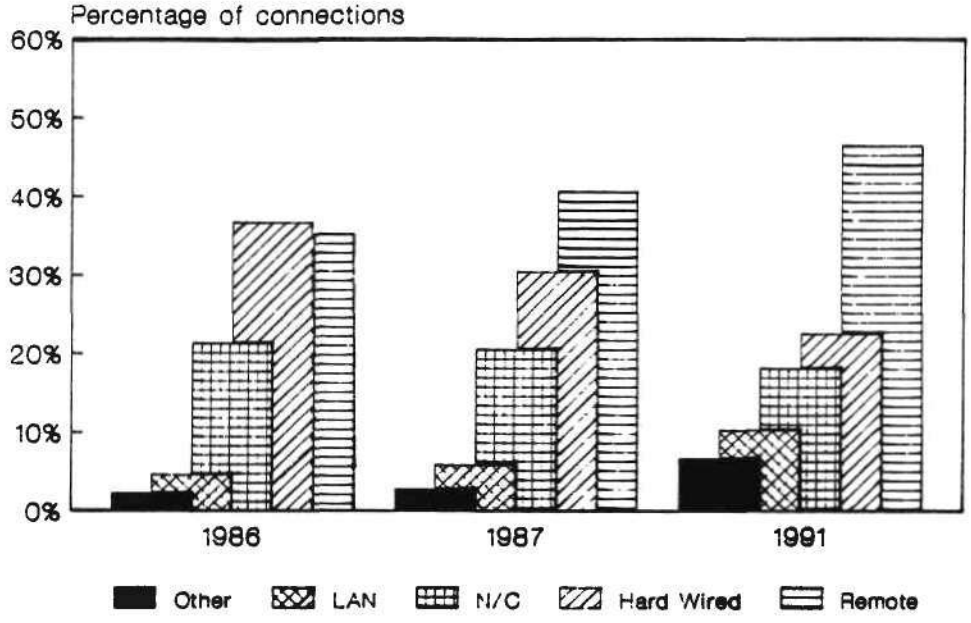
We believe that connections via LANs will show a tremendous growth rate, from 4.6 percent of all connections in 1986 to 10.3 percent by 1991.

Apart from the resource sharing offered by LANs (e.g., storage or printer sharing), one of their key benefits to large organizations is that they provide a flexible cabling solution. When users move around on a LAN, it is simple to unplug a terminal from the network and insert it elsewhere. With a hard-wired connection, such moves require recabling, which is both disruptive and expensive.

LAN connections to PCs and dumb terminals are expected to show significant growth. This will limit the growth of hard-wired and data PBX connections.

Figure 3

European Terminal Connection Trends (All Terminals)

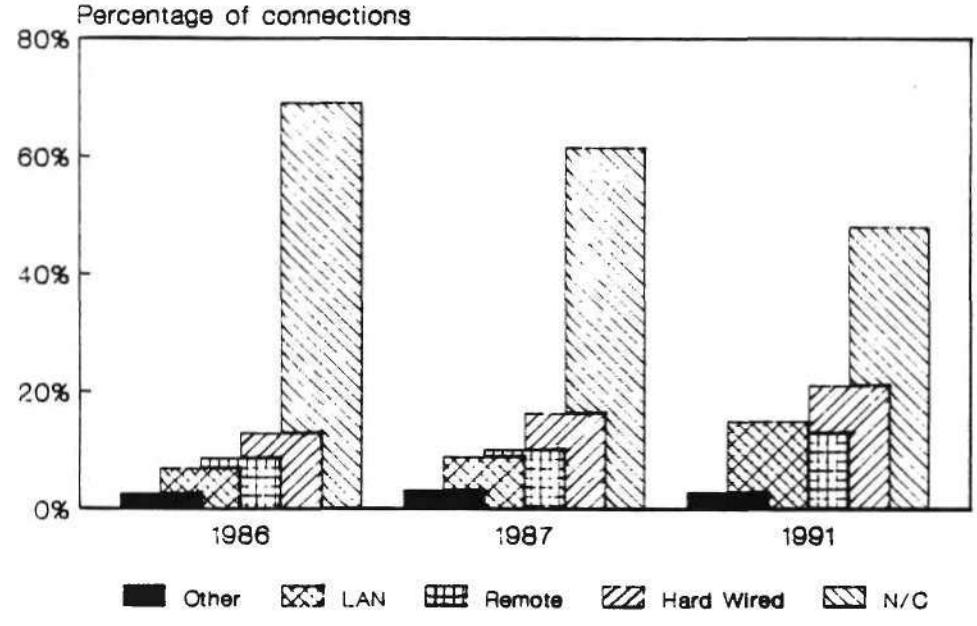


N/C not connected

Source: Dataquest October 1987

Figure 4

Euroepan Terminal Connection Trends (Personal Computers)

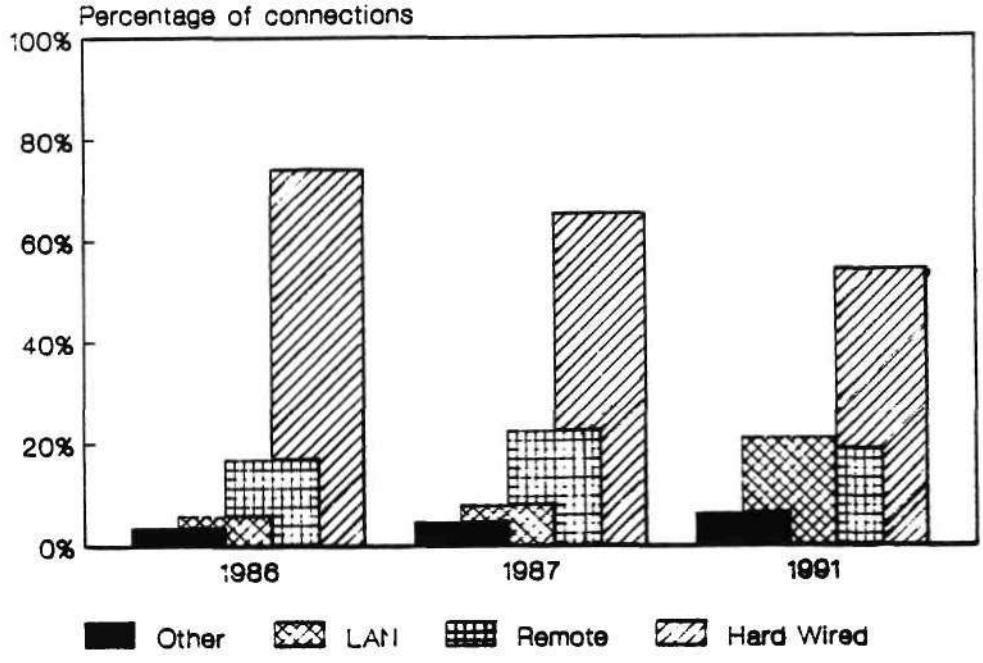


N/C = not connected

Source: Dataquest October 1987

Figure 5

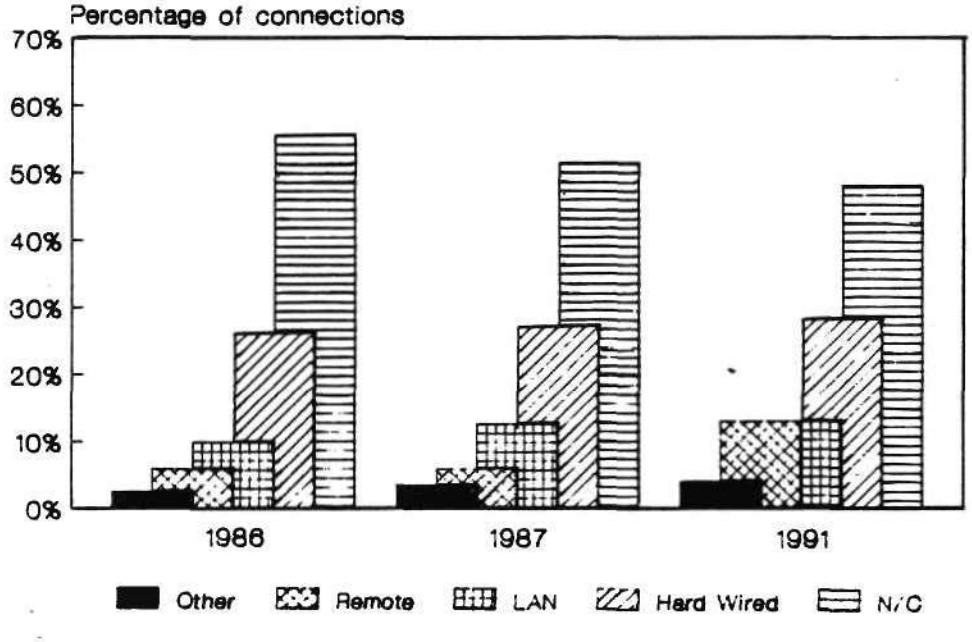
European Terminal Connection Trends (Display Terminals)



Source: Dataquest
October 1987

Figure 6

European Terminal Connection Trends (Word Processors)



N/C = not connected

Source: Dataquest
October 1987

PBX

PBXs will continue to be the main connection means for FAX, teletex, and videotex in 1991. Dataquest expects, though, that PBX or voice/data PBX solutions in Europe will show limited growth in data connections for the following reasons:

- The relatively high cost of connecting a terminal to a digital PBX compared to a data PBX
- The low data throughput (up to 64 Kbits per second for local connections on current products) compared to 1 Mbit per second for even a low-speed LAN
- Their low functionality (file handling and printer sharing facilities like PC LANs) for resource sharing compared to that of LANs
- The slow acceptance by data processing managers of traditional communications solutions to data communications connectivity

However, wide area gateways from LANs through a PBX represents a potential growth area.

Data PBX

Data PBX connections are expected to decline in importance for the following reasons:

- Users are migrating to LANs to achieve higher throughput speeds.
- The size and cost of low-end data PBXs precludes their use in new small networks, where LANs provide a cheap entry solution for as few as three users. These systems then grow into large LAN-based networks.
- Although data PBXs are very economic solutions for asynchronous connections when compared to LANs, users are more inclined toward LANs, which are seen to be the vogue in networking. (A typical cost per connection for a data PBX is $185, as opposed to $640 for a LAN.)
- The data PBX market has never gained any large momentum in Europe.

Hard-Wired

The hard-wired connections segment represents direct connections from data terminal equipment to multiuser minicomputers or mainframes. The high cost of reconfiguring a hard-wired network is leading customers to opt for more flexible solutions such as LANs, especially in new installations. The need to switch between resources (mainframes, etc.) in the hard-wired environment requires costly equipment compared to LANs.

Dataquest expects that by 1991, the large installed base of hard-wired connections will decline overall, from 36.7 percent to 22.5 percent of connections. The percentage of PC hard-wired connections will grow, however, from 12.9 percent to 21.1 percent. This represents the rapid growth of PC-to-mainframe connectivity by users who are not ready to use LANs.

Remote

A key growth trend will be in PC remote links; the PC is quickly becoming the focus for office systems technology. A significant growth area in remote lines will be X.25, while X.21 and modem links will also increase in percentage terms. The penetration of the X.400 standard for electronic mail will add to the growth in remote connections over the next three to five years.

ISDN

The connection technologies discussed so far raise important issues about the role of ISDN in local communications. The IEEE 802.9 standard for LANs could provide for 2-Mbit per second connections to the desktop on unshielded, twisted-pair cables. This could support voice/text and image on a distributed system. If IEEE 802.9 becomes a significant standard, the relative merits of ISDN connectivity will be reduced. While the merits of ISDN are being debated, LAN technology is making significant advances.

IMPLICATIONS FOR SUPPLIERS

Dataquest expects to see the following trends in supplier strategies:

- A conscious effort to understand previously unfamiliar markets, for example, communications suppliers moving into the computing area and vice versa. Digital Equipment in the United States recently made public its plans for wide area networking. This surprising move foreshadows the rapid changes to come in the connectivity race.

- An increase in joint ventures, mergers, and takeovers. Suppliers are finding this to be an attractive way of entering new markets and catching up with technology.

- More suppliers offering integrated communications hardware and office applications software as systems solutions. Although this is currently achieved by dealers, we expect to see suppliers use it as a product differentiation strategy.

- A prominence of vertical market offerings. More and more suppliers are beginning to identify specific segments like retailing rather than simply selling into general markets.

- Higher functionality and new features being offered on existing products in an effort to achieve product differentiation. What was once a plain old telephone can now be bought with IVDT functions (the Qwerty phone from British Telecom is an example).

- A plethora of new products, especially in the PC plug-in board market, like plug-in fax, telex, or voice store-and-forward cards. The recent launch of the Orator (voice/data card) from Lion Systems in the United Kingdom is an example of this rapid evolution.

- A significant price erosion across markets. Suppliers will fight to penetrate an installed base of desktops that is showing little growth.

DATAQUEST CONCLUSIONS

Dataquest expects the trends described in this newsletter to result in suppliers fighting for market share in Europe, not only with their traditional competitors, but also with organizations from previously separate areas. Hence computer, telecom, data communications, and LAN suppliers will be in competition with each other for the same business. The market will be characterized by numerous offerings from suppliers of incompatible desktop solutions. In these conditions, suppliers with standards-compatible, user-friendly, systems-based products will have an advantage.

Rapid changes in technology and sharp price competition will mean that market share will be more expensive to achieve and brand loyalty will be difficult to maintain. Dataquest believes that, despite the steady growth in the European data communications market, many suppliers will find themselves working very hard to maintain profitability in an increasingly fierce environment.

This newsletter shows that, after many years of talk about the convergence of computing and communications, and the integration of voice and data, these areas are finally beginning to merge, albeit at the transmission level at the moment. Integrated voice/data products or applications on the desktop have yet to succeed.

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Jennifer Berg
Michael D'Souza

Appendix A

DEFINITIONS OF KEYBOARD INFORMATION DEVICES

Display terminals are desktop electronic devices that are dependent upon a data communications link to a computer system. They have the following characteristics:

- They provide an interface between a human operator and a computer system or a communications network.
- They deliver a visual presentation of incoming data to the operator.
- They allow the operator to enter or modify information in the computer system via a keyboard, media reader, or other local device.

Personal computers (PCs) are computer systems that have the following characteristics:

- They are human-orientated, meaning they are intended to meet individual business, professional, educational, and personal data processing needs, and they do not generally act as instrument controllers or automation devices.
- They are single-user-orientated, meaning that, although communications may be involved, the systems are intended for the data processing needs of individuals and involve only one interactive device. PCs can generally be purchased, operated, and used by an individual rather than by an organization.
- They have full alphanumeric keyboards, which distinguishes them from programmable calculators, video games, and dedicated special-function computers.
- They have local programming capabilities using high-level programming languages, with most personal computers supporting BASIC, or a derivative of it. Other languages such as Pascal, FORTAN, and COBOL are also available on personal computers.
- They have a resident operating system in ROM or magnetic media. This distinguishes PCs from terminals.
- They are able to run general-purpose applications. This distinguishes PCs from systems that are dedicated through permanent hardware or firmware adaptation to functions such as word processing and financial analysis.
- For this study, PCs used in hobby or educational environments are not included. PCs that have integrated voice capability are also not included.

Integrated voice/data workstation (IVDT) products are desktop or board-level devices that integrate the functionality of a telephone and a terminal. This integrated functionality includes, at a minimum, simultaneous voice and data transmission. These devices are not double-counted in the display terminal or personal computer categories.

Word processors are workstations that are designed for entering, manipulation, filing, and printing text documents only. Workstations are defined as computer-based products that perform specifically defined functions as an aid to a user in completing a specifically defined task or series of tasks.

Full-size electronic typewriters are letter-quality printing devices that can be activated by depressing the keys of an electronically driven keyboard (flat or movable keys). This action causes type characters to be selected for printing by solid-state electronic logic and circuitry. These are desktop devices; this definition does not include portable or compact electronic typewriters. Nor does it include half-screen electronic typewriters.

Appendix B

CONNECTION TECHNOLOGIES

Generally speaking, a connection is defined as what the device is directly connected to, not what the device ultimately communicates with. Therefore, any device that has both a remote connection and another type of connection is counted under the other type of connection. Further, if a device has two types of connections, neither of which is remote, the most heavily used type is counted.

Private branch exchanges (PBXs) are customer premises telephone-switching systems that, by the dialing of an access code, permit telephones to interface to the public telephone central exchange of office. A PBX includes desktop end-user terminals, attendant consoles, switching cabinets, and interconnections between switching cabinets. An integrated voice/data PBX can switch both voice and data through the same equipment.

Local area network (LAN) Connections are combinations of hardware and software that enable connection of a device to a cable-based network system that serves a building or campus environment. Excluded are connections that are point-to-point, through PBXs or through data PBXs or data-over-voice products.

Data PBXs are digital electronic switches that allow terminals to switch and contend for computer ports by providing RS-232-C connections. Data PBXs do not provide for voice switching as a PBX or voice/data PBX would.

Hard-wired connection is a point-to-point connection from a device to a CPU, either directly or via a direct or nonintelligient intermediate communication controller or a multiplexer.

Remote connection is a connection to a modem, packet assembler/disassembler (PAD), wide area network or other device for transmitting data over remote-communication lines.

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EUROPEAN PC PRODUCTION CAPABILITY SHOWS EMERGING STRENGTH

INTRODUCTION

Dataquest estimates that PC production in Europe grew, in unit terms, 12 percent in 1987, reaching an estimated 2 million units. More than 75 percent of all PCs sold in Europe are manufactured locally; approximately 275,000 units produced in Europe will be exported outside the Continent.

Dataquest's wholly owned subsidiary, Intelligent Electronics Europe, shares its perspective of this strengthening commitment by PC manufacturers to produce in Europe.

PC MANUFACTURERS

Two broad categories of PC makers have a presence in Europe: the non–European multinational PC vendors that operate in Europe and the European companies. Currently, of the main PC manufacturers in Europe, 11 are non–European; of these, the only non–American vendor is the Japanese company Fujitsu, which manages a microcomputer plant in Malaga, Spain. Fujitsu Spain operates through a joint venture, Fesa, with a government–controlled agency. This is fairly typical of the Spanish computer industry, whereby the company can be considered a local company—and all the more valuable—since its microcomputer production is targeted essentially at the Spanish market.

Table 1 shows the main PC manufacturers in Europe, the location of their production facilities, and their product ranges.

Many U.S. multinational computer companies with ambitions to have significant presence throughout the world have established wholly owned PC–manufacturing plants in Europe. Companies such as Apple, Commodore, Hewlett–Packard, IBM, NCR, NorthStar, Unisys, Wang, and Zenith have all expressed their dedication to the European countries through their direct investments. Compaq is the latest to follow suit, and its plant located in Scotland will be operational this month. This European production facility should give the company a more committed image in the minds of the European end users.

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Table 1

European PC Manufacturers

Manufacturer	Country of Origin	Plant Location	Product Range
APD	Spain	Madrid, Spain	Europa, APD Uno 32/4, 32XX, 32/40
Apple	United States	Cork, Ireland	Apple II, Macintosh
Apricot	United Kingdom	Glenrothes, Scotland	Apricot Xen
Bull	France	Villeneuve, France	PC range, terminals
Bull	France	D'Ascq, France	PC range, terminals
Bull	France	Barcelona, Spain	Micral
Commodore	United States	Braunschweig, West Germany	PCs, home computers, Amiga
Compaq	United States	Erskine,	PCs
Dava	Finland	Helsinki, Finland	PCs 286 & 386
Ericsson	Sweden	Sweden	Ericsson PCs
Ferranti	United Kingdom	Withershaw, United Kingdom	PC AT, PCs 1860 & 2860
Fesa	Spain/Japan	Malaga, Spain	Secorusa 20, Senda
Forum	France	Longwy, France	Multiuser systems
HP	United States	Grenoble, France	Vectra 150, PCs
IBM	United States	Greenock, Scotland	PCs, ATs, PS/2
ICL	United Kingdom	United Kingdom	Multiuser system
ICL	United Kingdom	United Kingdom	Series 25, 39
Leanord	France	Aubourdin, France	System 2966
NCR	United States	Augsburg, West Germany	Silz Elan, PCs
Nixdorf	West Germany	Padenborn, West Germany	PCs 710/810/916, NCR 3390, 3392
Nokia Luxor	Finland	Espoo, Finland	Nokia PC, ABC
Nokia Luxor	Finland	Rodja, Finland	Terminals, Nokia PC
Normerel	France	Granville, France	Vectra 150, PCs
NorthStar	United States	Cork, Ireland	Multiuser system
Olivetti	Italy	Italy	PC series
Olivetti	Italy	Spain	PC series
Philips	The Netherlands	Vienna, Austria	PCs
Regencentralen	Denmark	Presto, Denmark	Piccoline-Partner
Siemens	West Germany	Augsburg, West Germany	PCD, PCX, PCM
Siemens	West Germany	Karlsruhe, West Germany	PC 16
SMT Goupil	France	Montpelier, France	G40, G65
SMT Goupil	France	Redon, France	G4, G40, G5
SMT Goupil	France	Granville, France	G5
SMT Goupil	France	Soisson, France	G4 Club
Telenova	Sweden	Nynashamn, Sweden	Scandis/Compis
Tikidata	Norway	Nuremberg, West Germany	PC Tiki
Triumph Adler	West Germany	Nuremberg, West Germany	Alphatronics PCs
Tulip	The Netherlands	Den Bosch, The Netherlands	PC, Compact, 8386
Unisys	United States	Villers Ecale, France	B20, B25
Wang	United States	Stirling, Scotland	Wang PC
Zenith	United States	Kells, Ireland	Desktop PCs

Source: Intelligent Electronics Europe
Dataquest
December 1987

The U.S. multinational companies have integrated worldwide corporate production strategies, with the assignment of each of their plants to specific regions. Production facilities in Europe usually serve the European markets. Often, they also serve the Middle East and Africa, or, like the Wang factory in Scotland, the non-European Commonwealth countries such as New Zealand and Australia.

More rarely, as with both NorthStar and NCR, the European manufacturing bases of the U.S. corporations cater to worldwide markets. Since the NorthStar operation in Ireland now houses the company's only manufacturing facility, it supplies the whole world. The NCR plant, located in the southern German town of Augsburg, ships nearly half of its PCs outside Europe. The German NCR company is also responsible for most of the R&D activities in the PC area. Together with the European manufacturers Olivetti and Ericsson, NCR is the only Europe-based PC manufacturer to have produced significant volumes for the OEM markets. Through OEM contracts with the German companies Nixdorf, Olympia, and Siemens, and with HISI, now Honeywell Bull, from Italy, the firm has realized a large share of its sales through the OEM business.

A major effect of this large investment in Europe-based PC plants by foreign firms has been the relative absence of protectionism in the field of PCs by either the national and local governments or from the EEC. France is possibly the main exception, in that, until recently, the French national manufacturers have enjoyed almost a monopolistic position within the French government-controlled markets. In spite of this, there have been no protectionist moves to halt imports of PCs. In addition, as Europe has a positive trade balance as far as PCs are concerned, no real efforts have been made to institute any protectionist measures like those undertaken in the fields of typewriters, photocopiers, and, more recently, printers.

Olivetti is still the leading European PC manufacturer. After recently having stopped the production of PCs at its French Logabax factory in Meaux, the Italian company now has only two PC plants: one in Scarmagno, Italy, and one in Barcelona, Spain. In addition, Olivetti now uses some of its existing production capacity near Naples to manufacture its new home computer model, the PC1.

SEMICONDUCTOR ANALYSIS

Dataquest estimates that personal computers will consume approximately 7 percent of the $6,780 million semiconductor market in Europe. Table 2 shows a comparison of the integrated circuit content of an IBM PC AT, a Compaq 386, and the IBM PS/2 Model 50.

Overall, the growth of semiconductor revenue for the computer marketplace looks healthy. The ratio of semiconductor revenue to computer revenue is expected to remain relatively constant from 1988 through 1990, at about 5 percent for the market as a whole and at about 6 percent for just PCs. Dataquest believes that the greatest opportunities for IC manufacturers serving the PC market lie in separate areas. The first is a continued growth in application-specific ICs. As PC manufacturers attempt to introduce smaller, faster, and less expensive machines, the demand for highly integrated chips is inevitable. Those ASICs directed at integrating traditional motherboard logic and also at maximizing peripheral controller functions and high-resolution graphics capabilities hold great promise. Second, along with the growth of application-specific logic chips, there are opportunities for dedicated processors and microcontrollers, particularly in the areas

of computer graphics and storage subsystems. Additionally, as notorious "memory munchers," these 32-bit machines will require ICs that are faster and have denser memories than their predecessors. Static RAMs and static column RAMs, as well as traditional DRAMs with densities of 1 megabit and above, will be consumed in ever-greater ratios within the PC market.

Table 2

The Integrated Circuit Content of PCs
Number of Integrated Circuits

Description	IBM PC AT	Compaq 386	IBM PS/2 Model 50
Standard Logic	128	115	82
Memory			
RAM	41	36	21
EPROM	N/A	2	5
Microdevices	9	14	4
Microprocessor	80286 (6 MHz)	80386	80286 (10 MHz)
Interrupt Control	x	x	x
DMA Control	x	x	
Counter/Timer	x	x	
I/O Port	x		
CRT Control	x		
Floppy Disk Control	x		x
Asyncronous Communications Control	x		
RTC plus RAM Upgrade		x	
RAM Control		x	
Peripheral Control		x	
ASICs	4	10	6

Note: x means that the chip is included in that model.
N/A = Not Available

Source: Dataquest
December 1987

DATAQUEST CONCLUSIONS

Although several of the European PC manufacturers already have built up markets outside their own countries, or even outside Europe, more European companies are now strengthening their activities in order to boost their export performances. In some cases, European companies have started to become significant worldwide players. A major reason for this change in marketing strategy is directly associated with production issues. Considering the high fixed costs of a manufacturing facility, it has become necessary, in order to remain competitive, to realize high sales volumes, which in turn require a deeper penetration of the home market and/or an increased marketing and sales effort aimed toward export markets. Companies such as APD, Bull, Ericsson, Goupil, Nixdorf, Nokia, Siemens, and Tulip are all increasing their marketing investments outside their home countries or traditional regional bases.

Jennifer Berg