Perspectives

PC Watch

Monthly Newsletter

***PC Watch** provides an invaluable source of information on European PC Production and related issues. This Newsletter brings together the combined intelligence of the Worldwide Electronics Applications Group and the Worldwide Personal Computer Group.*

Packard Bell Acquires Zenith Data Systems

Packard Bell, Groupe Bull and NEC have reached an agreement that gives Packard Bell control of the Bull subsidiary, Zenith Data Systems (ZDS). Under the agreement, NEC will contribute $283 million in new investment alongside Bull's transfer of ZDS, which is valued at $367 million. Groupe Bull and NEC will receive convertible preference shares in the combined organization, giving each 19.9 percent of the new company, just below the 20 percent level at which they would have to consolidate the new company's results in their own figures.

Dataquest estimates that Packard Bell was the world's fourth-largest PC maker in 1995 and the second-largest behind Compaq in the United States. ZDS was the thirteenth-largest PC vendor in the world and fourteenth in the United States. Combining their shipments would still leave Packard Bell fourth in the world. It would, however, become the largest PC vendor in the United States. In Europe Packard Bell was seventh and ZDS was thirteenth. Combining the two would result in them rising to fourth position after Compaq, IBM and Apple.

Dataquest

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Dataquest Perspective

The immediate impact of the transaction on Packard Bell is a strengthened balance sheet. The company has been short of cash on several occasions over the past few years, and it was widely rumored that the company recently had to borrow money from Intel. Cash is king, and the $283 million invested by NEC will help Packard Bell put the second half of 1995 behind it.

Packard Bell stated that the combined revenue of the companies was $5.5 billion in 1995. Significantly, the ZDS contribution to total revenue is more stable than Packard Bell's as ZDS has a broader product portfolio (including mobile computers and PC servers) and is in more predictable markets. The server and mobile computer businesses enjoy significantly higher margin structures than the home desktop market. This may enhance Packard Bell's ability to borrow money inexpensively in the future and help fuel additional expansion and business growth.

ZDS' business has been stagnating over the past few years. While the company continues to grow and has fairly balanced geographical coverage, total unit volumes have yet to break the 400,000 per-year mark. Packard Bell's Western European business is virtually the same size as that of ZDS. The doubling of business in Europe clearly helps, but is not that significant on a pure volume basis. Both companies still lack penetration in regions outside the United States and Western Europe, although Packard Bell has made great strides in recent years to remedy this.

It can be argued that, from NEC's vantage point, there are several benefits from increased investment in Packard Bell. First, a healthy Packard Bell means more DRAM and multimedia subcomponents to sell. This hardly justifies a further $283 million investment, but it helps if one considers Packard Bell as a captive buyer. There might also be strategic opportunities in using Packard Bell volumes to drive NEC's new standards or technologies to market. A more realistic view is that NEC wanted to protect its previous investment in Packard Bell. We have questioned NEC's previous investment of $170 million, but assuming that made sense, its new investment does also. A healthy global commercial systems business from ZDS is a potential long-term way to do this. We think this strategy could pay dividends that a nondiversified Packard Bell never could. At some point, Packard Bell will need access to far more money than is available internally. The public markets would not be an option without a healthy commercial systems business. However, even considering the above factors, we think there is more in it for NEC here than meets the eye. Apart from the global economies of scale in component-purchasing abilities that the new company will create, there is also the combination of the marketing skills of ZDS and Packard Bell and the technological expertise of NEC. One of the other low-lying fruits waiting to be plucked in Europe is a quick rationalisation of the shared factories in Angers, France.

Intel Introduces Fourth Generation Pentium Chip Sets

Two new Pentium chip sets previously known as Triton II and Triton VX have been formally launched as the 430HX and 430VX respectively. The current Triton chip set is renamed 430FX as part of the launch. The 430HX provides reliability and high performance for the business PC segment, and the 430VX supplies the maximum multimedia capability and low system costs required by the SOHO market segment. The chip sets are the first to provide support for the USB (Universal Serial Bus). Another common feature is the support of Concurrent PCI where system performance is enhanced by simultaneous activity capability on the CPU, PCI and ISA buses.

Beyond these features the chip sets diverge as described in Table 1.

Table 1
Comparison of Fourth Generation Pentium Chip Sets

	430VX	430HX
UMA Support	Yes	No
Synchronous DRAM	Yes	No
ECC Memory	No	Yes
Dual CPU Support	No	Yes
Packages	2 × 100 pin QFP	1 × 324 pin BGA
	2 × 208 pin QFP	1 × 208 pin BGA
Cost (10,00 Units)	$33.0	$37.50

Intel is sampling both chip sets now with volume production scheduled for the second quarter of 1996.

Dataquest Perspective

The 430VX originally focused on the low-end, UMA configurations and the inclusion of SDRAM support will increase memory bandwidth, minimizing performance loss resulting from the CPU and graphics controller accessing the same memory. Of course, a fundamental conflict exists because UMA targets low-end price points, which are the least likely to bear the incremental premium that will be charged for SDRAM relative to FPM or Extended Data Out (EDO) DRAM. Instead, look for SDRAM to be used initially in premium top-end machines where it can be used as a performance differentiator against EDO-equipped competitors.

The 430HX is really only of use in servers where the reliability offered by true Error Checking and Correcting (ECC) memory is of some advantage as is the ability to run two processors. Another benefit is that the 430HX is optimized to give approximately 10 percent improvement in performance with EDO DRAMs compared with the current Triton chip set.

Memory Developments in the PC Marketplace

The second half of 1995 and the switch to Pentium brought two major developments in the PC memory market, both in their own way brought surprises for memory vendors.

EDO Avalanche

Throughout 1995 EDO or Hyperpage mode was touted as the memory of choice for Pentium-based systems: the arrival of Intel's Triton chip set in late first quarter of 1995 started the bandwagon rolling. The production ramp was catered for by early EDO suppliers such as Toshiba, NEC and Samsung. However, in the late third quarter the trickle turned into a flood as all manufacturers of Pentium systems saw the need to feature EDO memory. The wholesale change to EDO caught DRAM suppliers by surprise because they had not anticipated such a fast transition and had not planned the appropriate mix of Fast Page Mode (FPM) and EDO products for the fourth quarter. Worse for some vendors was the fact that the size and organization of the devices they had introduced were not the optimum fit for the Pentium's 64-bit bus. Coupled with this was that the preferred speed for EDO memory is 60ns, which was not yielding well at some manufacturers.

The optimum device for the Pentium bus is the 1Mb × 16 device as this enables the minimum fit of 8 MB to be achieved with two 72-pin SIMMs, each containing two devices. The next best alternative would be the 1Mb × 4 device, where each SIMM needs eight devices. Using the above devices achieves a granularity for memory expansion purposes of 8 MB. This enabled PC vendors to offer 8 MB as a standard fit with the ability to offer another eight or more megabytes as a dealer-fitted upgrade, thereby maximizing their margins.

As the fourth quarter 1995 progressed, more memory vendors started to ship increasing quantities of EDO parts and some PC vendors decided that they could afford to offload their unwanted stocks of Fast Page Mode product. For the first time in three years this led to spot market prices that were below contract pricing, this trend has continued into the first quarter of 1996 as the availability of more EDO products enabled more FPM products to be offloaded. Aggravating the problem was the fact that several companies, of which Intel was the most public, were left with excess inventory following a poorer-than-expected fourth quarter. This inventory has to be shifted and many companies are doing this by continuing to offer it on the spot market and thereby driving spot market prices even lower than they were late in the fourth quarter.

Dataquest Perspective

Throughout these events, the price for 60ns EDO held firm, however, even this is coming under pressure. Clever buyers are finding ways to make the linkage established by the memory vendors between FPM and EDO work in their favor and both architectures are coming under pressure in contract negotiations. Dataquest now expects that there will be 6 to 8 percent price erosion in EDO and 8 to 12 percent price erosion in FPM pricing during first quarter contract negotiations. The spot market fluctuations for FPM will continue until all the excess FPM material is flushed out of the system and the market stabilizes until the supply/demand situation truly swings to the oversupply mode. This is unlikely to be until late 1996 when some of the new production capacity being built starts to come onstream.

Synchronous Burst Mode SRAM Whimper

In 1995 Intel indicated to the SRAM community that its prefered choice in 1996 for Cache SRAM would be the 1Mb Synchronous Burst Mode device in the 32K × 32 organization. This would result in a demand for 90 million units in 1996. So the world's SRAM vendors, 16 at the last count, went and designed such a device and in the second half of 1995 silicon started popping out from fabs and foundries in the United States and Asia. Inventories were built up and orders were eagerly awaited. SRAM vendors are still waiting.

The spot market price for this device is rumored to have already dipped below $8 in Taiwan and the parts are beginning to proliferate on Taiwan-supplied motherboards going into secondary- and tertiary-level PC integrators. Meanwhile in Europe the adoption of the part is slow; it would appear that there are two reasons for this. First, unless they were designed with a cache module socket, locally designed motherboards need to be redesigned to accomodate the part: most manufacturers are waiting for the availability of Intel's new chip sets prior to making this change. Second, most major players in the Consumer PC arena have chosen to spend any additional memory budget on fitting EDO DRAM rather than fitting any cache at all. This is purely a cost- and marketing-driven decision, which, in real terms, will result in the consumer getting a slower machine, but a tick can be placed against all the desired 'features" and the appropriate price break achieved.

Dataquest Perspective

The 1 Mb Synchronous Burst Mode Cache SRAM will be successful, but the adoption of this part will not start ramping in Europe until late in the second quarter. What we can expect to see is the price of the device moving down the price curve very quickly as all vendors with inventory fight to win sockets. We can expect that some of the players will find the going too volatile and will pull out very quickly. Some of the survivors will be a surprise to most watchers, but expect to see companies like UMC, Sony and Winbond among them.

Intel's Motherboard Operation's Semiconductor TAM

One of the most perplexing questions for any analyst gathering semiconductor market numbers in Europe is the impact of Intel's motherboard operations in Ireland. Intel is as tight-lipped about this operation as it is about any of its other businesses and it is therefore extremely difficult to determine the total available market (TAM) for any particular component. Intel's control of a significant part of the motherboard semiconductor TAM through sourcing the microprocessor, PC chip set and the BIOS flash memory internally makes the gathering of such data even more difficult. Furthermore, Intel is reputed to have rigorous non-disclosure agreements in place with all its major suppliers, therby cutting off at source any circumstancial data that could help derive the numbers.

The object of this article is to initiate some discussion on the subject and see whether collectively the semiconductor community can determine a workable number. The information used to derive the numbers in this article come from published sources, work done by Dataquest's PC Teardown Service and data passed on by industry sources.

Owing to the nature of Intel's motherboard business, the different motherboards and the various configurations in which they are supplied, it is difficult to determine one number for the TAM. In 1995 Intel predominantly shipped two different types of motherboard—Zappa and Endeavour—and their derivatives. The main difference between these two boards is that the Endeavour has on board soundblaster-compatible audio. We have therefore worked out the semiconductor costs common to both types of motherboard for three different configurations, that is, base motherboard with no memory, base motherboard with cache memory and base motherboard with cache memory, CPU and 8 MB of DRAM. Other than configuration, the other main differentiator will have been speed of processor fitted. To address this we have assumed a mix of processor speeds and have used a composite number for the processor cost.

Because of the complexity of the subject, we have not addressed areas such as the number of boards that include audio and/or video, neither have we broached the subject of complete PCs assembled by Intel in Ireland. Anyone who wants to pursue this matter further or wants a complete copy of the spreadsheet should contact Dataquest.

Table 2 shows the cost breakdown for the components common to both types of board. All Intel sourced silicon is costed as if bought on the open market and not at intercompany transfer. Table 3 shows the range of TAMs for the various configurations for 1995 and 1996 for a range of annual production figures.

Table 2
Costs for Components Common to All Intel Motherboards
(Dollars)

Type	Quantity	Average 1995 Cost	Part Number	Package	Description	Average 1995 Cost	Average 1996 Cost	Cost Change 1995 to 1996
Diode	1	0.01		PIH	Diode, axial, 0.375-in. long	0.01	0.01	-2.0%
Diode	4	0.05		SMT	Diode, EIA size A	0.19	0.19	-2.0%
IC	1	5.15	PC87306-IBA	PQFP-160	I/O, FDD, and keyboard controller	5.15	4.37	-15.1%
IC	1	9.14	SB82371FB	PQFP-208	PCI ISA/IDE accelerator	9.14	7.31	-20.0%
IC	1	0.21	74F125	SOIC-14	Buffer, quad-gated, three state	0.21	0.20	-5.0%
IC	1	3.36	ICS9159-02	SOIC-28	Clock controller for Pentium systems	3.36	2.69	-20.0%
IC	1	0.23	7407	SOIC-14	Hex buffer/driver, open collector, up to 30V output	0.23	0.21	-5.0%
IC	1	0.17	7406	SOIC-14	Hex inverter buffer/driver, open collector, up to 30V output	0.17	0.16	-5.0%
IC	1	0.12	74HCT14	SOIC-14	Hex Schmitt trigger	0.12	0.12	-5.0%
IC	1	0.19	74ALS00	SOIC-14	NAND Gates, quad 2-input	0.19	0.19	-1.0%
IC	3	0.27	74F245	SOIC-20	Octal bus transceiver, three-state, true	0.81	0.77	-5.0%
IC	4	0.42	74ALS245	SOIC-20	Octal bus transceiver, three-state, true	1.67	1.66	-1.0%
IC	1	0.26	431AC	SOIC-8	Reference voltage, programmable	0.26	0.26	-2.0%
IC	1	0.36	DS14185	SOIC-20	Serial port driver	0.36	0.35	-5.0%
IC	2	9.05	SB82438FX	PQFP-100	Triton data path	18.10	13.58	-25.0%
IC	1	22.85	SB82437FX	PQFP-208	Triton system component	22.85	18.28	-20.0%
BIOS	1	4.05	N28F001BX-T120	PLCC-32	Flash, 128K×8, 120ns	4.05	3.24	-20.0%
Transistor	5	0.04	R504	SOT-23	Transistor, small, SOT-23	0.19	0.19	-2.0%
Transistor	1	0.08		TO-220	Transistor, TO-220 package	0.08	0.08	-2.0%
Cache	8	3.80	AS7C3256-15	DIL-28	SRAM, 32K×8, 15ns	30.40	28.87	-5.0%
Cache Tag	1	3.80	AS7C3256-15	DIL-28	SRAM, 32K×8, 15ns	3.80	3.46	-9.0%
Processor	1	360.00	Pentium-Mix	CPGA-320	Pentium processor [1]	360	311.00	-13.6%
Memory	2	114.64	1Mb × 32, 70 ns	SIMM	DRAM SIMM, 1M×32, 70ns, no parity [2]	229.27	217.81	-5.0%
				Motherboard Semi. Cost (minus DRAM/CPU/Cache)		**67.16**	**53.85**	-19.8%
				Motherboard Semi. Cost (with Cache)		**101.36**	**86.18**	-15.0%
				Fully Populated Motherboard Semi. Cost		**690.63**	**614.98**	-11.0%

[1] Based on mix for 1995 of 40% 75MHz, 40% 90/100MHz, 20% 120/133 MHz, 1996 Mix assumed to be 15% 75 MHz, 40% 90/100 MHz, 25% 120/133 MHz, 20% 150/166 MHz

[2] 1995 Fast Page Mode, 1996 EDO 60nS

Source: Dataquest (February 1996 Estimates)

Table 3
Semiconductor TAM for Range of Annual Production Volumes

Annual Unit Volume	1.25 M	1.5 M	1.75 M	2.0 M	2.25 M	2.5 M
1995 TAM Range ($K)						
Motherboard Semi Cost (minus DRAM/CPU/Cache)	83,950	100,740	117,530	134,320	151,110	167,900
Motherboard Semi Cost (with Cache)	126,700	152,040	177,380	202,720	228,060	253,400
Fully populated Motherboard Semi. Cost	863,289	1,035,947	1,208,605	1,381,262	1,553,920	1,726,578
1996 TAM Range ($K)						
Motherboard Semi Cost (minus DRAM/CPU/Cache)	67,310	80,772	94,234	107,696	121,158	134,620
Motherboard Semi Cost (with Cache)	107,720	129,264	150,808	172,352	193,896	215,440
Fully populated Motherboard Semi. Cost	768,730	922,476	1,076,222	1,229,968	1,383,714	1,537,459

Source: Dataquest (February 1996 Estimates)

On the basis of estimated production capacity in 1995 we believe that Intel produced in the region of between 1.6 million and 1.8 million motherboards in Ireland. Our assumption is that, because of memory shortage, most motherboards will have been shipped fully populated, therefore, taking the 1.75 million units line in the spreadsheet, the TAM was $1.2 billion. Looking forward to 1996, we believe that the capacity for the Leixlip facility is 2.5 million units and the resulting 1996 TAM could be $1.5 billion.

Dataquest Perspective

If Intel was to purchase the above components on the open market, it would make the company one of the top five semiconductor purchasers in Europe. However, with the processor, BIOS flash device and the chip set sourced internally, the real interest to the semiconductor industry is the SAM, and this is dominated by the DRAM component. On a basis of 1.75 million units, the total SAM for 1995 was $483.8 million, of which the DRAM accounts for $401.2 million. This year will be even leaner for non-DRAM vendors as the SAM is $457.1 million, of which DRAM accounts for $381.1 million.

Dell Computer Corporation—Channels and Manufacturing

Corporate Information

Location	2214 W. Braker Lane, Suite D Austin, Texas 78758-4053 (512) 338-4400
President/CEO	Michael S. Dell
Vice Chairman	Morton L. Topfer
Fiscal Year 1995 Worldwide Sales (Year Ended January 29, 1995)	$3.5 billion
First Half 1996 Worldwide Sales (Ended July 30, 1995)	$2.3 billion
Number of Employees	6,400 full time

Corporate Overview

Dell Computer Corporation was incorporated in Texas in 1984 (it was later incorporated in Delaware), but its true origins were in the University of Texas college dormitory of Michael Dell. Its rise to the Fortune 500 is almost legendary—a case study for business schools. There are many facets to Dell's success, but one is key: Dell pioneered the direct response channel for personal computers. Dell used the direct response model to accomplish two critical advantages: First, it was able to provide custom systems quickly; second, and more importantly, Dell was able to offer systems at lower prices by avoiding a "middleman" between it and its customers.

Dell established one-on-one relationships with its customers, and frequently it was able to spot purchasing trends and understand customer requirements ahead of its competition. Through its close customer contact and build/configure-to-order processes, Dell was able to establish a reputation for excellent service and support and has ranked among the best PC companies for customer satisfaction.

Market Conditions Change in the 1990s

The direct model served Dell well through the 1980s, but market conditions started to change in the early 1990s, including the following:

- Top-tier vendors streamlined their operations to cut down overhead, reduce product development cycles, and get closer to their customers, as they were quickly losing market share to smaller, more nimble companies.
- Top-tier vendors also revamped their product lines to include lower-margin, lower-priced PC systems. This was initiated by Compaq Computer Corporation in June 1992 and was soon followed by IBM and others.
- Dell was not likely to remain the sole provider of systems through the direct channel. Its success spurred new competitors, most notably Gateway 2000, which saw its own star rise almost as quickly as Dell's. But it also spurred major computer vendors to attempt this channel, including Compaq and Digital Equipment.

Dell found itself competing on price with vendors with greater corporate resources, bigger installed bases, better access to technology, and greater brand recognition. It was in a precarious position, as it was being challenged by equally, if not more, nimble competitors emerging from below that were also targeting direct customers.

Dell Tries Retail

In 1991, Dell entered the retail channel, initiated by agreements with CompUSA, Staples, and Price Club. This move away from the direct channel was difficult for Dell, which counts the efficiencies of its processes that are oriented to providing systems directly as a primary competitive advantage. It had difficulty maintaining a price advantage here and found that it wasn't able to make money in this channel. As a result, Dell chose not to compete in the retail channel in 1994; rather, it refocused its efforts to direct marketing alone.

By pulling out of the retail market, Dell essentially quit competing for the consumer-market customer, typically a first-time computer buyer. The consumer market has been the fast-growing market sector in the PC industry for at least the last two years, and Dataquest expects this to continue through 1997. Dell has openly said that it would not pursue the first-time buyer, but to sell and support business customers and experienced users.

Despite the lack of strategy to address the consumer market, Dell has been extremely successful in 1995 (see the "Financial Profile" section). And competitors in the consumer market are finding that it is not a particularly profitable one. On November 1, 1995, *The Wall Street Journal* reported that the net profit margins on home PCs are often as low as 1 percent, requiring large volumes of sales. The large volumes can be achieved mostly by those with well-known brand names and those successful in capturing new customers. Vendors playing in the home PC market expect to reap the rewards in several years, some willing to endure losses in the short term.

Financial Profile

Dell's financial performance in the last three years, including the first two quarters of fiscal 1996, is shown in Table 4.

Dell's financial performance last year and so far this year have made it a Wall Street darling. In the May 1995 issue of *Fortune* magazine, it ranked Dell as No. 1 in the Fortune 500 for "Best Investment," based on its 81 percent return to investors in 1994. The first two quarters of 1995 (Dell's fiscal 1996) were stunning as well. Compared to the same period last year, sales were up 50 percent, and net income rose 167 percent. The second quarter of fiscal 1996 is the ninth consecutive quarter of positive results for the company.

In October 1995, Dell directors authorized a two-for-one stock split, its second stock split since it went public in June 1988. This brings the number of outstanding shares of Dell stock to almost 100 million.

Table 4
Dell Revenue and Income Summary: FY 1993 through First Half FY 1996

Fiscal Year	Revenue ($K)	Net Income ($K)	Earnings per Share ($)
1993 (Year Ended January 31, 1993)	2,013,924	101,642	2.59
1994 (Year Ended January 30, 1994)	2,873,165	-35,833	-1.06
1995 (Year Ended January 29, 1995)	3,475,343	149,177	3.38
First Half 1996	2,341,526	126,773	2.43

Source: Dell Computer Corporation

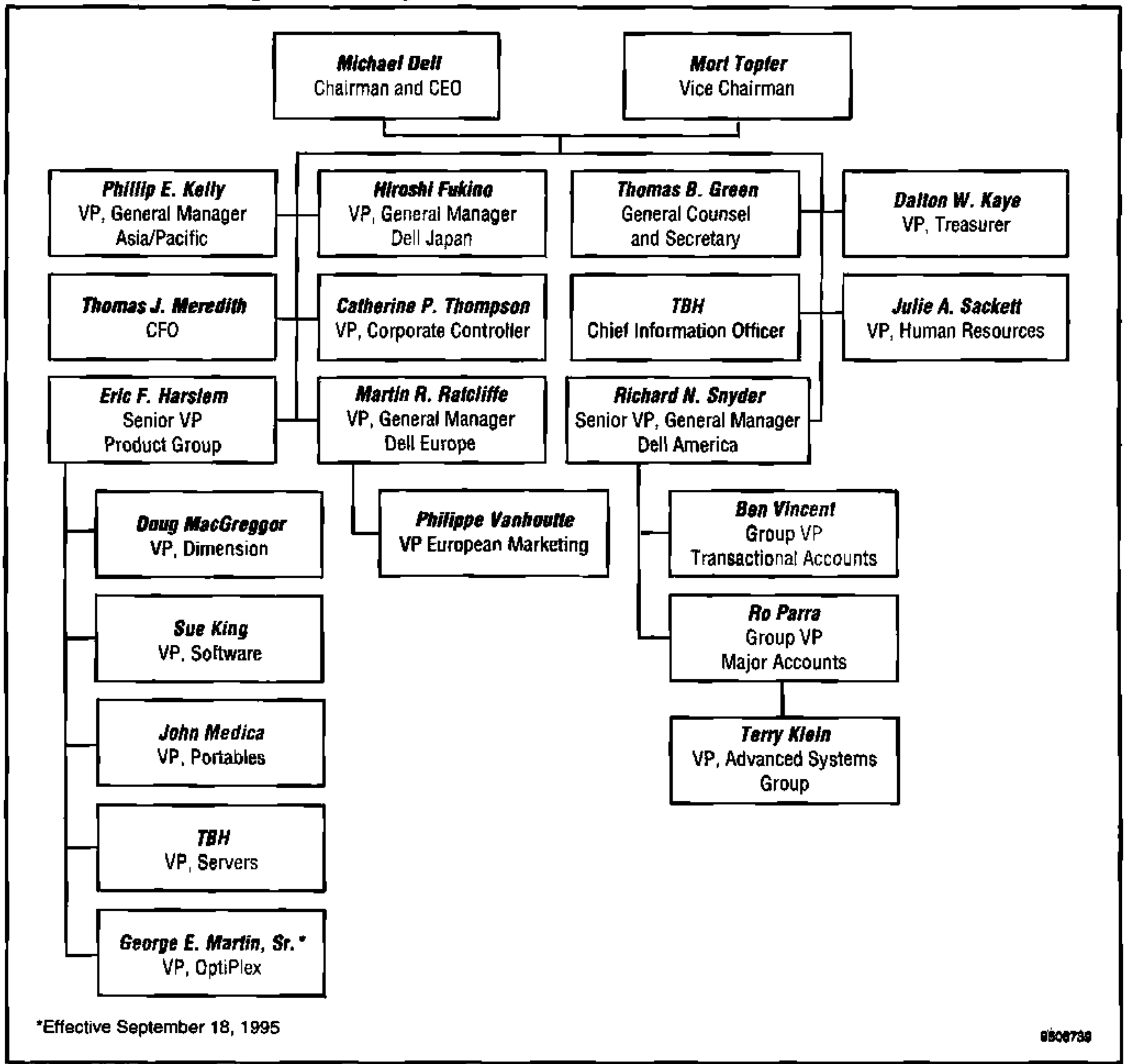
Organization

Since the arrival of Mort Topfer from Motorola in the position of vice chairman, Dell has changed its modus operandi regarding staffing and personnel. It now looks to hire some of the best in the business to run key businesses, rather than rely almost solely on internal expertise. One of the first of these hires, John Medica, Dell's vice president of portables, is a prime example. Mr. Medica is credited largely with the successful introduction of the Apple PowerBook notebooks, and he came to Dell in March 1993 to completely overhaul its notebook products and strategy. He now is also credited with the Dell Latitude notebooks, another success story. Dell has since hired other executives from PC competitors, including Eric Harslem, senior vice president (products), also from Apple.

This strategy requires a significant investment in the short term that is expected to pay off in the long term, although in the case of Mr. Medica, the payoff came fairly quickly. Long-term planning is indicative of Dell's maturation as a company and understanding of how to position itself for growth and profitability.

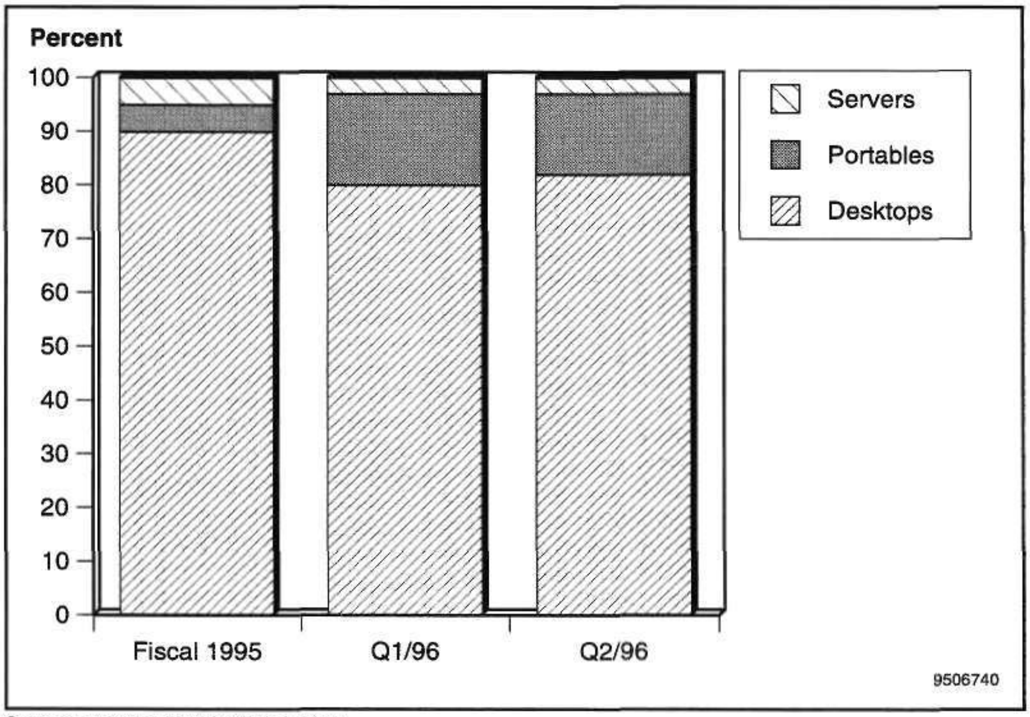
Dell is organized by administrative functions (financial, human resources, legal, operations, and so on), product development activities, marketing and service and support, and international operations. The product development activities are segmented by portables, Dimension desktops, OptiPlex desktops, and servers. The Dell organization chart is shown in Figure 1.

Figure 1
Dell Computer Corporation Organization



Source: Dell Computer Corporation

Figure 2
Percentage of Dell Revenue by Product Type



Source: Dell Computer Corporation

Pricing Strategy

Dell traditionally positioned itself as a price leader; its aggressive pricing helped Dell forge its place among the biggest PC vendors in the world (it was number 7 in both unit shipments and revenue in 1994, according to Dataquest). It lost some of its edge primarily for the following three reasons:

- Dell deviated from its business model by attempting to reach customers through retail channels. Retail did not work for Dell, particularly because its entire internal structure and processes are built around its direct, build-to-order model.
- New competitors were quick to challenge Dell's technology and price leadership, especially Gateway 2000, which operates with very low overheads.
- Major PC manufacturers, led by Compaq, introduced value products to compete on price. Customers responded, and price became the most important factor in choosing a PC system. This led to a weeding-out of third-tier vendors that no longer offered significantly lower prices than the name-brand vendors. Given a choice, customers were more likely to choose a brand with a name they recognized and associated with quality. Large vendors were also able to take advantage of economies of scale, keeping costs lower. Under these circumstances, smaller vendors lost their competitive edge.

Dell sharpened its edge by streamlining its operations and processes to serve its customer base exclusively through the direct channel and by focusing on "mainstream" technology leadership. Dell has a strong foothold in commercial markets, which account for 90 percent of its sales (versus 10 percent in consumer markets). It is now positioning itself as a product leader with competitive pricing that continues to attract a knowledgeable customer base. The biggest threat for the Dimension product line (Dell's biggest seller by far) is Gateway 2000, which has its own advantage of very low overhead. But Dell has been quicker to expand into new regions with its direct approach, and it has a strong portables product line—a weak point for Gateway.

Dell has been very aggressive on product and pricing leadership, striking back at Gateway and causing competitors to wonder how it is able to price the way it does. Recently, however, Gateway has pushed back in notebooks with the mid-September introduction of its new line of Pentium-based notebook computers called Solo. The basic model, a 75-MHz box with 8MB of RAM, modular CD-ROM (exchangable with the floppy drive), a 10.2-inch TFT display, 540MB hard disk, a touch pad pointing device, and headphones included, is priced very competitively at $3,499. There are six models in the line—the top model incorporates a 120-MHz Pentium microprocessor. Although Gateway has not been very successful with its earlier notebook and ultraportable offerings (HandBook, ColorBook, and Liberty), the features and pricing on Solo make the line very attractive, and a potential threat to Latitude.

Distribution

Dell's strength in the PC market stems from its successful development of direct response/direct salesforce as alternate distribution channels to traditional dealers and other reseller channels. Unlike its competitors in the top tier that distribute through resellers, Dell has established efficient processes in all aspects of the organization to support this means of doing business. By the early 1990s, Dell started to significantly impact PC market share in the United States, causing major computer vendors to take notice and initiate their own direct efforts. But the only competitors that have had real competitive impact on Dell in this channel are those that are also structured to service direct sales, particularly Gateway 2000. Dell and Gateway do not have the channel management issues to contend with that plague Compaq, Apple, or IBM.

The problem Dell has with its approach to the market is that it is not only its strength, but also its weakness. While the direct response model is relatively efficient, it is extremely dependent on the predisposition of customers to buy direct, which is typically a binary attribute: Customers are either inclined to buy direct or not. Dataquest has found that the growth in the direct response channel has flattened as a percentage of total PC shipments. Because major competitor Gateway 2000 has continued to grow, Dataquest believes Dell is growing above the rate of the market by increasing its presence in major accounts. But this, too, has a downside: New major account business is decreasing, although Dell is in a good position to ride upgrade cycles in existing accounts. In any case, Dell is faced with the limitations of a single channel of distribution.

Key Channels

While Dell is known for its presence in the direct channels, it does almost 10 percent of its business through value-added resellers (VARs), by far its largest reseller channel. In 1994, the retail channels accounted for less than 5 percent of Dell's unit shipments and revenue in the United States (see Table 5).

Dell began its foray into the retail market in 1990 (its first agreement was with CompUSA) and pulled out of this market in the United States and Canada in July 1994, only four years later. The retail channel was not a money maker for Dell, which has traditionally been operating on slim margins. Dell was losing money at a time when it was having financial problems, and Dell was quickly losing share in retail to the top four retail vendors as well—Apple, Compaq, IBM, and Packard Bell.

Dell's systems are not set up to serve it well in a reseller channel: Manufacturing is build to order, and reseller channels require that vendors stock inventory. Dell decided it was in its best interest to stick to what it does best (and most profitably)—service customers directly. This appears to be a wise decision on Dell's part. Its profit margins jumped this year, and a formidable new competitor—Hewlett-Packard—entered the retail market.

Table 5
Dell's US PC Unit Shipments and Revenue by Distribution Channel in 1994

	Units	Percentage of Total	Revenue ($K)	Percentage of Total
Direct Salesforce	395,962	50.1	943,162	50.7
Direct Fax/Phone	289,258	36.6	690,734	37.2
Value-Added Reseller	75,129	9.5	172,780	9.3
Warehouse Clubs	11,784	1.5	18,733	1.0
PC Superstores	10,241	1.3	18,323	1.0
Consumer Electronics Store	5,073	0.6	7,517	0.4
Dealer	2,482	0.3	7,226	0.4
PC Store	276	<0.1	803	<0.1
Total	790,206	100.0	1,859,277	100.0

Source: Dataquest (December 1995)

Distribution Strategy: In the United States and Overseas

As Dell moves forward, it is concentrating its efforts on its top three channels in the United States: direct salesforce, direct response, and VARs. It has recently increased its field salesforce in the United States, expanding with both account executives and systems engineers. These personnel are especially effective in servicing major accounts (large corporate, government, and educational organizations), which made up 65 percent of total sales for Dell in its second fiscal quarter of 1996. Based on its financial results so far in fiscal 1996, Dell's belief that it should stay with direct distribution has been strongly reinforced.

Overseas, however, Dell has to contend with the acceptance of its method of selling in various countries and cultures. It has not yet established a significant direct salesforce in any other than in the United States, where the direct salesforce generates more units and revenue than any other channel. It has successfully implemented direct response business in Japan and the United Kingdom, but Dataquest analysts in Europe believe that direct response will never catch on in some countries there, particularly Germany.

In the Asia/Pacific region, Dataquest analysts believe that most countries are not ready for the direct response channel, although that could change in the future. Dell is counting on the relationship-based business tradition in the region to be beneficial for its direct sales approach and is targeting this region to account for 30 percent of its worldwide sales by the year 2000, up from about 5 percent this year. It is investing $250 million over the next three years to establish its presence in the region and has built a manufacturing plant and customer service center in Penang, Malaysia. Dell expects that manufacturing in Penang will commence in early 1996; the customer service center is currently operating. It initiated a major advertising campaign in Hong Kong in August and will follow into Singapore and Malaysia. Dell already has a presence in Japan and Australia and will work through distributors rather than directly with customers in China and Indonesia because of government restrictions.

Service

Dell's main customer service center is in Austin, Texas. Dell also has service centers in Montepellier, France, and Wicklow, Ireland. Dell's customer service and support organization employs about 500 people in the United States; Dataquest estimates that it employs another 100 people in its other service centers. Customer service at Dell encompasses technical support, training (mostly for employees), online services, and fee-based services (help desk, application support, and network support). There are also people dedicated to creating service account tools and monitoring call quality and to providing spare parts to customers.

Customer service employees at Dell receive six weeks of training, two of which are listening on the phone. Employees receive ongoing training on new products and mainstream applications and operating systems. Currently, Windows 95 is a main focus of training.

The service organization is split to service two primary customer types: transactional (less technical small office/home office customers) and major accounts (more technical MIS customers). Customers are initially directed into one of two telephone queues, either the transactional queue or major account queue. If the call is technical and is specific to a particular product line, it will be directed to a technician dedicated to that product line (the Latitude product has its own 800 number). Calls coming into Dell are routed by an automated, menu-driven system and are answered in the order they come in.

Manufacturing

Dell's manufacturing is based on a build-to-order model, which is particularly suitable to responding to customers directly. Dell has fine-tuned its manufacturing process to this model and is benefiting from manufacturing efficiencies stemming from a single model. The process consists of assembly, functional testing, and quality control of both finished goods and components. Of 4,500 Dell employees in North America, 1,600 are involved in various aspect of manufacturing, including purchasing and logistics. The number of manufacturing employees in North America involved in direct line operations is 850. Dell's manufacturing method can best be described as modified cellular manufacturing. Dell's workers build part of the systems in groups.

Dell's manufacturing facilities are shown in Table 6. Both the US and Ireland facilities have been certified as meeting ISO 9002 quality standards.

Table 6
Dell Manufacturing Facilities

Location	Size	Product Lines
Austin, Texas (Operates Two Shifts Five Days a Week: 7:00 a.m. to 3:30 p.m.; 4:00 p.m. to 12:30 a.m.)	235,000 square feet (received ISO 9002 certification in August 1993)	9 manufacturing lines: 7 desktops, 1 servers, and 1 portables
Limerick, Ireland	300,000 square feet (received ISO 9002 certification in 1992)	5 manufacturing lines: 3 desktops (soon to be 5), 1 portables, and 1 servers
Penang, Malaysia (Production Starting in Early 1996)	238,000 square feet	2 desktop manufacturing lines at start-up

Source: Dell Computer Corporation

Manufacturing Process

The process from order to ship at Dell is as follows:

- Customer places order.
- Order goes to Financial Services for a credit check.
- Once through credit check, order goes into a "pending production" file.
- Manufacturing downloads the "pending production" file (downloads are done every two hours).
- Manufacturing creates paper "travelers" for each unit using software that translates the sales SKUs into manufacturing parts numbers and includes a unique bar code that identifies the system specifications and the customer. (This "traveler" stays with the system throughout the manufacturing process and indicates the order that the system is a part of.)
- Production schedules line.
- Assembly personnel build the system.
- Boxing
- Accumulate all systems until order is complete, then print labels
- Ship

An order typically takes two to three days to get through the manufacturing process.

The build-to-order process has some distinct advantages, including the following:

- Systems are not built until sold. As a result, Dell has virtually no finished goods inventory and turns component inventory quickly.
- The isolated areas of automation allow for flexibility. Any product can be built on any line, and different shifts can build different products.
- Systems are customized to particular customers. (Systems can be custom-labeled also.)
- Systems are ready to use right out of the box.

The disadvantages of the build-to-order line include the following:

- A delay in one area of the line can affect the rest of the line.
- It is impractical for manufacturing for most reseller channels.
- Customer cannot decide to purchase a Dell computer and bring that computer home the same day.

Special Orders

Dell has a program called Dell Plus, which allows Dell to address special integration needs through the manufacturing process. For these customers, a project manager is assigned to the account. The project manager writes a script for special orders, which is followed through by manufacturing. Customers pay additionally for this function; the amount depends on the level of integration.

Inventory

Dell's build-to-order system allows for essentially no finished goods inventory. In North America, Dell maintains inventory levels at about 24 days for components. The worldwide aggregate days of inventory is about 34 days. Dell does run into backlog problems, resulting from its efforts to manage the flow of customer orders cost-effectively. On January 29, 1995, it had a backlog of $95 million, compared with $38 million a year ago.

Dell's Manufacturing Partners

Dell's manufacturing partners for portables include the following:

- Quanta Computer Inc., which builds unconfigured Latitude notebooks
- Sony Corporation, which builds unconfigured Latitude XP notebooks

Logistics

In February 1995, Dell signed a global logistics agreement with Roadway Logistics Systems (ROLS). The agreement is essentially an outsourcing of Dell's logistics requirements. ROLS will oversee Dell's entire manufacturing process, from the flow of raw materials to the shipment of systems. Dell maintains that in the PC industry, because of the very short product cycles and wavering customer demand, logistics can account for significantly more than the 10 to 15 percent of manufacturing cost for most industries. By outsourcing to a company with logistics expertise, Dell hopes to minimize the cost impact of logistics.

Intel

In a media event held in New York City in March 1995, Dell made its processor strategy very clear: It is following the Intel line all the way. Dell does not purchase CPUs from any source other than Intel, even though some comparable processors are available from other vendors. When Intel introduces a new processor, Dell has a system available that incorporates that processor the same day.

According to Michael Dell, Intel has been improving the microprocessor cycle by introducing a major processor upgrade every two years. This typically causes more demand on the market for systems and gives Dell the opportunity to move more systems. As Mr. Dell sees it, there are three phases in a processor's cycle: the emerging phase, the expansion phase, and the mature phase. Dell is focusing on the emerging stage. This stage is certainly the most attractive in that the profit margins are highest. The challenge is to be able to deliver systems in volume as the new technology emerges. Dell anticipates that it will have systems incorporating Intel's P6 processor by early next year in desktops.

Dataquest Conclusions

Dell has gone through some difficult times and has shown that it can move quickly and make the changes necessary to re-establish a leadership position on the market and improve profitability. But some of the aspects of Dell that make it a successful company also can inhibit it.

Competition

Despite efforts by numerous competitors, Dell is better at selling systems through its combined direct salesforce and direct response programs. However, Gateway 2000 has sold three times more systems through the direct response (fax/phone) channel than Dell in 1994 in the United States. While Dell operates on slim margins and is extremely competitive on price with the top tier, Gateway's operations in South Dakota result in lower overhead costs, which allow it to challenge Dell on price.

In notebooks, however, Gateway has not yet had an impact on the market. Its HandBook and ColorBook entries never took off, and Dell clearly pushed ahead with its introduction of Latitude. But Gateway isn't giving up on the portables market. In November 1995, it introduced a new notebook line called the Gateway 2000 Solo portable PC. The first of these systems incorporates high-end technology features—90-MHz Pentium, 10.2-inch active display, 8MB RAM, stereo speakers, modular CD-ROM, and 3.5-inch floppy drives, removable 540MB hard disk drive, lithium-ion battery, Windows 95, and Microsoft Works 95—at a very competitive price of $3,999.

In its pursuit of major accounts, Dell comes up against the top PC vendors in the industry, including number 1 Compaq. Compaq became aggressive on price in 1992 and has yet to let up. Customers who may have chosen Dell solely on price may turn to Compaq, with its reputation for service and experience in enterprise systems. Compaq has lost its technology edge, however, an advantage Dell needs to maintain.

Packard Bell's tremendous success in the consumer channel doesn't appear to affect Dell directly, but it certainly presents a barrier to entry into the consumer market for Dell. With its price strategy, Packard Bell has caused the consumer market to be a very difficult one in which to compete. Only the top vendors with resources to carry them through nonprofitable times are still targeting this market. This includes new entrant Hewlett-Packard, which, with its quick rise in the PC industry, is also a strategic competitor for Dell.

Strategy

In June 1994, Mort Topfer joined Dell as vice chairman. Mr. Topfer came from Motorola, where he was corporate executive vice president of Motorola Inc. He has fostered cultural change and brought a focus to the company on emphasizing people, improving planning and processes, and global expansion. Under the influence of Mr. Topfer, Dell has devoted resources to hiring the best personnel it can, committing to both developing its own people and bringing in new staff as the circumstances deem necessary. Other recent top management changes include the addition of Eric Harslem, senior vice president, Product Group, and John Medica, vice president, Portables, both from Apple Computer.

In product development, Dell has been quick to adopt new technology, particularly new processors from Intel. While it will introduce products with new technology it designates as mainstream, it is not likely to introduce new technology for unproved purposes/markets (that is, handhelds). With the new Latitude notebooks, Dell has regained considerable ground in the notebook market in very short order, thanks to the efforts of Mr. Medica and his team.

Dell has developed very efficient and effective processes oriented toward its means of distribution. This is particularly true with build-to-order manufacturing, which virtually eliminates problems arising from finished goods inventory by building only systems that have already been sold. Dell has received good marks for service and support, although not as high as the tops in the industry: IBM, Compaq, and Hewlett-Packard.

On the down side, Dell really has no distinct strategy to target the consumer and small office/home office markets, particularly first-time buyers. Faced with a maturing business market, the PC industry is turning its focus to the consumer market, which has exploded in the last two years, first in the United States, followed by Europe and Japan. Dell's method of direct marketing typically does not offer end-users physical access to products before they purchase. By excluding itself from this market, Dell will not be able to threaten the market share of the top PC makers.

The lack of strategy for the first-time computer buyer is really a limitation of Dell's distribution strategy, which it credits as its strength. While Dell's processes are extremely efficient to serve customers directly, they are difficult to readjust to serve customers in other ways. Dataquest believes that exclusive dependence on this channel can hinder Dell's continued growth. Dell has grown faster than the rate of the market by taking share from competitors in major accounts rather than from new business, where the growth rate is decreasing—particular for the large and medium-size businesses that Dell targets. Although upgrade cycles will help offset this decreasing growth rate, this is what may inhibit Dell from growing its business over time.

With Dell's ability to bring new technology to market quickly, particularly processors (because of its loyalty to Intel and Pentium), it is well positioned to grow in the portables market and to increase its share. It was the first to use lithium-ion battery technology across its entire Pentium line and is likely to continue with this aggressive technology approach. Dell is a formidable force in the PC industry, but it is not without its limitations. Many of its tactical moves in the last year have supported a long-term approach to success (particularly in hiring seasoned management). However, its purposeful exclusion from targeting the first-time buyer is turning its back on a tremendous market opportunity. In time, perhaps Dell will be flexible on this stance and find a way to tap into a market with enormous potential.

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Dataquest
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ELECTRONIC EQUIPMENT PRODUCTION MONITOR
EUROPE 1996

TABLE OF CONTENTS

Dataquest

Perspectives

Electronic Equipment Production Monitor

Market Analysis

This Quarterly Industry Review looks at production of electronic equipment in Europe during the first quarter of 1996 (January-March).

Quarterly Industry Review

European Electronic Equipment Production

Introduction

Recently Dataquest has completed its forecast for electronic equipment production in Europe for 1995 to 2000. The equipment production forecast is carried out initially in the spring of each year, and is revised, if necessary, in the autumn. This report summarizes production in the four high-volume equipment sectors covered by the Equipment Production Monitor service, electronic data processing (EDP), communications, consumer, and transportation (automotive) and gives a brief comparison with the forecast published in May 1995 (SAPM-EU-QR-9501). All growth rates refer to growth in ex-factory sales revenue.

Table 1 contains Dataquest's latest estimate of equipment production in 1995, and gives the forecast for the period 1995 to 2000. Total equipment production is forecast to grow with a CAGR of 8.9 percent for the period 1995 to 2000, this is a higher growth rate than the 6.2 percent for 1994 to 1999 in the spring 1995 forecast. In addition to the four high-volume product areas, the category "Other Equipment" includes both industrial electronics equipment, and civil and military aerospace equipment. Figure 1 illustrates the growth in equipment production for the four high-volume product areas. The strongest growth over the forecast period is for data processing equipment, with a forecast CAGR of 12.6 percent; which is higher than the spring 1995 forecast of 7.2 percent for 1994 to 1999. Significant growth of 11.7 percent is also forecast for the transportation (automotive) sector, although this is slightly lower than the spring 1995 forecast of 12.0 percent for 1994 to 1999. The communications

Dataquest

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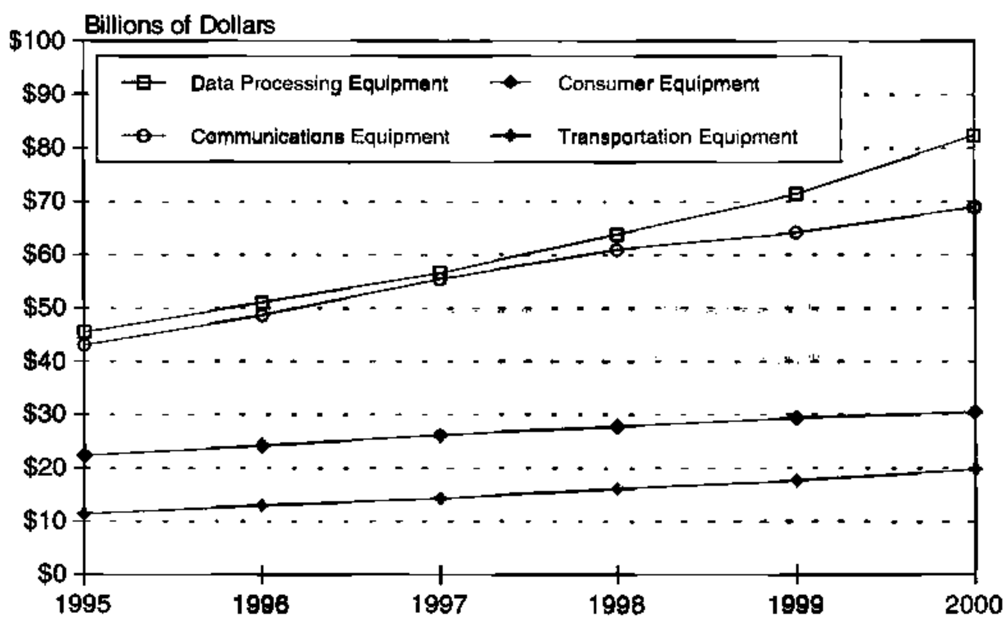
sector has a forecast CAGR of 9.9 percent, compared with 6.9 percent for 1994 to 1999 in the spring 1995 forecast. Finally, the consumer equipment sector has a forecast CAGR of 6.4 percent for 1995 to 2000, higher than the spring 1995 forecast of 5.7 percent for 1994 to 1999.

Table 1
European Electronic Equipment Production by Industry Sector—History and Forecast (Factory Revenue in Billions of Dollars)

	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Total Equipment Production	171.6	187.8	205.3	223.8	240.5	262.5	8.9%
Data Processing Equipment	45.5	51.1	56.6	63.9	71.4	82.4	12.6%
Communications Equipment	43.1	48.7	55.5	61.0	64.2	69.0	9.9%
Consumer Equipment	22.4	24.2	26.2	27.8	29.4	30.5	6.4%
Transportation Equipment	11.4	13.0	14.3	16.1	17.7	19.8	11.7%
Other Equipment	49.2	50.8	52.7	55.0	57.8	60.8	4.3%

Source: Dataquest (May 1996 Estimates)

Figure 1
European Electronic Equipment Production by Industry Sector History and Forecast (Factory Revenue in Billions of Dollars)



Source: Dataquest (May 1996 Estimates)

Data Processing Equipment

Data processing equipment is estimated to account for 26.5 percent of the total equipment manufactured in 1995, and the sector exhibits the highest forecast growth rate for the period 1995 to 2000. The growth in production of data processing equipment is being driven for the most part by the personal computer, together with the knock-on effect on PC-related equipment. The recent trend towards selling PCs into the home market, and the increasing demands of corporate customers, requires products to be manufactured to order and available for delivery almost immediately. Because PC buyers expect to obtain a specific model quickly, most equipment (including rigid disk drives and monitors) is manufactured in Europe. PCs alone account for 45 percent of the data processing sector, and local production has influenced a significant increase in factory revenue for both rigid disk drives and PC monitors. Monitors in particular have been the subject of numerous announcements during the past 12 months, as companies reveal plans to manufacture in Europe.

The increasing power of PCs has meant that midrange computer revenue is being eroded by PC server equipment and low-end workstations are being squeezed by high-end PC configurations. Another area of data processing equipment showing very strong growth is smart cards and chip cards, with a forecast CAGR of slightly more than 35 percent from 1995 to 2000.

Communications Equipment

Communications equipment is estimated to account for 25.1 percent of the total equipment manufactured in 1995, and has a forecast CAGR of almost 10 percent for the period 1995 to 2000. Slightly more than 35 percent of the revenue from communications equipment is derived from public telecoms equipment, predominantly central office switch systems and line card production. However, this is a mature market in Europe, and export-led growth is required just to maintain factory revenues. The strong growth in the telecoms equipment sector is generated by the production of mobile radio communication equipment, which provides approximately 30 percent of revenue, and is forecast to grow with a CAGR of more than 20 percent from 1995 to 2000.

This growth in mobile communications equipment is driven by strong European demand for cellular telephone products, which increases production of both handsets and the associated infrastructure equipment. As more countries adopt the European GSM digital cellular standard, infrastructure production should increase, along with export opportunities for handsets. In addition to mobile communication products, other equipment with strong forecast growth includes ISDN adapters and network interface cards.

Consumer Equipment

Consumer equipment is estimated to account for 13.0 percent of the total equipment manufactured in 1995, and has a forecast growth rate of 6.4 percent for the period 1995 to 2000. In 1995, 57 percent of consumer equipment revenue was generated from appliances, including microwave ovens and washer dryers. Although air conditioners and dishwashers are forecast to enjoy factory revenue growth of over 8 percent, the substrate as a whole is forecast to have revenue growth of just 2.7 percent. This means that the appliances subsector is forecast to fall to 48 percent of total consumer revenue by 2000.

However, the major forecast growth within the consumer sector is provided by the manufacture of video equipment. In 1995, 29 percent of the consumer sector factory sales revenue was derived from the video equipment subsector; with a forecast CAGR from 1995 to 2000 of 12.3 percent, this share should increase to 38 percent, helped by forecast growth of more than 15 percent in camcorder revenue, and forecast growth in set-top boxes (STB) of more than 27 percent. The expected 32 percent fall in analog STBs is more than offset by a predicted increase in digital revenue of more than 60 percent. It is this strong forecast growth, together with a forecast of a steady 7 percent increase from color television production which underpins the video subsector.

Transportation Equipment

Transportation equipment is estimated to account for 6.6 percent of the total equipment manufactured in 1995, and has the second-highest forecast growth rate, of 11.7 percent, for the period 1995 to 2000. Transportation equipment is effectively automotive equipment, and almost 70 percent of revenue is derived from powertrain systems and safety and convenience systems. By 2000 the safety and convenience subsector, which includes airbags, antilock braking and security systems, is expected to be the largest subsector in factory revenue terms; with forecast growth of 12.4 percent from 1995 to 2000. However, the highest forecast growth is for driver information systems, with predicted factory revenue growth of almost 18 percent during 1995 to 2000. In-car entertainment is forecast to grow by slightly more than 15 percent over the forecast period, and body and vehicle control is forecast to grow by more than 11 percent from 1995 to 2000.

Industry News

Acer To Assembly PCs in France

Since revealing that it would set up a PC assembly operation in Finland (to supply the Russian market) in the final months of 1995, Acer has now announced a similar facility in France. The site is near Paris, and will assemble PCs destined for markets in the south of Europe. The company is investing about $15 million, and expects to be producing about 120,000 units a year by 1997.

Acer has stated quite clearly that it will assemble close to regional markets, and use swift fulfillment and logistics as a competitive weapon. This announcement puts another key piece of the assembly network into the jigsaw, in a bid to help Acer to increase its sales volume in Europe.

Avex Acquires Ericsson Backplane Manufacturing

Avex, the US-headquartered contract electronics manufacturer (CEM), is acquiring the part of Ericsson responsible for manufacturing backplanes, in a deal worth about $30 million. The backplane facility is in Katrineholm, Sweden, and will become Avex's second European site, alongside East Kilbride in Scotland. Avex intends to install surface mount assembly equipment at the plant in order to offer full PCB assembly capabilities.

This deal is similar to many others reported in this document. Ericsson has divested part of its business which is not regarded as core, while striking a preferred-supplier relationship with the new owner. The new owner (in this case Avex) is focused on manufacturing, and intends to use the acquired facility to offer additional manufacturing services, as well as broadening its customer base.

Daewoo Plans Further Investment

The electronics arm of Daewoo, the Korean conglomerate, has announced a series of investments across Europe. It will invest an additional $22.7 million at its VCR manufacturing plant in Antrim, Northern Ireland. The VCR factory was set up in 1988 and received additional investment in 1995 for the production of tuner assemblies.

The company also plans to build a second cathode ray tube (CRT) manufacturing site at Mont-Saint-Martin in France. The existing facility has been in production only since November 1995, but demand from TV factories in France, Germany and Spain has helped to justify the additional $150 million investment. Daewoo is also expected to announce that it is setting up a plant to manufacture fridges in Europe, and is close to revealing the site of its European semiconductor fab.

Daewoo continues its aggressive drive to gain market share in Europe, and has found success in white goods (notably microwave ovens and washing machines), as well as televisions and VCRs. Growing awareness of the Daewoo brand, (together with product pricing that barely allows a profit margin), is driving demand for both equipment and local production.

D2D Up for Sale

As ICL revealed that it had made a $47 million operating loss in 1995, it also announced that it is transferring its PC and server business to its parent company Fujitsu (see page 6) and is seeking a buyer for a majority stake in its contract electronics manufacturing (CEM) subsidiary, Design to Distribution (D2D). ICL stated that it was looking to sell a majority stake in D2D within the next 18 months.

With 1995 revenue of $530 million, D2D made a small loss, believed to be less than 1.5 percent of sales. It currently uses manufacturing sites exclusively in the United Kingdom, and its customers include Sun, Pace and Dell. Requests from its customers for global coverage (in Asia/Pacific and the United States) is cited as one of the reasons for the disposal. Another factor is ICL's desire to move away from hardware production and marketing, and instead concentrate on software, services and systems integration.

This decision, though difficult to make, should be positive for both D2D and ICL, which has moved from being a vertically-integrated computer company, to a provider of business solutions. Retaining a stake in D2D will help ICL maintain production of mainframe, and other specialist products that require complex manufacturing processes. It also allows ICL to focus investment and management time on its core business.

By becoming part of a global CEM business, D2D should benefit from increased investment, and a management team that fully understands the demands of the CEM marketplace. D2D is a prime target for second-tier contract manufacturers with plants in Asia/Pacific and the United States, looking for European facilities. This may find favor with existing customers, who would prefer continued competition in the European and global markets.

IBM PC Production in Russia to Stop

Having assembled almost 500,000 PCs since 1993 (at its plant in Kvant near Moscow), IBM has had to cease production for tax reasons. The facility, which enjoyed investment of $2 million, relied on importing components which were exempt from duty; as well as an offer by the Russian government to purchase up to 100,000 units.

However, the large order from the government has failed to materialize. And for the last couple of years IBM has been squeezed by reduced tax exemptions on the components it imports, as well as various Russian organizations obtaining import duty exemptions for importing assembled PCs.

With tariffs adding as much as 21.5 percent to the selling price, it is not surprising that IBM has become fed up with organizations as diverse as the Russian National Sports Association and war veterans groups importing and selling PCs for less than locally manufactured models.

IBM is evaluating its options about how best to supply the Russian market, and may well import finished units from its plants in Germany or Scotland. It could either set up a joint venture with one of the special interest groups that enjoy the current tax benefits, or import via a country such as Finland using an established trading company (in a similar way to Acer).

ICL's PC Business Goes to Fujitsu

Timed to coincide with the announcement about D2D (see page 5) and the 1995 financial results, ICL also revealed plans to transfer ownership of its PC business to parent company Fujitsu. The volume-products division, which had sales of just over $1 billion in 1995, has responsibility for the design, manufacture and marketing of ICL's PC and server products. The current operation will become part of a new company, 80 percent owned by Fujitsu Global Personal Systems, with ICL retaining a 20 percent stake.

Fujitsu shipped 1 million units in the Japanese market in 1995, a growth of 71 percent over 1994. In Europe, ICL manufactured and shipped 500,000 units in 1995 (helped by its acquisition of Aquarius Robotron in June 1995) representing unit growth of 53 percent. The goal of the new company is to become a top-five PC supplier worldwide, and to be among the top three PC suppliers in Europe.

The new company will continue to use several locations for the manufacture of its products; PCs for the consumer market in Germany (at the former Aquarius Robotron factory), PCs for the corporate market in Finland, and both Intel and SPARC-based servers under contract at D2D.

ICL has given several reasons for passing its PC business to Fujitsu, the most credible is ICL's repositioning as a services and systems integration company. However, this decision owes almost as much to Fujitsu's desire to become a worldwide PC manufacturer. By acquiring instant market share in Europe, Fujitsu hopes to repeat its success in Japan on a worldwide basis.

Success in the PC market is as much to do with brand awareness and an understanding of the distribution channel, as low manufacturing costs and economies of scale. However, the combined volume does offer the opportunity to rationalize component purchasing, and to procure materials from Fujitsu's component and peripheral divisions.

All three European manufacturing locations will require some local procurement, and with several distinct product ranges, true economies of scale may be hard to come by; especially as the new company proposes no immediate consolidation of manufacturing locations. In addition, ICL is relying on the "Japanese" Fujitsu brand-name to help leverage it into the growing consumer market. Unfortunately, while Fujitsu may be a trusted brand for IT managers, it is not yet a household name. Dataquest will watch the progress of this new PC company with interest.

Matsushita's Television Production in the Czech Republic

Matsushita has announced that it is setting up a production facility to manufacture color televisions at Pilsen, in the Czech Republic. Initial investment in the plant is around $45 million, and the output is destined for Eastern Europe, Russia and the CIS. Production is due to start in April 1997, with an initial capacity of 300,000 units a year, forecast to rise to a capacity of 1.1 million units by 2000.

Matsushita is likely to benefit from the strong demand for affordably priced televisions in Central and Eastern Europe, where the opportunity to receive a wider choice of program material is driving demand. In addition to numerous commercial and independent television stations springing up across Russia, the CIS and Eastern Europe, there is the added potential of satellite television broadcasts to the region. The Czech Republic offers a relatively stable economic and political environment, which together with low labor costs should ensure that the facility will manufacture a significant number of television units.

Motorola Consolidates Cellular Headquarters

Motorola is investing $175 million as part of a plan to consolidate scattered sites around Swindon, England, into a single headquarters for its cellular infrastructure division. The site will house various functions associated with the business, including engineering, design and manufacturing. The first phase should be completed by October 1997, with the completion of the project in 1998.

As well as consolidation, this investment is destined to fuel expansion of the infrastructure business, in anticipation of increased growth in digital cellular networks in Europe and elsewhere.

Nokia Is Pulling Out of Television Production

After announcing job cuts and further restructuring in January 1996, Nokia has now announced that it will withdraw from television production in Germany. The television part of the consumer electronics division has been affected by declining television sales in Western Europe (especially in France and Germany); and although it has been seeking a buyer or joint-venture partner for the business, it has been unsuccessful so far.

A major obstacle to any prospective buyer of the television business were the plants in Germany which manufacture receivers at Bochum and television components at Ziemetshausen. The sites, which manufacture televisions with relatively basic functionality and smaller screen sizes, will be closed. However, Nokia's television manufacturing facility in Turku, Finland is likely to remain; and the company is in discussions with a number of possible owners. The plant in Finland will be used to maintain production of Nokia and other (including Luxor) branded sets. These televisions tend be feature-rich, and include PALplus, widescreen, and surround sound models.

The rest of the consumer electronics division, which manufactures products such as computer monitors, set top boxes (STBs), audio products and cellular phone chargers is unaffected by this announcement.

Nokia's consumer electronics division has been significantly restructured in recent years, and posted a small operating profit of $4.2 million in 1994. However, with fierce competition in the television business, it is only truly global players such as Philips and Matsushita that can afford to invest in new manufacturing capacity.

In addition to not achieving profitable growth from its television division, Nokia has been restructuring in recent years to focus more closely on its core communications business. Increased price competition for cellular handsets in Europe means that Nokia has to invest heavily in order to maintain sales revenue. Divesting its tyres and television divisions, allows the company to dedicate resources to competitive markets, where it has a commanding position.

Philips Sells Business Communications Equipment to Telecom Sciences ...

A new company, Telecom Sciences Corporation (TSc), has been formed to take over Philips' business communications division, based in Airdrie, Scotland. The company designs and manufactures telephones and private business exchanges for small and medium-size companies. TSc has raised $30 million to finance the purchase of a company with annual sales of about $75 million.

Philips sold parts of its communications infrastructure division to AT&T during 1995, and this further announcement underlines Philips commitment to concentrating on its mobile personal communications products (see next article).

... And Invests in French GSM Facility

Philips has announced that it is setting up a consumer communications division, based in Le Mans, France, which will focus on mobile and consumer telephony products. About 80 percent of the current output from the site is cordless telephones; and other products will include cellular telephones, answering machines, and video telephones.

The company plans to invest about $155 million in the facility, and part of this will be used to fund GSM handset production. Philips is ending its agreement with Nokia which supplied GSM cellular phones, and instead will develop and manufacture GSM handsets at Le Mans.

Siemens-Nixdorf Sells Its High Performance Printers Business

Siemens-Nixdorf has announced that it is selling its high-performance printer division to Océ van der Grinten, the Netherlands-based office automation company, for $536 million. The printers operate at very high speed using prisms to split a single laser beam into multiple beams in order to maximize throughput. They tend to be used with mainframe applications which generate large amounts of repetitive printing, such as payroll and banking systems.

The printer division, headquartered in Boca Raton, Florida and employing 1,500 people in Munich, will become an independent business unit within the Océ group. The rationale behind the disposal is that Siemens-Nixdorf does not consider the printer division to be a core part of its business, and that it would fit better within Océ.

Sony Produces Consumer Electronics in Hungary

Joining companies such as IBM, Philips and Samsung, which already have assembly plants in the country, Sony plans to build a manufacturing facility in Hungary. The factory, sited in Goedoelloe near Budapest, initially will produce CD players and stereo systems, with plans to manufacture televisions and VCRs at a later date. The site should be complete by the end of 1996, with production commencing in 1997.

Sony's aim in setting up the plant was to get products to market faster, in both East and West Europe. The company's investment, of $20 million, should have been more than offset by the very generous terms offered by the Hungarian government to attract manufacturing companies to invest there. Benefits range from exemption of duty on imported components, and significant tax reductions on the initial investment, to 10 years of reductions in tax on profits.

US Robotics' Customer Support May Lead to Production

US Robotics, the US-based manufacturer of modems and networking equipment, is setting up a European technical support center in Dublin, Ireland. Investment of $2.8 million will provide a facility staffed with technicians and consultants to support US Robotics' high-end network systems.

Although the initial investment is in a customer support facility, Dataquest believes it to be a precursor for further European investment by the US modem giant. US Robotics has a significant market share in Europe, particularly in the low end of the market, and it has been threatening to manufacture equipment locally for some time now. If the initial venture in Ireland proves successful, then it is likely that the company will announce a production facility nearby.

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Perspectives

Electronic Equipment Production Monitor

Market Analysis

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1	Compaq	1,350	2,000	2,000	1,900	40.7%	2,250	18.4%
2	IBM	1,500	1,750	1,750	1,600	6.7%	1,900	18.8%
3	Apple	750	975	900	900	20.0%	900	0.0%
4	Hewlett-Packard	500	800	800	750	50.0%	950	26.7%
5	SNI	400	760	760	700	75.0%	875	25.0%
6	Vobis	550	650	650	650	18.2%	725	11.5%
7	Olivetti	660	600	600	600	-9.1%	800	33.3%
8	Dell	550	650	700	600	9.1%	700	16.7%
9	Escom	425	680	700	550	29.4%	700	27.3%
10	AST	200	440	400	450	125.0%	550	22.2%
11	Digital Equipment	350	450	400	410	17.1%	475	15.9%
12	Packard-Bell	250	375	350	400	60.0%	500	25.0%
13	ICL	280	400	350	345	23.2%	410	18.8%
14	ZDS	320	350	350	330	3.1%	400	21.2%
15	Tulip	179	200	200	235	31.7%	320	36.2%
	Eastern Europe	973	1,200	1,200	1,100	13.1%	1,550	40.9%
	Other	3,764	4,200	3,870	4,355	15.7%	4,250	-2.4%
	Total	13,000	16,480	15,980	15,875	22.1%	18,255	15.0%
	Top 15 Companies	8,264	11,080	10,910	10,420	26.1%	12,455	19.5%

Source: Dataquest (March 1996 Estimates)

Table 2
Preliminary 1995 Fourth-Quarter European PC Production by Microprocessor for Top 15 Vendors
(Thousands of Units)

Manufacturer	<=386	486SX	486DX	486DX2	486DX4	Pentium	Pentium Pro	68XXX	Power PC	Total
Apple	–	–	–	–	–	–	–	–	236.9	236.9
AST	–	–	–	29.4	23.1	78.7	–	–	–	131.2
Compaq	–	3.1	–	73.5	100.0	409.4	–	–	–	586.0
Digital Equipment	–	–	–	2.4	12.8	86.3	–	–	–	101.5
Dell	–	–	–	3.0	8.5	98.7	–	–	–	110.2
Escom	–	–	1.0	3.5	9.8	113.8	–	–	–	128.1
Hewlett-Packard	–	–	–	39.6	19.6	186.5	–	–	–	245.7
IBM	–	6.0	0.6	93.7	62.9	316.8	–	–	–	480.0
ICL	–	1.4	–	16.7	5.5	63.6	–	–	–	87.2
Olivetti	–	8.3	0.8	34.7	31.1	87.1	–	–	–	162.0
Packard-Bell	–	2.2	–	23.5	19.0	130.3	–	–	–	175.0
SNI	–	10.7	0.8	64.3	8.6	124.1	–	–	–	208.5
Tulip	–	0.3	–	11.8	7.9	38.7	–	–	–	58.7
Vobis	–	0.1	–	13.5	27.9	148.0	–	–	–	189.5
ZDS	–	–	0.1	38.6	8.0	45.8	–	–	–	92.5
Total Units	0.0	32.1	3.3	448.2	344.7	1,927.8	0.0	0.0	236.9	2,993.0
Percentage	0.0%	1.1%	0.1%	15.0%	11.5%	64.4%	0.0%	0.0%	7.9%	

Source: Dataquest (March 1996 Estimates)

Table 3
Total 1995 and 1996 European PC Production Forecast by Quarter for Top 15 Manufacturers
(Thousands of Units)

Manufacturer	1995	Q1/95	Q2/95	Q3/95	Q4/95	1996	Q1/96	Q2/96	Q3/96	Q4/96
Apple	950	254	195	180	237	1,100	240	300	240	320
AST	398	123	97	78	131	500	140	70	90	150
Compaq	2,000	460	440	460	586	2,400	550	500	550	800
Digital Equipment	390	99	90	100	102	475	110	100	115	150
Dell	550	150	143	160	110	700	160	145	180	215
Escom	600	122	136	173	128	750	188	150	113	300
Hewlett-Packard	775	168	168	184	246	950	229	203	213	306
IBM	1,600	385	333	403	480	1,900	450	400	500	550
ICL	342	86	86	68	87	410	103	103	82	123
Olivetti	598	144	144	132	162	750	175	175	150	200
Packard-Bell	400	92	84	75	175	500	121	107	112	161
SNI	620	124	155	155	209	830	208	166	208	249
Tulip	234	47	59	82	59	320	64	80	112	64
Vobis	625	156	156	137	190	760	160	180	155	265
ZDS	328	84	81	73	93	400	100	100	80	120
Top 15 Companies	10,410	2,493	2,365	2,460	2,993	12,745	2,996	2,779	2,899	3,973

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Table 4
European PC Production by Microprocessor
(Thousands of Units)

Microprocessor	Units 1994	Percent 1994	Units 1995	Percent 1995	Units 1996	Percent 1996
386 or less	392	3.0%	0	0.0%	0	0.0%
80486SX	4,996	38.4%	853	5.4%	0	0.0%
80486DX	2,119	16.3%	135	0.8%	0	0.0%
80486DX2	3,774	29.0%	5,119	32.2%	1,340	7.3%
80486DX4	208	1.6%	1,781	11.2%	1,250	6.8%
Pentium Class	704	5.4%	7,079	44.6%	14,230	78.0%
Pentium Pro	0	0.0%	0	0.0%	500	2.7%
68XXX	559	4.3%	209	1.3%	0	0.0%
Power PC	191	1.5%	667	4.2%	910	5.0%
Other	57	0.4%	32	0.2%	25	0.1%
Total	13,000	100.0%	15,875	100.0%	18,255	100.0%

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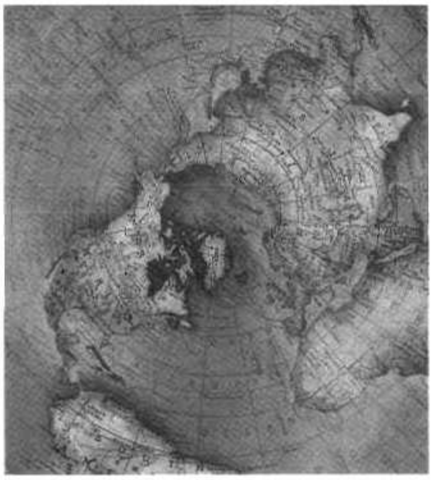

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European Electronic Equipment Production Forecast

Market Statistics
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Table of Contents

List of Tables

European Electronic Equipment Production Forecast

Introduction

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

This document contains tables detailing the spring 1996 electronics equipment production forecast. European production is estimated for the years 1990 to 2000. Production tables contain both historical data and forecasts. In most tables, historical data begin in 1990 and end in 1995, while forecast data provide estimates for 1996 through 2000. Tables detail the type of production data by application market and unit of measure.

Changes in Definitions

Ex-factory revenue is used throughout this document instead of end-user revenue. Ex-factory revenue measures the value of equipment as they are shipped out of a factory. End-user revenue takes into account retailing costs such as distribution costs, wholesale overhead costs, storage costs, and other additional costs that are not associated with the production side of equipment costing. Ex-factory revenue therefore provides a meaningful estimation of equipment I/O ratios as a more accurate indication of semiconductor content value of equipment built in Europe.

Equipment definition and segmentation has also been changed in the Electronic Data Processing, Communications, and Transportation segments. The details of these changes are outlined in the Definitions section of this document.

Segmentation

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

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

For forecasting purposes, Dataquest segments the electronics industry into six broad semiconductor application markets, desegregated into narrower electronic system groups, as follows:

- Data Processing
  - Computers
  - Data Storage
  - Input/Output Devices
  - Dedicated Systems

- Communications
  - Premise Telecom
  - Public Telecom
  - Mobile/Radio Communications Equipment
  - Other Communications
  - Broadcast and Studio Equipment
- Industrial
  - Security and Energy Management Systems
  - Manufacturing and Instrumentation Systems
  - Robot Systems
  - Medical Equipment
  - Other Industrial Equipment
- Consumer
  - Audio
  - Video
  - Personal Electronics
  - Appliances
- Military and Civil Aerospace
- Transportation

For detailed definitions of the above, please see pages 3 to 6.

Forecast Assumptions and Changes to Previously Published Forecasts

In line with the 1995 published research, this year we have separated the forecast assumptions and changes to market forecast from this document. The Semiconductor Application Markets Europe group will publish in June 1996 a *Market Trends* report which will be an explanatory document for these estimates. This *Market Trends* document will also cover in more detail the economic assumptions, market conditions and production trends in each application segment.

A more detailed and comprehensive semiconductor forecast by application will be provided twice a year in June 1996 and November 1996. In each of these forecast perspectives more semiconductor detail will be provided including an application forecast by product (MOS Memory, MOS Micro, Discretes)

Exchange Rates

Dataquest uses an average annual exchange rate for each European country for converting revenue to US dollar values. When forecasting electronic equipment production, it is important to maintain consistency and continuity, thus we maintain exchange rates at constant 1995 calendar year. This prevents any inconsistencies in the conversion of growth projections and currency fluctuations. The 1995 exchange rate estimate uses actual average monthly exchange rates from January through December (this data is gathered and supplied by the Dun and Bradstreet Corporation). The annual rate is estimated as the arithmetic mean of the 12 monthly rates. Exchange rates are provided in Table 1 for your reference. Exchange rates for historical years are available on request.

Table 1
1995 Exchange Rates

	Foreign Currency per US Dollar	US Dollar per Foreign Currency
Austria (Schilling)	10.06	0.099
Belgium (Franc)	29.42	0.034
Denmark (Krone)	5.59	0.179
Europe (ECU)	0.77	1.293
Finland (Markka)	4.37	0.229
France (Franc)	4.97	0.201
Germany (Mark)	1.43	0.699
Greece (Drachma)	231.34	0.004
Ireland (Punt)	0.62	1.607
Italy (Lira)	1,628.21	0.001
Netherlands (Gulden)	1.60	0.624
Portugal (Escudo)	149.77	0.007
Spain (Peseta)	124.40	0.008
Sweden (Krona)	7.14	0.140
Switzerland (Franc)	1.18	0.848
United Kingdom (Pound)	0.63	1.580

Source: Dun & Bradstreet, Dataquest (May 1996)

Definitions

This section lists the definitions used by Dataquest to present the data in this document. Complete definitions for all terms associated with Dataquest's segmentation of the high-technology marketplace can be found in the *Dataquest Semiconductor Market Definitions* book filed under the tab **Market Statistics** in the Semiconductor Application Markets, Europe binder. ***Bold italic*** text is used to highlight the differences in this year's segmentation from last year's.

Electronic systems groups comprise the following specific electronic equipment types:

Electronic Data Processing

- Computer Systems: Includes Supercomputers, mainframe computers, midrange computers, workstations, personal computers (including personal digital assistants or PDAs).
- **Data Storage Devices**: Includes fixed/rigid disk drives, flexible/removable disk drives, optical disk drives, tape drives (streamers), and solid state storage devices (including PCMCIA memory cards).
- **Input/Output Devices** (includes previous categories Terminals and Input/Output devices): Includes alphanumeric terminals, graphics terminals, monitors, printers, media-to-media data conversion, magnetic ink character recognition, optical scanning equipment, plotters, mice, keyboards, digitizers, and other input/output devices.
- **Dedicated Systems**: Includes electronic copiers, electronic calculators and personal organizers, smart cards (IC cards), dictating/transcribing equipment, electronic typewriters and dedicated word processors, banking systems and funds transfer systems and terminals, point-of-sales terminals and electronic cash registers, and mailing/letter-handling/addressing equipment

Communications

- **Premise Telecoms Equipment** (Sometimes referred to as "customer premise equipment") Includes:
  - Image and text communications such as facsimile and facsimile cards, and video teleconferencing
  - Data communications equipment: This year this section has been redefined to reflect the segmentation which appears in the industry. The equipment is segmented by speed categories rather than function. Included are modems and modem cards, 64Kb access equipment, 2Mb and below access equipment, backbone equipment, ISDN access equipment, networks interface cards (LAN cards), ***LAN hubs and switches***, and LAN interconnect
  - Premise switching equipment such as PBX telephone equipment, and key telephone systems, interactive voice response systems, call accounting and automatic call distributors (ACDs).
  - Desktop terminal equipment such as telephone sets/pay telephones and cordless telephones, and teleprinters.
- **Public Telecom Equipment:** Includes transmission equipment such as multiplexers, carrier systems, microwave radio, laser and infrared transmission equipment, and satellite communications equipment and central office switching equipment.
- **Mobile/Radio Communications Equipment**: Includes cellular telephones (including microcellular telephones) (for example, DCS-1800, GSM, PHP), mobile radios and mobile radio base station equipment; pagers and accompanying base station equipment; portable radio receivers and transmitters; radio checkout equipment; and other RF communications equipment.
- **Other Communications:** Includes airborne, marine and ground systems sold as complete packages that include transceivers, power amplifiers, antennae, repeaters, transmitters, checkout (testing), monitoring, evaluation and other equipment including terminal and broadcast equipment.
- **Broadcast and Studio Equipment**: Includes audio equipment, video equipment, transmitters and RF power amplifiers, studio transmitter links, cable TV equipment, closed circuit TV equipment, and other equipment such as studio and theatre equipment.

Industrial

- **Energy/Security Management Systems:** Includes alarm systems, such as intrusion detection and fire detection systems and energy management systems.
- **Manufacturing and Instrumentation Systems**: Includes semiconductor production equipment, controllers and actuators, sensor systems, management systems, semiconductor-dedicated automatic test equipment (ATE), all other ATE, oscilloscopes and wave-form analysers, nuclear instruments, and other test and measuring equipment.
- **Robots:** Includes automated material handling, robot systems, robot-aided laser equipment, and robotic systems.
- **Medical Equipment**: Includes X-ray equipment, ultrasonic and scanning equipment, blood and body fluid analysers, patient monitoring equipment, and other diagnostic and therapeutic equipment.
- **Other Industrial Equipment**: Includes power supplies, traffic control equipment, industrial and scientific research equipment, other industrial electronic equipment such as vending machines, laser systems, and teaching machines and aids.

Consumer

- **Audio Equipment:** Includes compact disk players, radio combinations, stereo hi-fi components, amplifiers, preamplifiers, tuners, cassette-decks, graphic equalizers, turntables, speakers, equipment used in studio broadcast, home environments (equipment that interpret frequencies corresponding to audible sound waves) and musical instruments.
- **Video Equipment:** Includes video cameras and camcorders, video cassette recorders and video tape recorders, color, monochrome and LCD televisions and ***digital set-top-box*** and ***analog set-top-box.***
- **Personal Electronics:** Includes electronic game systems and cartridges, electronic toys, cameras, watches and clocks.
- **Appliances**: Includes air conditioners, microwave ovens, washers and dryers, refrigerators and freezers, dishwashers, and ranges and ovens.

Military and Civil Aerospace

- Military and Civil Aerospace: Includes military electronics such as radar and sonar, missiles and weapons, space-related electronics, communications and navigation equipment, electronic warfare, aircraft systems, military computer systems, simulation systems, and military electronics not elsewhere classified; and civil aerospace electronics such as radar, space-related electronics, communications and navigation equipment, flight systems and simulation systems.

Transportation (Automotive)

Transportation electronics includes:

- **In-car entertainment** systems such as AM/FM radio, cassette, compact disk players, and radio cassette combination systems.
- **Body controls** such as multiplex systems, lighting controls including automatic headlight systems, timers, reminders, and sequential signal controls, and other body controls including aerodynamic aid control and power window/roof controls. Vehicle controls such as steering control, 2WD/4WD control, suspension control, active suspension, collision avoidance systems, collision warning systems, and cruise control.
- **Driver information** systems such as dashboard/instrument clusters, analog or digital clusters, electronic analog/digital clocks and compasses, electronic thermometers, head-up displays, navigation and location systems, signal and warning lights, and trip computer.
- **Powertrain systems** such as engine management systems, ignition control, fuel injection systems, and transmission control.
- **Safety and convenience** systems such as climate control systems, airbag control systems, automatic/interval wiper, keyless entry and door locks, security systems, memory seats, memory steering, memory mirrors, automatic seat belt systems, and antilock braking and traction control systems.

Regional Definitions

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

Line Item Definitions

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

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

Data Sources

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

- Dataquest's estimates of systems manufacturers end-user revenue
- Trade association data
- Various European Union and government agency statistics
- Japanese Government and trade association (MITI, MOF, and EIAJ) intelligence
- Estimates presented by knowledgeable and reliable industry spokespersons
- Published product literature and prices
- Other Dataquest research groups (including Computer Systems, Telecommunications and Document Management).

Unlike in Japan and the United States where government bodies supply regular production statistics, European-wide statistic programs are in their infancy, we believe that the estimates presented here are the most reliable and meaningful generally as they apply to the component manufacturers.

Forecast Methodology

Dataquest uses a variety of forecasting techniques (both qualitative and quantitative) that vary by technology area. An overview can be found in *Dataquest Research and Forecast Methodology Guide.*

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

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

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

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

European Overview

Table 2
Segment Overview, European Electronic Equipment Production (Millions of Dollars) History (Ex-Factory Revenue)

	1990	1991	1992	1993	1994	1995	CAGR 1990-1995
Total Equipment	**$139,272**	**$142,646**	**$143,606**	**$149,722**	**$158,558**	**$171,450**	**4.2%**
Data Processing	$37,469	$36,859	$34,899	$38,002	$41,482	$45,481	4.0%
Computers	$30,430	$28,719	$26,658	$28,165	$30,901	$34,694	2.7%
Data Storage	$908	$1,298	$1,418	$1,673	$2,040	$1,830	15.1%
Input/Ouput Devices	$3,879	$4,385	$4,185	$4,877	$4,565	$4,916	4.9%
Dedicated Systems	$2,252	$2,458	$2,639	$3,287	$3,976	$4,041	12.4%
Communications	$28,698	$31,087	$32,899	$35,117	$37,983	$43,065	8.5%
Premise Telecom Equipment	$4,943	$5,317	$5,613	$5,798	$6,494	$7,270	8.0%
Public Telecom Equipment	$14,305	$15,375	$15,186	$15,197	$15,173	$15,483	1.6%
Mobile/Radio Communications Equipment	$2,566	$2,996	$4,793	$8,049	$10,144	$13,609	39.6%
Other Communications	$5,949	$6,510	$6,422	$5,103	$5,337	$5,700	-0.9%
Broadcast and Studio	$935	$890	$885	$970	$834	$1,003	1.4%
Industrial	$26,078	$26,196	$27,491	$26,295	$27,217	$28,634	1.9%
Security/Energy Management Systems	$2,566	$2,594	$2,668	$2,600	$2,730	$2,948	2.8%
Manufacturing and Instrumentation Systems	$15,698	$15,716	$16,448	$15,553	$15,964	$16,700	1.2%
Robot Systems	$689	$733	$790	$819	$871	$930	6.2%
Medical Equipment	$3,700	$3,692	$4,025	$3,941	$4,169	$4,450	3.8%
Other Industrial	$3,425	$3,461	$3,560	$3,382	$3,483	$3,606	1.0%
Consumer	$19,789	$20,516	$19,453	$20,300	$21,175	$22,370	2.5%
Audio	$1,543	$1,463	$1,352	$1,299	$1,517	$1,659	1.5%
Video	$5,089	$5,754	$5,112	$5,349	$5,786	$6,467	4.9%
Personal Electronics	$1,148	$1,109	$1,161	$1,207	$1,380	$1,462	5.0%
Appliances	$12,010	$12,190	$11,829	$12,445	$12,492	$12,782	1.3%
Other Consumer Equipment	-	-	-	-	-	-	
Military and Civil Aerospace	$20,976	$21,171	$21,055	$21,447	$20,851	$20,613	-0.3%
Transportation	$6,262	$6,817	$7,808	$8,562	$9,958	$11,398	12.7%

Source: Dataquest (May 1996 Estimates)

Table 3
Segment Overview, European Electronic Equipment Production (Millions of Dollars) Forecast (Ex-Factory Revenue)

	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Total Equipment	**$171,450**	**$187,647**	**$205,116**	**$223,729**	**$240,377**	**$262,424**	**8.9%**
Data Processing	$45,481	$51,089	$56,563	$63,899	$71,410	$82,401	12.6%
Computers	$34,694	$38,505	$42,418	$47,586	$53,408	$62,163	12.4%
Data Storage	$1,830	$2,526	$2,625	$2,894	$3,069	$3,533	14.1%
Input/Ouput Devices	$4,916	$5,886	$7,132	$8,513	$9,461	$10,532	16.5%
Dedicated Systems	$4,041	$4,172	$4,388	$4,906	$5,473	$6,174	8.8%
Communications	$43,065	$48,678	$55,466	$60,968	$64,201	$68,963	9.9%
Premise Telecom Equipment	$7,270	$7,891	$8,517	$9,255	$9,628	$10,080	6.8%
Public Telecom Equipment	$15,483	$15,117	$15,150	$15,302	$15,440	$15,188	-0.4%
Mobile/Radio Communications Equipment	$13,609	$18,802	$24,720	$28,641	$30,819	$34,879	20.7%
Other Communications	$5,700	$5,849	$6,002	$6,666	$7,182	$7,656	6.1%
Broadcast and Studio	$1,003	$1,020	$1,076	$1,104	$1,131	$1,159	2.9%
Industrial	$28,634	$30,307	$32,370	$34,789	$37,766	$41,008	7.4%
Security/Energy Management Systems	$2,948	$3,214	$3,535	$3,924	$4,395	$4,966	11.0%
Manufacturing and Instrumentation Systems	$16,700	$17,700	$18,900	$20,290	$22,009	$23,717	7.3%
Robot Systems	$930	$995	$1,085	$1,193	$1,324	$1,483	9.8%
Medical Equipment	$4,450	$4,648	$4,913	$5,207	$5,572	$6,018	6.2%
Other Industrial	$3,606	$3,750	$3,938	$4,174	$4,466	$4,823	6.0%
Consumer	$22,370	$24,169	$26,172	$27,826	$29,386	$30,474	6.4%
Audio	$1,659	$1,754	$1,937	$2,091	$2,225	$2,367	7.4%
Video	$6,467	$7,775	$9,105	$10,098	$11,076	$11,550	12.3%
Personal Electronics	$1,462	$1,551	$1,658	$1,752	$1,848	$1,948	5.9%
Appliances	$12,782	$13,089	$13,471	$13,884	$14,237	$14,608	2.7%
Other Consumer Equipment	-	-	-	-	-	-	
Military and Civil Aerospace	$20,613	$20,492	$20,335	$20,254	$20,019	$19,808	-0.8%
Transportation	$11,398	$13,029	$14,330	$16,117	$17,653	$19,830	11.7%

Source: Dataquest (May 1996 Estimates)

Electronic Data Processing

Table 4
Segment Detail, European Electronic Data Processing Equipment Production
(Millions of Dollars)
History (Ex-Factory Revenue)

	1990	1991	1992	1993	1994	1995	CAGR 1990-1995
Data Processing	**$37,469**	**$36,859**	**$34,899**	**$38,002**	**$41,482**	**$45,481**	**4.0%**
Computer Systems	$30,430	$28,719	$26,658	$28,165	$30,901	$34,694	2.7%
Supercomputers	-	-	-	-	-	-	
Mainframes	$10,535	$11,259	$8,305	$7,191	$6,684	$5,760	-11.4%
Midrange Computers	$9,237	$9,279	$6,685	$6,103	$6,002	$5,183	-10.9%
Superminicomputers	$6,416	$6,627	$4,739	$4,339	$4,316	$3,589	-11.0%
Minicomputers	$1,652	$1,595	$1,192	$1,090	$1,024	$1,011	-9.4%
Microcomputers	$1,168	$1,057	$754	$674	$662	$582	-13.0%
Workstations	$510	$993	$1,833	$1,755	$1,965	$3,101	43.5%
Personal Computers	$10,148	$7,188	$9,835	$13,116	$16,250	$20,651	15.3%
Data Storage	$908	$1,298	$1,418	$1,673	$2,040	$1,830	15.1%
Rigid Disk Drives	$793	$1,166	$1,265	$1,492	$1,770	$1,417	12.3%
Flexible/Removable Media	$9	-	-	-	-	-	-100.0%
Optical Disk Drives	$5	$6	$13	$25	$97	$221	112.4%
Tape Drives	$100	$126	$140	$156	$173	$192	13.8%
Input/Ouput Devices	$3,879	$4,385	$4,185	$4,877	$4,565	$4,916	4.9%
Displays	$1,359	$1,307	$935	$1,040	$991	$1,182	-2.7%
Serial Printers	$639	$1,176	$1,016	$1,270	$872	$865	6.3%
Line Printers	$534	$487	$391	$415	$337	$352	-8.0%
Page Printers	$536	$512	$579	$706	$750	$841	9.4%
Input Devices	$810	$901	$1,261	$1,442	$1,611	$1,671	15.6%
Other Output Devices	$2	$2	$3	$3	$4	$4	18.2%
Dedicated Systems	$2,252	$2,458	$2,639	$3,287	$3,976	$4,041	12.4%
Office Equipment	$1,996	$2,145	$2,248	$2,592	$3,093	$3,044	8.8%
Copiers and Duplicators	$1,739	$1,887	$1,983	$2,328	$2,861	$2,838	10.3%
Electronic Calculators	$67	$54	$53	$47	$41	$27	-16.8%
Dictating, Transcribing	$32	$36	$39	$36	$29	$23	-6.4%
Electronic Typewriters	$158	$168	$173	$181	$162	$156	-0.3%
Cash Registers	$152	$183	$195	$188	$162	$133	-2.7%
Smart Cards (IC Cards)	$104	$130	$196	$507	$722	$864	52.8%

Source = Dataquest (May 1996 Estimates)

Table 5
Segment Detail, European Electronic Data Processing Equipment Production (Millions of Dollars)
Forecast (Ex-Factory Revenue)

	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Data Processing	**$45,481**	**$51,089**	**$56,563**	**$63,899**	**$71,410**	**$82,401**	**12.6%**
Computer Systems	$34,694	$38,505	$42,418	$47,586	$53,408	$62,163	12.4%
Supercomputers	-	-	-	-	-	-	-
Mainframes	$5,760	$5,127	$4,374	$3,887	$3,507	$3,336	-10.3%
Midrange Computers	$5,183	$5,302	$5,298	$5,292	$5,261	$6,024	3.1%
Superminicomputers	$3,589	$3,597	$3,431	$3,258	$3,071	$3,194	-2.3%
Minicomputers	$1,011	$1,095	$1,192	$1,294	$1,384	$1,508	8.3%
Microcomputers	$582	$609	$676	$740	$806	$1,323	17.8%
Workstations	$3,101	$3,892	$4,409	$5,217	$5,946	$6,716	16.7%
Personal Computers	$20,651	$24,184	$28,337	$33,190	$38,693	$46,087	17.4%
Data Storage	$1,830	$2,526	$2,625	$2,894	$3,069	$3,533	14.1%
Rigid Disk Drives	$1,417	$2,109	$2,303	$2,582	$2,780	$3,252	18.1%
Flexible/Removable Media	-	-	-	-	-	-	-
Optical Disk Drives	$221	$212	$119	$107	$84	$60	-23.0%
Tape Drives	$192	$205	$203	$205	$205	$221	2.9%
Input/Ouput Devices	$4,916	$5,886	$7,132	$8,513	$9,461	$10,532	16.5%
Displays	$1,182	$1,948	$2,686	$3,375	$3,896	$4,455	30.4%
Serial Printers	$865	$958	$1,142	$1,429	$1,703	$1,987	18.1%
Line Printers	$352	$437	$574	$816	$820	$850	19.3%
Page Printers	$841	$898	$952	$1,007	$1,043	$1,119	5.9%
Input Devices	$1,671	$1,640	$1,773	$1,880	$1,993	$2,114	4.8%
Other Output Devices	$4	$5	$5	$6	$6	$7	10.0%
Dedicated Systems	$4,041	$4,172	$4,388	$4,906	$5,473	$6,174	8.8%
Office Equipment	$3,044	$2,890	$2,706	$2,502	$2,217	$2,128	-6.9%
Copiers and Duplicators	$2,838	$2,708	$2,531	$2,357	$2,087	$2,019	-6.6%
Electronic Calculators	$27	$23	$20	$16	$13	$9	-19.5%
Dictating, Transcribing	$23	$17	$14	$11	$9	$6	-23.0%
Electronic Typewriters	$156	$142	$142	$118	$109	$94	-9.7%
Cash Registers	$133	$110	$86	$73	$61	$50	-17.6%
Smart Cards (IC Cards)	$864	$1,172	$1,596	$2,331	$3,194	$3,995	35.8%

Source: Dataquest (May 1996 Estimates)

Communications

Table 6
Segment Detail, European Communications Equipment Production (Millions of Dollars) History (Ex-Factory Revenue)

	1990	1991	1992	1993	1994	1995	CAGR 1990-1995
Communications	**$28,698**	**$31,087**	**$32,899**	**$35,117**	**$37,983**	**$43,065**	**8.5%**
Premise Telecom Equipment	$4,943	$5,317	$5,613	$5,798	$6,494	$7,270	8.0%
Image and Text Communication Equipment	$1,330	$1,273	$1,098	$899	$865	$883	-7.9%
Facsimile	$348	$342	$334	$288	$313	$349	0.0%
Video Teleconferencing	$6	$11	$15	$23	$24	$34	39.1%
Telex	$95	$80	$66	$55	$47	$40	-15.9%
Videotex	$807	$758	$586	$424	$364	$330	-16.4%
CCTV	$73	$83	$96	$107	$117	$131	12.5%
Data Communication Equipment	$1,068	$1,285	$1,565	$1,754	$2,254	$2,754	20.9%
Modems	$379	$362	$391	$290	$399	$388	0.5%
64-Kb Access Equipment	$100	$93	$83	$68	$52	$40	-16.9%
2-Mb Access Equipment	$16	$15	$13	$11	$18	$25	9.4%
Backbone Equipment	$186	$245	$283	$279	$305	$325	11.8%
ISDN Access Equipment	$16	$51	$94	$135	$247	$357	85.5%
Network Interface Cards	$319	$399	$474	$544	$600	$714	17.5%
LAN Hubs and Switches	$29	$81	$159	$309	$423	$575	82.4%
LAN Interconnect	$24	$40	$67	$118	$209	$331	69.6%
Premise Switching Equipment	$1,553	$1,703	$1,842	$1,913	$2,062	$2,284	8.0%
PBX/Key Telephone Systems	$1,501	$1,617	$1,721	$1,732	$1,786	$1,921	5.1%
Call Processing Equipment	$52	$86	$120	$182	$276	$363	47.3%
Voice Messaging	$9	$17	$23	$42	$57	$80	56.2%
Call Accounting	$17	$29	$49	$88	$140	$151	55.1%
Automatic Call Distributors	$27	$40	$48	$52	$79	$133	37.5%
Desktop Terminal Equipment	$992	$1,056	$1,108	$1,232	$1,314	$1,348	6.3%
Telephones	$973	$1,031	$1,077	$1,195	$1,271	$1,298	5.9%
Standard Telephones	$829	$851	$825	$830	$781	$717	-2.8%
Cordless Telephones	$144	$181	$247	$353	$478	$558	31.1%
Video Telephones	$0	$0	$6	$11	$12	$23	NA
Answering Machines	$20	$25	$31	$37	$43	$51	20.9%
Public Telecom Equipment	$14,305	$15,375	$15,186	$15,197	$15,173	$15,483	1.6%
Transmission Equipment	$5,790	$5,627	$5,784	$6,534	$6,949	$6,953	3.7%
Central Office Switching	$8,434	$9,628	$9,281	$8,552	$8,116	$8,432	0.0%
Public Packet Data Switching	$81	$119	$121	$111	$109	$98	3.8%

(continued)

Table 6 (Continued)
Segment Detail, European Communications Equipment Production (Millions of Dollars)
History (Ex-Factory Revenue)

	1990	1991	1992	1993	1994	1995	CAGR 1990-1995
Mobile/Radio Communications Equipment	$2,566	$2,996	$4,793	$8,049	$10,144	$13,609	39.6%
Cellular Telephones	$547	$656	$991	$2,088	$3,432	$5,525	58.8%
Analog Cellular	$547	$576	$556	$702	$835	$401	-6.0%
Digital Cellular	$0	$80	$435	$1,386	$2,598	$5,124	NA
Mobile Communication Equipment	$2,019	$2,340	$3,803	$5,961	$6,712	$8,084	32.0%
Mobile Radio Base Station Equipment	$1,293	$1,496	$2,527	$3,978	$4,343	$5,153	31.9%
Pagers and Base Stations Equipment	$90	$101	$114	$126	$150	$210	18.5%
Other Mobile Radio	$637	$743	$1,162	$1,858	$2,219	$2,722	33.7%
Other Communications	$5,949	$5,949	$5,949	$5,949	$5,949	$5,949	0.0%
Broadcast and Studio	$935	$935	$935	$935	$935	$935	0.0%

NA = not applicable
Source: Dataquest (May 1996 Estimates)

Table 7
Segment Detail, European Communications Equipment Production (Millions of Dollars) Forecast (Ex-Factory Revenue)

	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Communications	**$43,065**	**$48,678**	**$55,466**	**$60,968**	**$64,201**	**$68,963**	**9.9%**
Premise Telecom Equipment	$7,270	$7,891	$8,517	$9,255	$9,628	$10,080	6.8%
Image and Text Communication Equipment	$883	$850	$889	$953	$940	$1,014	2.8%
Facsimile	$349	$370	$389	$402	$384	$398	2.7%
Video Teleconferencing	$34	$52	$73	$104	$140	$203	43.3%
Telex	$40	$34	$30	$27	$12	$4	-36.4%
Videotex	$330	$254	$250	$267	$242	$238	-6.3%
CCTV	$131	$140	$147	$153	$162	$171	5.4%
Data Communication Equipment	$2,754	$3,186	$3,601	$4,049	$4,227	$4,362	9.6%
Modems	$388	$416	$358	$261	$192	$172	-15.0%
64-Kb Access Equipment	$40	$34	$29	$28	$28	$27	-7.2%
2-Mb Access Equipment	$25	$27	$28	$31	$29	$27	1.5%
Backbone Equipment	$325	$345	$360	$405	$411	$421	5.3%
ISDN Access Equipment	$357	$529	$703	$883	$995	$1,068	24.5%
Network Interface Cards	$714	$831	$1,002	$1,205	$1,296	$1,358	13.7%
LAN Hubs and Switches	$575	$595	$650	$713	$693	$735	5.0%
LAN Interconnect	$331	$409	$471	$523	$584	$555	10.9%
Premise Switching Equipment	$2,284	$2,445	$2,616	$2,795	$2,964	$3,135	6.5%
PBX/Key Telephone Systems	$1,921	$1,996	$2,081	$2,166	$2,248	$2,334	4.0%
Call Processing Equipment	$363	$449	$536	$629	$717	$801	17.1%
Voice Messaging	$80	$108	$143	$185	$199	$215	22.0%
Call Accounting	$151	$163	$175	$187	$194	$199	5.7%
Automatic Call Distributors	$133	$178	$217	$256	$324	$386	23.8%
Desktop Terminal Equipment	$1,348	$1,410	$1,411	$1,459	$1,496	$1,569	3.1%
Telephones	$1,298	$1,346	$1,334	$1,367	$1,395	$1,457	2.3%
Standard Telephones	$717	$698	$665	$649	$651	$642	-2.2%
Cordless Telephones	$558	$605	$632	$692	$718	$790	7.2%
Vdeo Telephones	$23	$43	$37	$27	$25	$24	1.6%
Answering Machines	$51	$64	$77	$92	$102	$112	17.3%
Public Telecom Equipment	$15,483	$15,117	$15,150	$15,302	$15,440	$15,188	-0.4%
Transmission Equipment	$6,953	$7,030	$7,211	$7,488	$7,604	$7,678	2.0%
Central Office Switching	$8,432	$7,995	$7,856	$7,734	$7,765	$7,449	-2.5%
Public Packet Data Switching	$98	$92	$82	$80	$71	$62	-8.8%

(continued)

Table 7
Segment Detail, European Communications Equipment Production (Millions of Dollars) Forecast (Ex-Factory Revenue)

	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Mobile/Radio Communications Equipment	$13,609	$18,802	$24,720	$28,641	$30,819	$34,879	20.7%
Cellular Telephones	$5,525	$7,924	$9,867	$12,524	$14,077	$16,691	24.7%
Analog Cellular	$401	$324	$234	$171	$122	$79	-27.8%
Digital Cellular	$5,124	$7,600	$9,633	$12,353	$13,956	$16,612	26.5%
Mobile Communication Equipment	$8,084	$10,878	$14,853	$16,118	$16,742	$18,189	17.6%
Mobile Radio Base Station Equipment	$5,153	$7,200	$10,560	$11,746	$12,679	$14,375	22.8%
Pagers and Base Stations Equipment	$210	$288	$346	$421	$518	$643	25.1%
Other Mobile Radio	$2,722	$3,390	$3,947	$3,951	$3,546	$3,171	3.1%
Other Communications	$5,700	$5,849	$6,002	$6,666	$7,182	$7,656	6.1%
Broadcast and Studio	$1,003	$1,020	$1,076	$1,104	$1,131	$1,159	2.9%

Source: Dataquest (May 1996 Estimates)

Industrial

Table 8
Segment Detail, European Industrial Equipment Production (Millions of Dollars) History (Ex-Factory Revenue)

	1990	1991	1992	1993	1994	1995	CAGR 1990-1995
Industrial	**$26,078**	**$26,196**	**$27,491**	**$26,295**	**$27,217**	**$28,634**	**1.9%**
Security/Energy Management Systems	$2,566	$2,594	$2,668	$2,600	$2,730	$2,948	2.8%
Manufacturing and Instrumentation Systems	$15,698	$15,716	$16,448	$15,553	$15,964	$16,700	1.2%
Robot Systems	$689	$733	$790	$819	$871	$930	6.2%
Medical Equipment	$3,700	$3,692	$4,025	$3,941	$4,169	$4,450	3.8%
Other Industrial	$3,425	$3,461	$3,560	$3,382	$3,483	$3,606	1.0%

Source: Dataquest (May 1996 Estimates)

Table 9
Segment Detail, European Industrial Equipment Production (Millions of Dollars) Forecast (Ex-Factory Revenue)

	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Industrial	**$28,634**	**$30,307**	**$32,370**	**$34,789**	**$37,766**	**$41,008**	**7.4%**
Security/Energy Management Systems	$2,948	$3,214	$3,535	$3,924	$4,395	$4,966	11.0%
Manufacturing and Instrumentation Systems	$16,700	$17,700	$18,900	$20,290	$22,009	$23,717	7.3%
Robot Systems	$930	$995	$1,085	$1,193	$1,324	$1,483	9.8%
Medical Equipment	$4,450	$4,648	$4,913	$5,207	$5,572	$6,018	6.2%
Other Industrial	$3,606	$3,750	$3,938	$4,174	$4,466	$4,823	6.0%

Source: Dataquest (May 1996 Estimates)

Consumer

Table 10
Segment Detail, European Consumer Equipment Production (Millions of Dollars)
History (Ex-Factory Revenue)

	1990	1991	1992	1993	1994	1995	CAGR 1990-1995
Consumer	**$19,789**	**$20,516**	**$19,453**	**$20,300**	**$21,175**	**$22,370**	**2.5%**
Audio	$1,543	$1,463	$1,352	$1,299	$1,517	$1,659	1.5%
Compact Disk Players	$775	$725	$669	$708	$837	$910	3.3%
Digital Compact Cassette Players	$0	$0	$6	$19	$30	$68	NA
Radio Combinations	$428	$437	$402	$321	$370	$358	-3.5%
Stereo Hi-Fi Components	$275	$240	$217	$196	$222	$256	-1.4%
Musical Instruments	$66	$61	$59	$55	$58	$67	0.4%
Video	$5,089	$5,754	$5,112	$5,349	$5,786	$6,467	4.9%
Video Cameras/Camcorders	$374	$404	$372	$366	$482	$636	11.2%
VCRs	$1,084	$1,224	$968	$1,090	$1,223	$1,378	4.9%
Color Televisions	$3,051	$3,498	$3,111	$3,187	$3,304	$3,463	2.6%
Black-and-White Televisions	$22	$16	$19	$16	$16	$12	-11.0%
Set-Top Boxes	$557	$611	$641	$689	$760	$977	11.9%
Digital STB	$0	$0	$0	$0	$14	$250	NA
Analog STB	$557	$611	$641	$689	$746	$727	5.5%
Personal Electronics	$1,148	$1,109	$1,161	$1,207	$1,380	$1,462	5.0%
Watches	$1,025	$972	$1,006	$1,041	$1,195	$1,260	4.2%
Clocks	$123	$137	$154	$166	$185	$201	10.4%
Appliances	$12,010	$12,190	$11,829	$12,445	$12,492	$12,782	1.3%
Air Conditioners	$339	$398	$473	$536	$626	$645	13.8%
Microwave Ovens	$1,582	$1,701	$1,787	$1,551	$1,540	$1,572	-0.1%
Washers and Dryers	$3,042	$3,069	$2,910	$3,168	$3,021	$3,165	0.8%
Refrigerators/Freezers	$3,566	$3,457	$3,217	$3,388	$3,394	$3,395	-1.0%
Dishwashers	$986	$1,056	$1,178	$1,393	$1,660	$1,747	12.1%
Ranges and Ovens	$2,495	$2,508	$2,263	$2,409	$2,251	$2,258	-2.0%

NA = not applicable
Source: Dataquest (May 1996 Estimates)

Table 11
Segment Detail, European Consumer Equipment Production (Millions of Dollars) Forecast (Ex-Factory Revenue)

	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Consumer	**$22,370**	**$24,169**	**$26,172**	**$27,826**	**$29,386**	**$30,474**	**6.4%**
Audio	$1,659	$1,754	$1,937	$2,091	$2,225	$2,367	7.4%
Compact Disk Players	$910	$936	$1,002	$1,056	$1,108	$1,159	4.9%
Digital Compact Cassette Players	$68	$123	$180	$250	$318	$360	39.5%
Radio Combinations	$358	$366	$393	$394	$408	$427	3.6%
Stereo Hi-Fi Components	$256	$261	$291	$316	$314	$341	5.9%
Musical Instruments	$67	$69	$72	$75	$77	$81	3.8%
Video	$6,467	$7,775	$9,105	$10,098	$11,076	$11,550	12.3%
Video Cameras/Camcorders	$636	$764	$864	$983	$1,090	$1,300	15.3%
VCRs	$1,378	$1,488	$1,664	$1,744	$1,957	$2,101	8.8%
Color Televisions	$3,463	$3,685	$3,991	$4,293	$4,599	$4,909	7.2%
Black-and-White Televisions	$12	$10	$7	$6	$5	$4	-21.6%
Set-Top Boxes	$977	$1,828	$2,580	$3,072	$3,425	$3,236	27.1%
Digital STB	$250	$1,176	$2,051	$2,794	$3,248	$3,128	65.8%
Analog STB	$727	$653	$529	$278	$178	$108	-31.7%
Personal Electronics	$1,462	$1,551	$1,658	$1,752	$1,848	$1,948	5.9%
Watches	$1,260	$1,333	$1,420	$1,495	$1,569	$1,646	5.5%
Clocks	$201	$218	$239	$257	$279	$302	8.5%
Appliances	$12,782	$13,089	$13,471	$13,884	$14,237	$14,608	2.7%
Air Conditioners	$645	$705	$766	$832	$893	$960	8.3%
Microwave Ovens	$1,572	$1,603	$1,633	$1,662	$1,690	$1,717	1.8%
Washers and Dryers	$3,165	$3,227	$3,275	$3,322	$3,339	$3,378	1.3%
Refrigerators/Freezers	$3,395	$3,403	$3,424	$3,455	$3,478	$3,506	0.6%
Dishwashers	$1,747	$1,857	$2,072	$2,274	$2,464	$2,642	8.6%
Ranges and Ovens	$2,258	$2,293	$2,302	$2,339	$2,373	$2,406	1.3%

Source: Dataquest (May 1996 Estimates)

Military and Civil Aerospace

Table 12
Segment Detail, European Military and Civil Aerospace Equipment Production (Millions of Dollars) History (Ex-Factory Revenue)

	1990	1991	1992	1993	1994	1995	CAGR 1990-1995
Military and Civil Aerospace	**$20,976**	**$21,171**	**$21,055**	**$21,447**	**$20,851**	**$20,613**	-0.3%
Military Electronic Equipment Systems	$17,626	$17,388	$17,061	$17,315	$16,928	$16,526	-1.3%
Radar and Sonar	$3,300	$3,200	$3,100	$3,107	$3,000	$2,900	-2.6%
Missiles and Weapons	$2,737	$2,622	$2,500	$2,555	$2,423	$2,303	-3.4%
Space-Related Electronics	$890	$870	$869	$882	$891	$899	0.2%
Communications and Navigation	$2,500	$2,550	$2,585	$2,696	$2,729	$2,719	1.7%
Electronic Warfare	$2,300	$2,350	$2,313	$2,347	$2,300	$2,254	-0.4%
Aircraft Systems	$1,950	$1,900	$1,850	$1,845	$1,772	$1,701	-2.7%
Military Computer Systems	$728	$756	$794	$833	$875	$919	4.8%
Military Simulation Systems	$321	$340	$350	$375	$394	$413	5.2%
Other Military Equipment	$2,900	$2,800	$2,700	$2,674	$2,545	$2,418	-3.6%
Civil Aerospace Electronic Equipment Systems	$3,350	$3,783	$3,994	$4,133	$3,923	$4,087	4.1%
Radar	$900	$1,096	$1,151	$1,174	$1,200	$1,247	6.7%
Space-Related Electronics	$1,000	$1,100	$1,150	$1,303	$1,400	$1,498	8.4%
Communications and Navigation	$350	$375	$401	$378	$282	$297	-3.3%
Flight Systems	$1,000	$1,100	$1,173	$1,154	$909	$904	-2.0%
Simulation Systems	$100	$112	$119	$123	$132	$141	7.1%

Source: Dataquest (May 1996 Estimates)

Table 13
Segment Detail, European Military and Civil Aerospace Equipment Production (Millions of Dollars) Forecast (Ex-Factory Revenue)

	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Military and Civil Aerospace	**$20,613**	**$20,492**	**$20,335**	**$20,254**	**$20,019**	**$19,808**	**-0.8%**
Military Electronic Equipment Systems	$16,525	$16,242	$15,947	$15,729	$15,229	$14,895	-2.1%
Radar and Sonar	$2,900	$2,800	$2,650	$2,500	$2,300	$2,150	-5.8%
Missiles and Weapons	$2,302	$2,206	$2,126	$2,037	$1,858	$1,710	-5.8%
Space-Related Electronics	$899	$908	$918	$927	$905	$900	0.0%
Communications and Navigation	$2,719	$2,756	$2,770	$2,784	$2,798	$2,812	0.7%
Electronic Warfare	$2,254	$2,209	$2,182	$2,180	$2,079	$2,038	-2.0%
Aircraft Systems	$1,701	$1,667	$1,650	$1,686	$1,700	$1,717	0.2%
Military Computer Systems	$919	$965	$1,013	$1,064	$1,117	$1,170	4.9%
Military Simulation Systems	$413	$434	$456	$478	$502	$527	5.0%
Other Military Equipment	$2,418	$2,297	$2,182	$2,073	$1,969	$1,871	-5.0%
Civil Aerospace Electronic Equipment Systems	$4,088	$4,249	$4,388	$4,525	$4,790	$4,913	3.7%
Radar	$1,248	$1,191	$1,214	$1,239	$1,264	$1,289	0.6%
Space-Related Electronics	$1,498	$1,588	$1,667	$1,742	$1,944	$2,002	6.0%
Communications and Navigation	$297	$326	$333	$339	$346	$353	3.6%
Flight Systems	$904	$995	$1,015	$1,035	$1,056	$1,077	3.6%
Simulation Systems	$141	$150	$160	$170	$181	$192	6.4%

Source: Dataquest (May 1996 Estimates)

Transportation

Table 14
Segment Detail, European Transportation Equipment Production (Millions of Dollars) History (Semiconductor Consumption)

	1990	1991	1992	1993	1994	1995	CAGR 1990-1995
Transportation	**$6,262**	**$6,817**	**$7,808**	**$8,562**	**$9,958**	**$11,398**	**12.7%**
In-Car Entertainment Systems	$431	$447	$500	$550	$618	$800	13.2%
Body Control and Vehicle Control Electronics	$885	$908	$970	$1,083	$1,347	$1,500	11.1%
Driver Information Systems	$452	$519	$576	$654	$847	$1,025	17.8%
Powertrain Systems	$3,090	$3,264	$3,822	$3,860	$3,976	$4,098	5.8%
Safety and Convenience Systems	$1,404	$1,679	$1,940	$2,415	$3,171	$3,975	23.1%

Source: Dataquest (May 1996 Estimates)

Table 15
Segment Detail, European Transportation Equipment Production (Millions of Dollars) Forecast (Semiconductor Consumption)

	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Transportation	**$11,398**	**$13,029**	**$14,330**	**$16,117**	**$17,653**	**$19,830**	**11.7%**
In-Car Entertainment Systems	$800	$1,027	$1,163	$1,337	$1,480	$1,616	15.1%
Body Control and Vehicle Control Electronics	$1,500	$1,658	$1,841	$2,123	$2,351	$2,549	11.2%
Driver Information Systems	$1,025	$1,254	$1,417	$1,525	$1,819	$2,313	17.7%
Powertrain Systems	$4,098	$4,381	$4,670	$5,279	$5,584	$6,229	8.7%
Safety and Convenience Systems	$3,975	$4,710	$5,240	$5,854	$6,419	$7,123	12.4%

Source: Dataquest (May 1996 Estimates)

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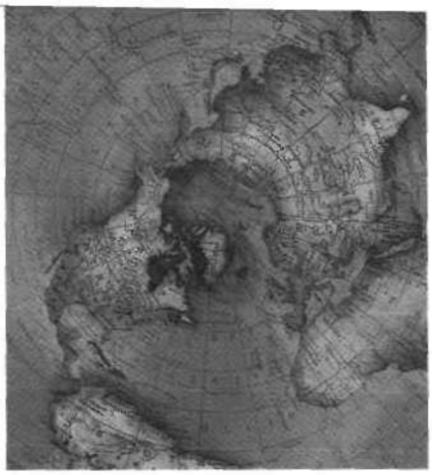

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High-Volume Electronic Equipment Unit Production Forecast and Semiconductor Analysis—Europe

Market Statistics

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Table of Contents

List of Figures

List of Figures (Continued)

List of Tables

Chapter 1
Introduction and Definitions

Introduction

This *Market Statistics* report represents Dataquest's third annual forecast for European electronic systems by value, unit volume, semiconductor content and market forecast. Dataquest has selected 29 key application systems that have high-volume production worldwide. These key systems are identified by Dataquest as being leading indicators of semiconductor consumption trends by end-application market segment. These data are derived from research by Dataquest analysts in all its four major regions: United States, Japan, Europe and Asia/Pacific.

This year we have added seven new categories:

- In Electronic Data Processing, we have added the line-item category Motherboards, which is a recap of the Personal Computer (PC) line and should not be added to the PC line.
- In Communications, we effectively have added three new line-item categories by: splitting Central Office/Premise Line Cards into Central Office Line Cards and PBX Line Cards; splitting Cordless Telephones into Digital Cordless Telephones and Analog Cordless Telephones, and splitting Cellular Telephones into Digital Cellular Telephones and Analog Cellular Telephones.
- In Consumer, we have split Set-Top Boxes into two new line-item categories: Digital Set-Top Boxes and Analog Set-Top Boxes.
- In Automotive, we have added two new line-item categories: Antilock Braking System (ABS) Control Units and Airbag Control Modules.

The 29 leading indicators selected by Dataquest are:

- Electronic Data Processing:
  - PCs
  - Motherboards
  - Workstations
  - Rigid Disk Drives
  - Optical Disk Drives
  - Page (Laser) Printers
  - Serial Printers
- Communications
  - Fax Machines
  - LAN Cards
  - Modems
  - Answering Machines
  - Corded Telephones
  - Analog Cordless Telephones
  - Digital Cordless Telephones
  - Central Office Line Cards
  - PBX Line Cards (Lines)
  - Analog Cellular Telephones
  - Digital Cellular Telephones

- Pagers
- Consumer
  - Personal/Portable Stereos
  - Color Televisions
  - Video Cassette Recorders
  - Camcorders
  - Analog Set-Top Boxes
  - Digital Set-Top Boxes
- Automotive
  - Auto Stereos
  - Engine Control Units
  - ABS Control Units
  - Airbag Control Modules

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

This *Market Statistics* contains tables detailing the spring 1996 electronics equipment production forecast. European production is estimated for the years 1995 to 2000. Production tables contain both historical data and forecasts. In most tables, historical data begin with 1994, while forecast data provide estimates for 1996 through 2000. Tables detail the type of production data by system application market and unit of measure.

Exchange Rates

Dataquest uses an average annual exchange rate for each European country for converting revenue US dollar values. When forecasting electronic equipment production, it is important to maintain consistency and continuity; in this way we maintain exchange rates at constant 1995 calendar year. This prevents any inconsistencies in the conversion of growth projections and currency fluctuations. The 1995 exchange rate estimate uses actual average monthly exchange rates from January through December (these data are collected by the Dun & Bradstreet Corporation). The annual rate is estimated as the arithmetic mean of the 12 monthly rates. Exchange rates are provided in Table 1-1. Exchange rates for historical years are available on request.

Table 1-1
1995 Exchange Rate Table

Country	Foreign Currency per US Dollar	US Dollar per Foreign Currency
Austria (Schilling)	10.06	0.0994
Belgium (Franc)	29.42	0.0340
Denmark (Krone)	5.59	0.1788
European Union (ECU)	0.77	1.2927
Finland (Markka)	4.37	0.2288
France (Franc)	4.97	0.2012
Germany (Mark)	1.43	0.6988
Greece (Drachma)	231.34	0.0043
Ireland (Punt)	0.62	1.6067
Italy (Lira)	1,628.21	0.0006
Netherlands (Gulden)	1.60	0.6240
Norway (Krone)	6.33	0.1581
Portugal (Escudo)	149.77	0.0067
Spain (Peseta)	124.40	0.0080
Sweden (Krona)	7.14	0.1401
Switzerland (Franc)	1.18	0.8475
United Kingdom (Pound)	0.63	1.5799

Source: Dun & Bradstreet, Dataquest (November 1996)

Definitions

Regional Definitions

Europe: Western Europe and Central and Eastern Europe.

Western Europe

Includes Austria, Belgium, Denmark, Eire (Ireland), Finland, France, Germany, Greece, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom, and Rest of Western Europe (Andorra, Cyprus, Gibraltar, Liechtenstein, Republic of Monaco, San Marino, Vatican City, Iceland, Malta, and Turkey).

Central and Eastern Europe

Includes Albania, Belarus, Bosnia, Bulgaria, the Czech Republic, Croatia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, the Federal Republic of Yugoslavia, Russian Federation, Armenia, Azerbaijan, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Tajikistan, Turkmenistan, Ukraine and Uzbekistan.

Line Item Definitions

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

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

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

Data Sources

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

- Dataquest's estimates of systems manufacturers' end-user revenue
- Trade association data
- Various European Commission and government agency statistics
- Japanese Government and trade association (MITI, MOF and EIAJ) intelligence
- Estimates presented by knowledgeable and reliable industry spokespersons
- Published product literature and prices
- Other Dataquest research groups (including Computer and Client/Server Systems, Telecommunications and Document Management).

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

Forecast Methodology

Dataquest uses a variety of forecasting techniques (both qualitative and quantitative) that vary by technology area. An overview of Dataquest forecasting techniques can be found in *Dataquest Research Methodology Document.*

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

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

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

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

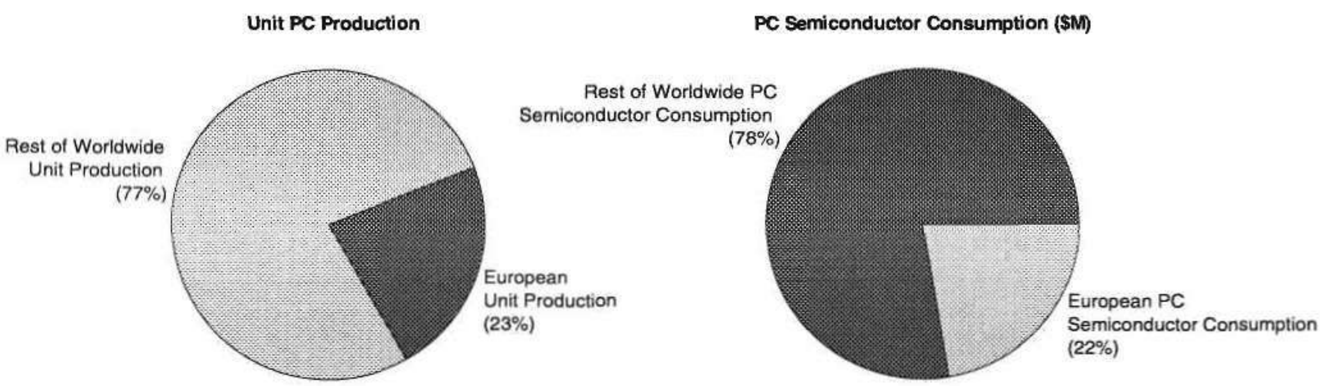
Chapter 2
Electronic Data Processing

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

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Units (K)	13,000	15,885	18,252	20,990	24,138	27,638	31,784	14.9%
Factory ASP ($)	1,250	1,300	1,325	1,350	1,375	1,400	1,450	2.2%
Factory Revenue ($M)	16,250	20,651	24,184	28,337	33,190	38,693	46,087	17.4%
Semiconductor Content ($)*	470	585	525	550	585	610	660	2.4%
Semiconductor TAM ($M)	6,110	9,293	9,582	11,545	14,121	16,859	20,977	17.7%

* Includes graphics, SIO/PIO, storage adapters, memory SIMMs
Source: Dataquest (November 1996 Estimates)

Figure 2-1
1996 European PC* Production and Semiconductor Consumption as a Percentage of Worldwide Forecast



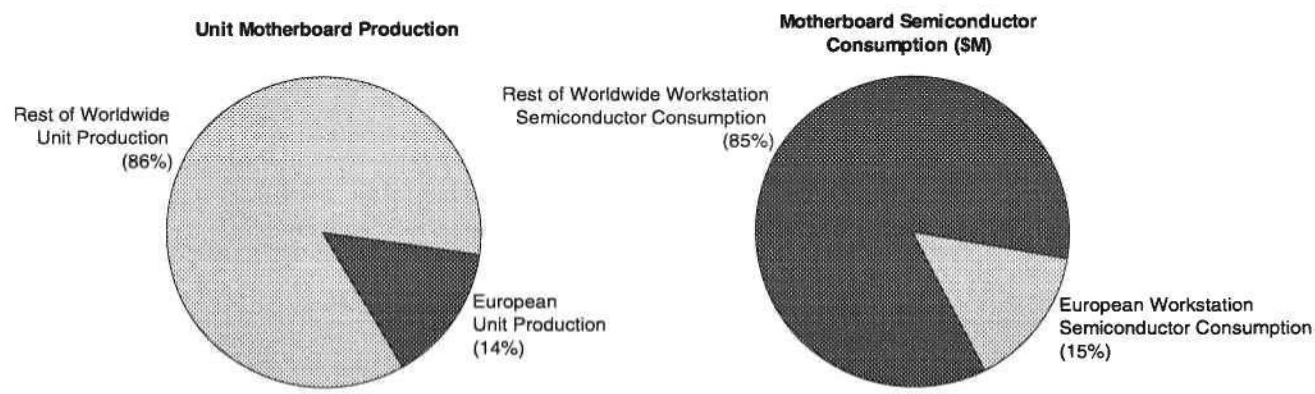
* Includes graphics, SIO/PIO, storage adapters, memory SIMMs
Source: Dataquest (November 1996 Estimates)

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

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Units (K)	6,350	9,560	9,685	10,750	11,850	13,000	14,700	9.0%
Factory ASP ($)	122	129	134	140	145	151	157	4.0%
Factory Revenue ($M)	774	1,235	1,301	1,502	1,722	1,965	2,311	6.4%
Semiconductor Content ($)	48	60	68	73	77	79	82	16.0%
Semiconductor TAM ($M)	305	576	658	787	916	1,021	1,208	16.0%

* Recap, also included in PCs
Source: Dataquest (November 1996 Estimates)

Figure 2-2
1996 European Motherboard Production and Semiconductor Consumption as a Percentage of Worldwide Forecast



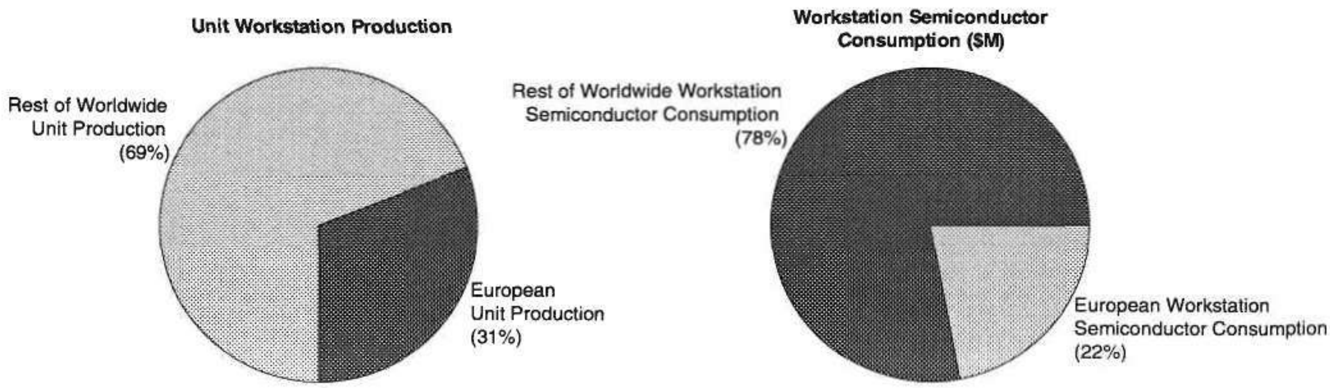
Source: Dataquest (November 1996 Estimates)

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

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Units (K)	211	245	290	345	390	430	470	13.9%
Factory ASP ($)	9,013	12,356	13,122	12,479	13,078	13,528	13,990	2.5%
Factory Revenue ($M)	1,901	3,028	3,807	4,306	5,101	5,818	6,577	16.8%
Semiconductor Content ($)	1,300	1,485	1,250	1,210	1,200	1,250	1,250	-3.4%
Semiconductor TAM ($M)	274	364	363	418	468	538	588	10.1%

Source: Dataquest (November 1996 Estimates)

Figure 2-3
1996 European Workstation Production and Semiconductor Consumption as a Percentage of Worldwide Forecast



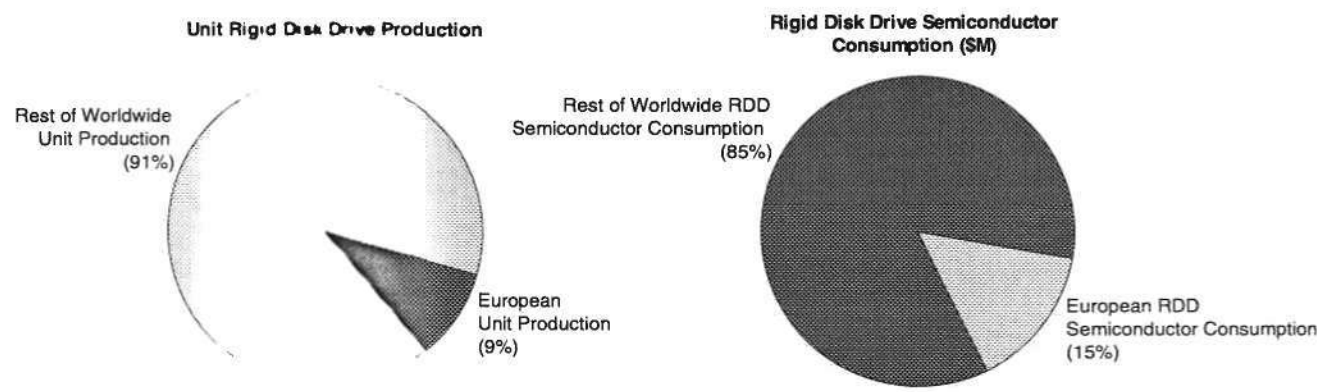
Source: Dataquest (November 1996 Estimates)

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

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Units (K)	4,230	6,242	10,815	13,010	15,460	18,050	22,740	29.5%
Factory ASP ($)	250	178	170	163	157	150	144	-4.2%
Factory Revenue ($M)	1,058	1,111	1,839	2,121	2,427	2,708	3,275	24.1%
Semiconductor Content ($)	60	68	59	53	50	46	43	-8.8%
Semiconductor TAM ($M)	254	425	633	691	775	834	976	18.1%

Source: Dataquest (November 1996 Estimates)

Figure 2-4
1996 European Rigid Disk Drive Production and Semiconductor Consumption as a Percentage of Worldwide Forecast



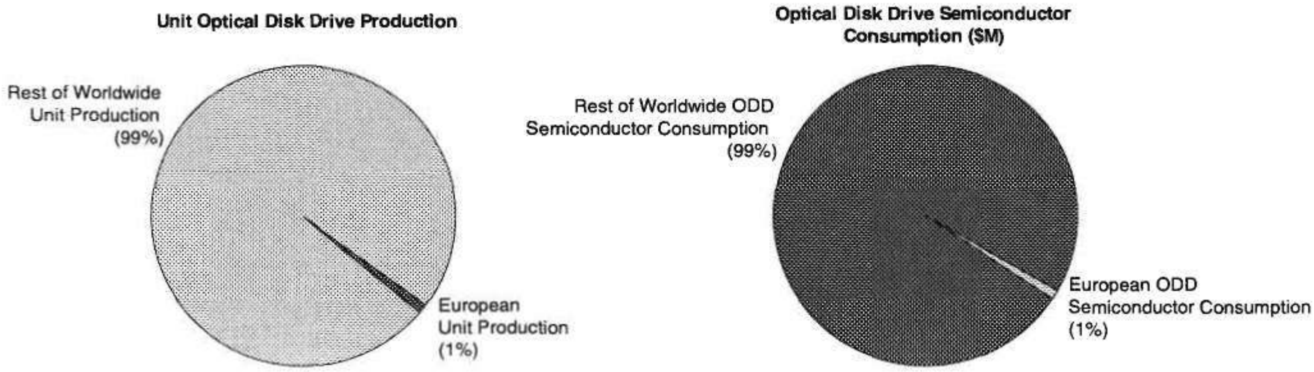
Source: Dataquest (November 1996 Estimates)

Table 2-5
High-Volume Electronic Equipment Production
Region: Europe
Category: Electronic Data Processing—Optical Disk Drives

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Units (K)	269	254	271	375	571	610	521	15.4%
Factory ASP ($)	362	379	333	318	188	138	115	-21.3%
Factory Revenue ($M)	97	96	90	119	107	84	60	-9.1%
Semiconductor Content ($)	55	49	44	40	38	34	30	-9.1%
Semiconductor TAM ($M)	15	12	12	15	22	21	16	4.9%

Source: Dataquest (November 1996 Estimates)

Figure 2-5
1996 European Optical Disk Drive Production and Semiconductor Consumption as a Percentage of Worldwide Forecast



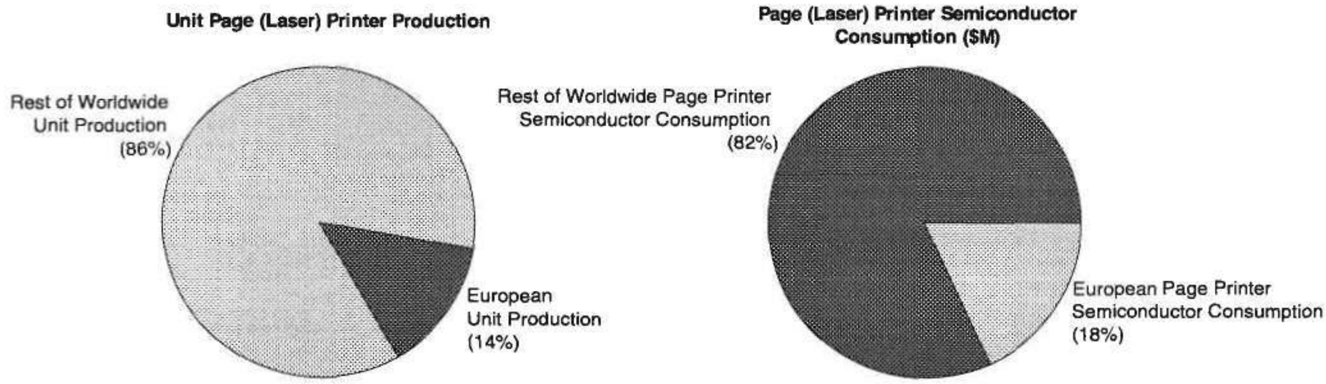
Source: Dataquest (November 1996 Estimates)

Table 2-6
High-Volume Electronic Equipment Production
Region: Europe
Category: Electronic Data Processing—Page (Laser) Printers

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Units (K)	906	1,099	1,237	1,363	1,486	1,602	1,791	10.3%
Factory ASP ($)	827	765	726	698	678	651	625	-4.0%
Factory Revenue ($M)	750	841	898	952	1,007	1,043	1,119	5.9%
Semiconductor Content ($)	148	162	158	136	120	110	100	-9.2%
Semiconductor TAM ($M)	134	178	195	185	178	176	179	0.1%

Source: Dataquest (November 1996 Estimates)

Figure 2-6
1996 European Page (Laser) Printer Production and Semiconductor Consumption as a Percentage of Worldwide Forecast



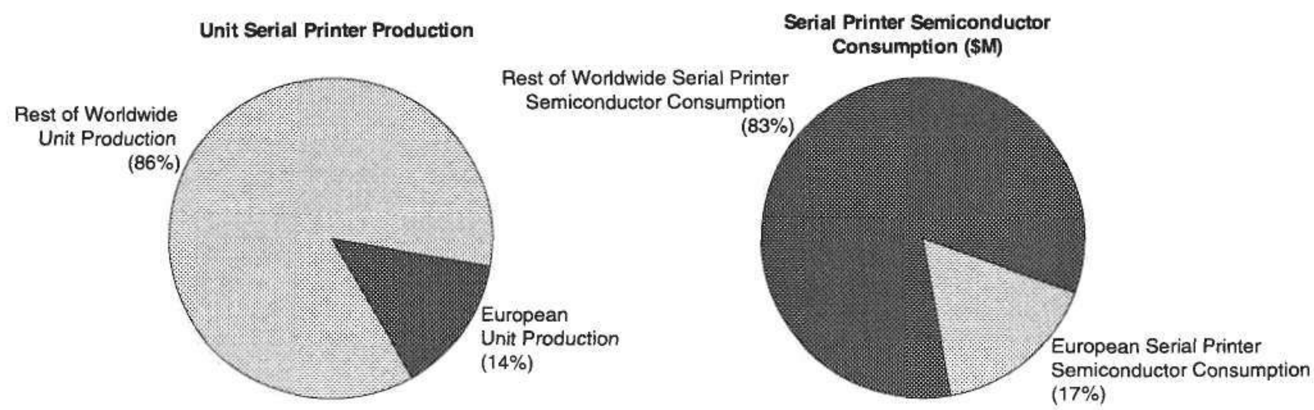
Source: Dataquest (November 1996 Estimates)

Table 2-7
High-Volume Electronic Equipment Production
Region: Europe
Category: Electronic Data Processing—Serial Printers

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Units (K)	2,945	3,205	3,683	4,513	6,109	7,884	9,374	23.9%
Factory ASP ($)	296	270	260	253	234	216	212	-4.7%
Factory Revenue ($M)	872	865	958	1,142	1,429	1,703	1,987	18.1%
Semiconductor Content ($)	27	31	31	31	30	29	30	-0.7%
Semiconductor TAM ($M)	80	99	114	140	183	229	281	23.1%

Source: Dataquest (November 1996 Estimates)

Figure 2-7
1996 European Serial Printer Production and Semiconductor Consumption as a Percentage of Worldwide Forecast



Source: Dataquest (November 1996 Estimates)

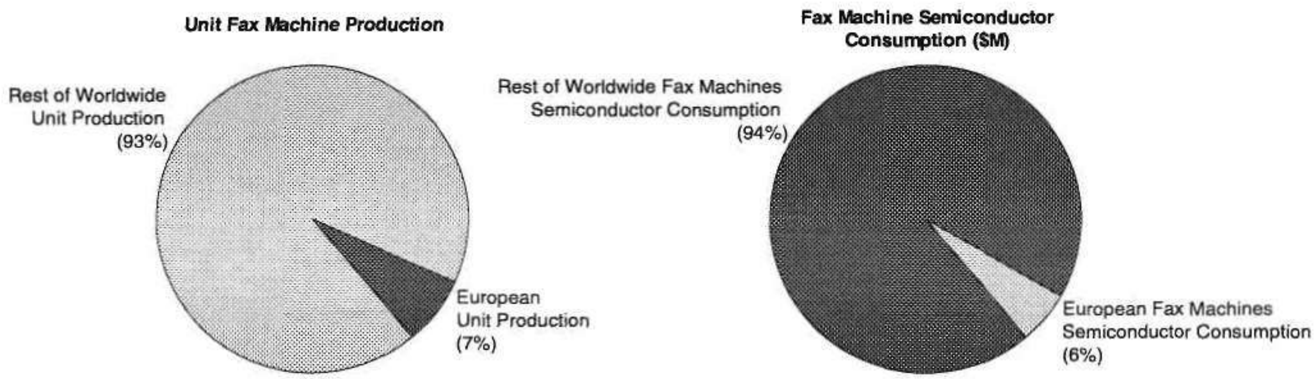
Chapter 3
Communications

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

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Units (K)	524	640	770	912	1,058	1,197	1,404	17.0%
Factory ASP ($)	597	545	480	426	380	321	284	-12.3%
Factory Revenue ($M)	313	349	370	389	402	384	398	2.7%
Semiconductor Content ($)	67	63	56	52	48	42	38	-9.3%
Semiconductor TAM ($M)	35	40	43	47	51	50	54	6.1%

Source: Dataquest (November 1996 Estimates)

Figure 3-1
1996 European Fax Machine Production and Semiconductor Consumption as a Percentage of Worldwide Forecast



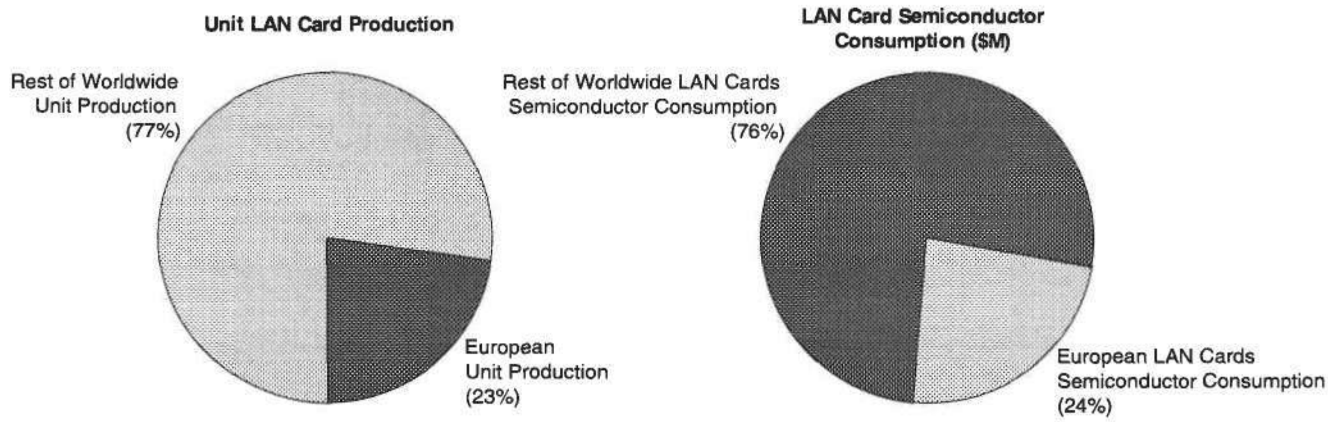
Source: Dataquest (November 1996 Estimates)

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

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Units (K)	3,985	5,494	6,929	8,644	10,722	11,836	13,164	19.1%
Factory ASP ($)	151	130	120	116	112	110	103	-4.5%
Factory Revenue ($M)	600	714	831	1,002	1,205	1,296	1,358	13.7%
Semiconductor Content ($)	32	27	25	24	24	24	23	-3.2%
Semiconductor TAM ($M)	126	150	175	210	259	285	305	15.3%

Source: Dataquest (November 1996 Estimates)

Figure 3-2
1996 European LAN Card Production and Semiconductor Consumption as a Percentage of Worldwide Forecast



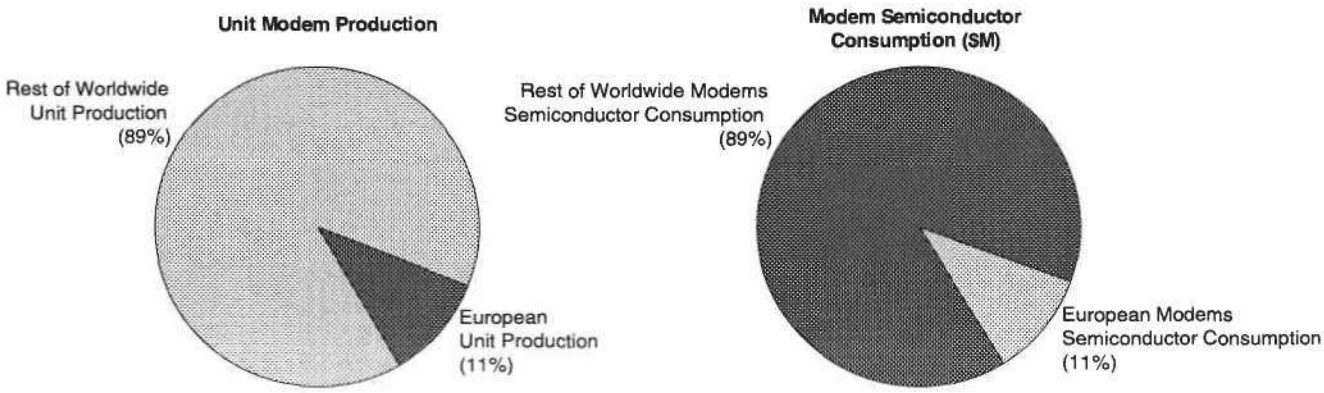
Source: Dataquest (November 1996 Estimates)

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

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Units (K)	2,025	2,550	3,660	3,770	3,350	2,998	2,867	2.4%
Factory ASP ($)	197	152	114	95	78	64	60	-17.0%
Factory Revenue ($M)	399	388	416	358	261	192	172	-15.0%
Semiconductor Content ($)*	37	35	34	33	32	31	30	-3.0%
Semiconductor TAM ($M)	76	89	124	124	107	93	86	-0.7%

* External and internal, data and fax
Source: Dataquest (November 1996 Estimates)

Figure 3-3
1996 European Modem* Production and Semiconductor Consumption as a Percentage of Worldwide Forecast



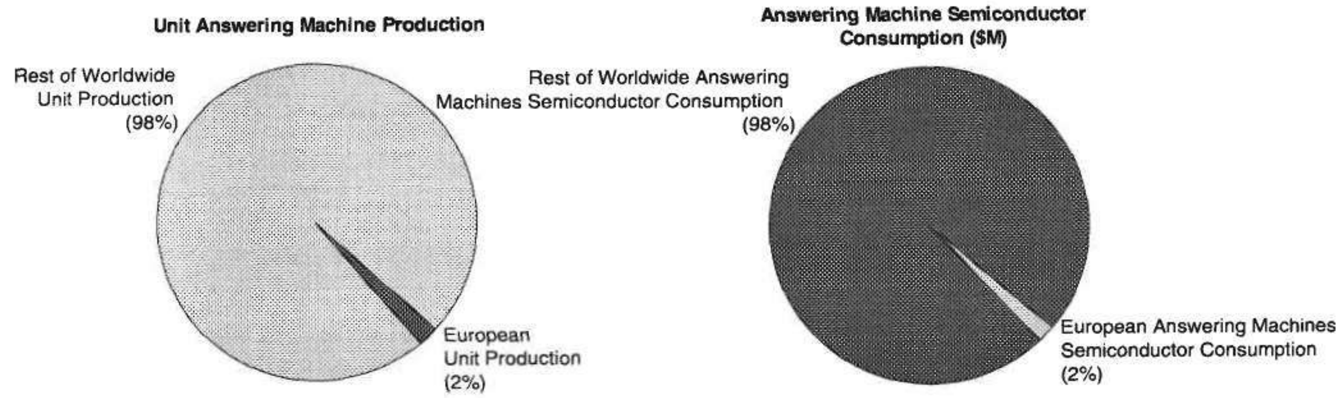
* External and internal, data and fax
Source: Dataquest (November 1996 Estimates)

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

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Units (K)	378	472	628	818	1,048	1,256	1,506	26.1%
Factory ASP ($)	113	107	102	94	88	81	75	-6.9%
Factory Revenue ($M)	43	51	64	77	92	102	113	17.5%
Semiconductor Content ($)	9	10	12	14	16	17	17	12.0%
Semiconductor TAM ($M)	3	5	8	12	17	21	26	41.3%

Source: Dataquest (November 1996 Estimates)

Figure 3-4
1996 European Answering Machine Production and Semiconductor Consumption as a Percentage of Worldwide Forecast



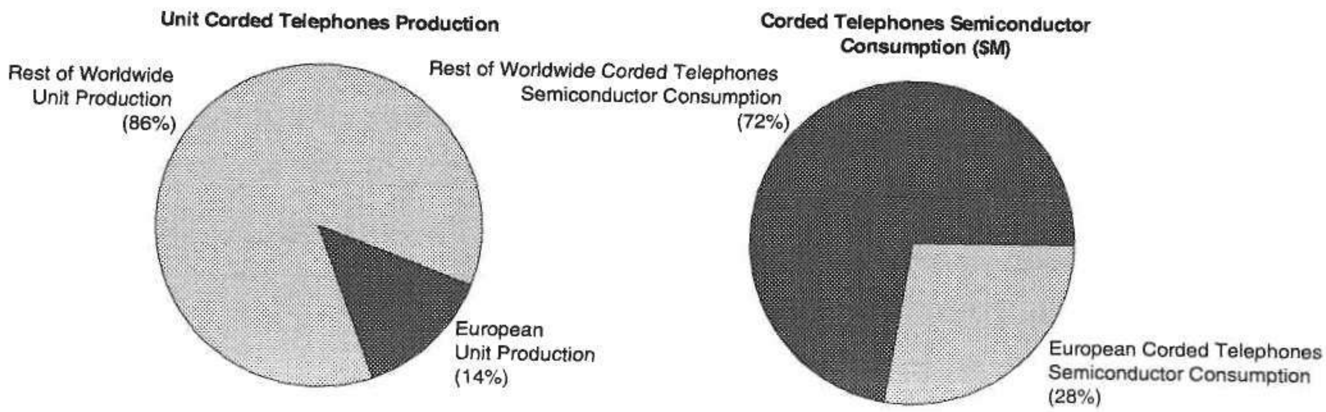
Source: Dataquest (November 1996 Estimates)

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

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Units (K)	23,670	21,735	21,500	21,281	21,020	20,947	20,872	-0.8%
Factory ASP ($)	33	33	33	32	32	32	32	-0.6%
Factory Revenue ($M)	781	717	710	681	673	670	668	-1.4%
Semiconductor Content ($)	6	7	7	7	7	8	8	3.1%
Semiconductor TAM ($M)	148	143	149	150	155	161	160	2.2%

Source: Dataquest (November 1996 Estimates)

Figure 3-5
1996 European Corded Telephones Production and Semiconductor Consumption as a Percentage of Worldwide Forecast



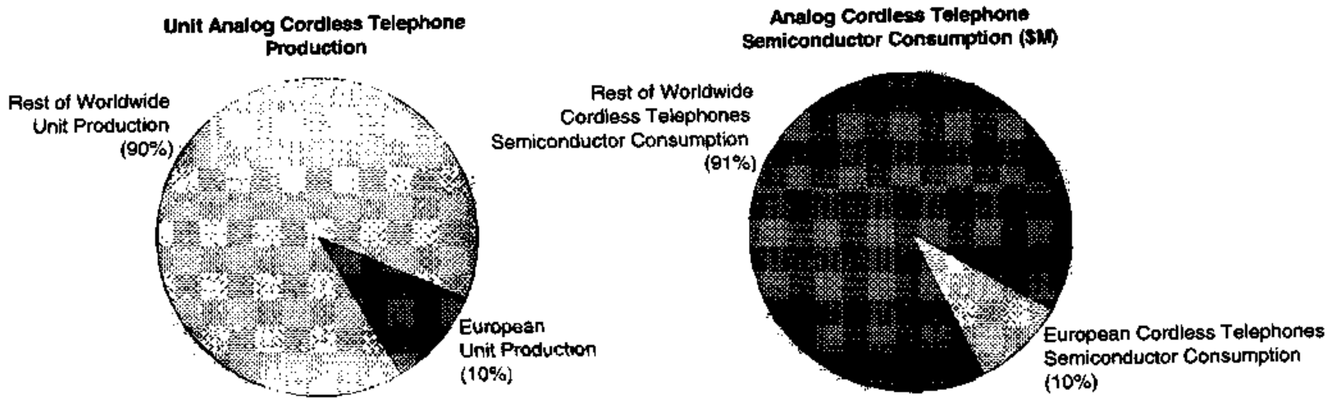
Source: Dataquest (November 1996 Estimates)

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

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Units (K)	3,609	4,081	4,272	3,857	3,724	3,643	3,500	-3.0%
Factory ASP ($)	116	110	103	99	95	90	87	-4.6%
Factory Revenue ($M)	419	449	440	382	354	328	305	-7.5%
Semiconductor Content ($)	30	30	26	26	26	25	25	-3.6%
Semiconductor TAM ($M)	108	122	111	100	97	91	88	-6.5%

Source: Dataquest (November 1996 Estimates)

Figure 3-6
1996 European Analog Cordless Telephone Production and Semiconductor Consumption as a Percentage of Worldwide Forecast



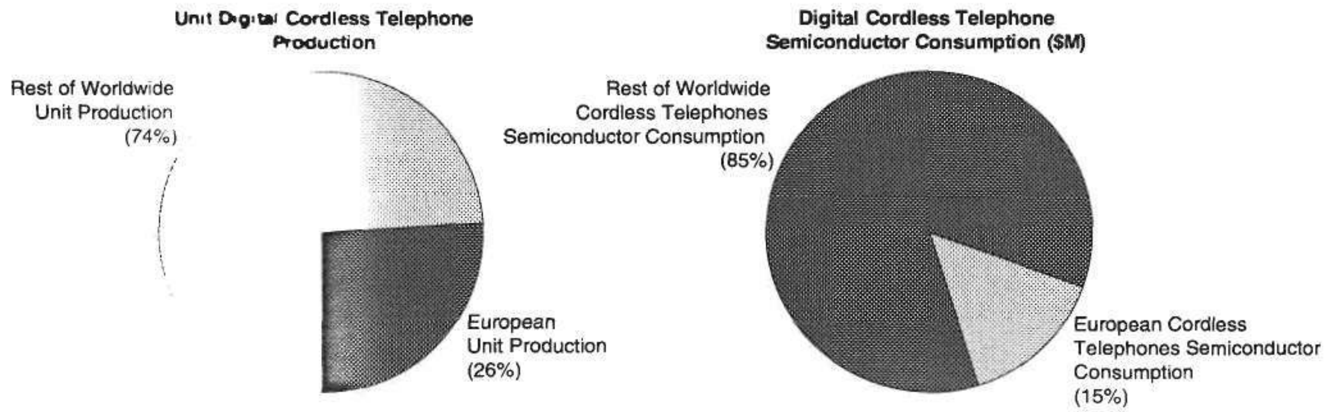
Source: Dataquest (November 1996 Estimates)

Table 3-7
High-Volume Electronic Equipment Production
Region: Europe
Category: Communications—Digital Cordless Telephones

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Units (K)	189	936	1,860	2,810	3,860	4,692	6,000	45.0%
Factory ASP ($)	80	74	74	74	73	67	66	-2.3%
Factory Revenue ($M)	15	69	138	207	282	314	394	41.7%
Semiconductor Content ($)	45	47	48	49	49	45	43	-1.7%
Semiconductor TAM ($M)	8	44	89	136	188	209	260	42.6%

Source: Dataquest (November 1996 Estimates)

Figure 3-7
1996 European Digital Cordless Telephone Production and Semiconductor Consumption as a Percentage of Worldwide Forecast



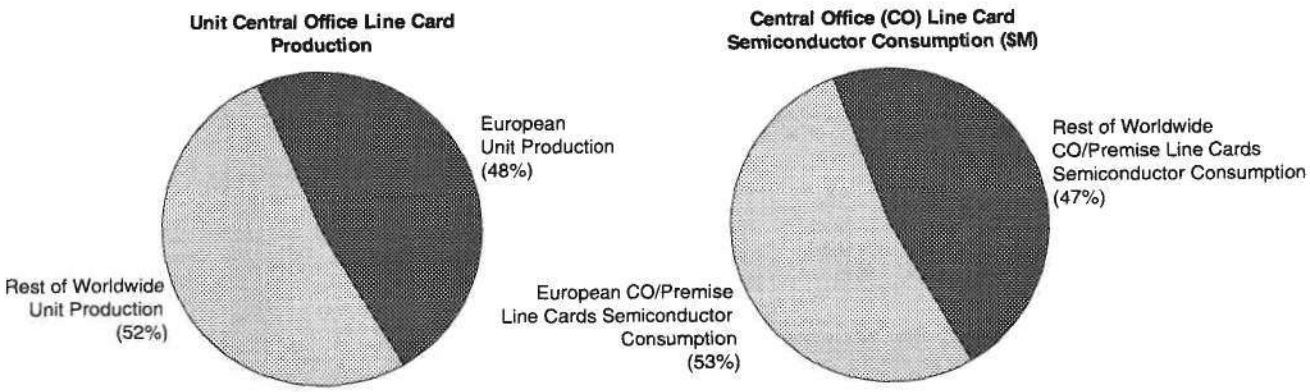
Source: Dataquest (November 1996 Estimates)

Table 3-8
High-Volume Electronic Equipment Production
Region: Europe
Category: Communications—Central Office Line Cards

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Units (K) [Lines]	41,550	48,400	49,610	51,850	54,500	57,990	60,920	4.7%
Factory ASP ($) [per Line]	113	108	102	97	92	90	88	-4.0%
Factory Revenue ($M)	4,695	5,227	5,060	5,029	5,014	5,219	5,361	0.5%
Semiconductor Content ($)	15	16	17	18	18	19	19	3.3%
Semiconductor TAM ($M)	632	782	836	909	995	1,102	1,157	8.2%

Source: Dataquest (November 1996 Estimates)

Figure 3-8
1996 European Central Office Line Card Production and Semiconductor Consumption as a Percentage of Worldwide Forecast



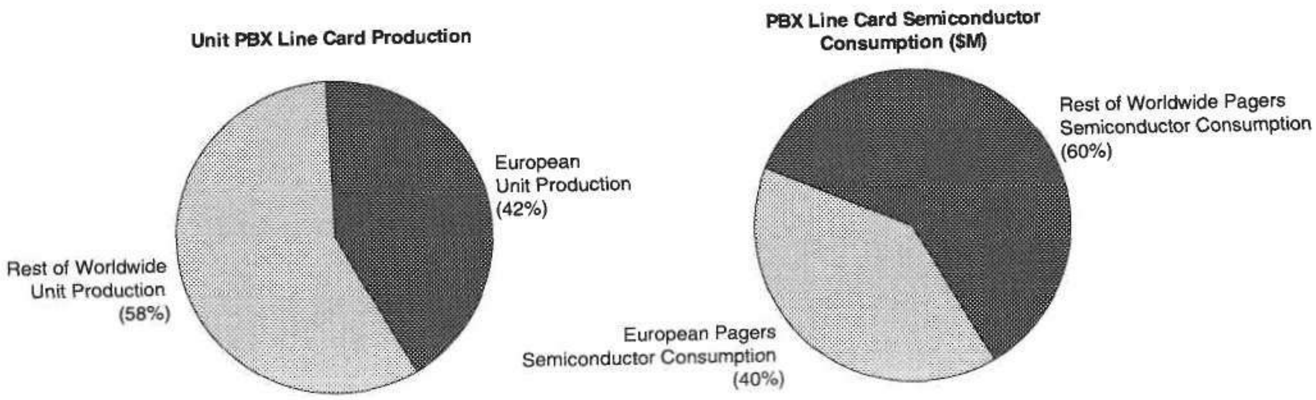
Source: Dataquest (November 1996 Estimates)

Table 3-9
High-Volume Electronic Equipment Production
Region: Europe
Category: Communications—PBX Line Cards (Lines)

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Units (K)	11,300	11,800	12,200	12,500	12,900	13,220	13,600	2.9%
Factory ASP ($)	107	100	95	92	89	86	84	-3.4%
Factory Revenue ($M)	1,209	1,180	1,159	1,150	1,148	1,137	1,142	-0.6%
Semiconductor Content ($)	14	13	13	13	12	12	12	-1.6%
Semiconductor TAM ($M)	158	153	159	163	155	159	163	1.2%

Source: Dataquest (November 1996 Estimates)

Figure 3-9
1996 European PBX Line Card (Lines) Production and Semiconductor Consumption as a Percentage of Worldwide Forecast



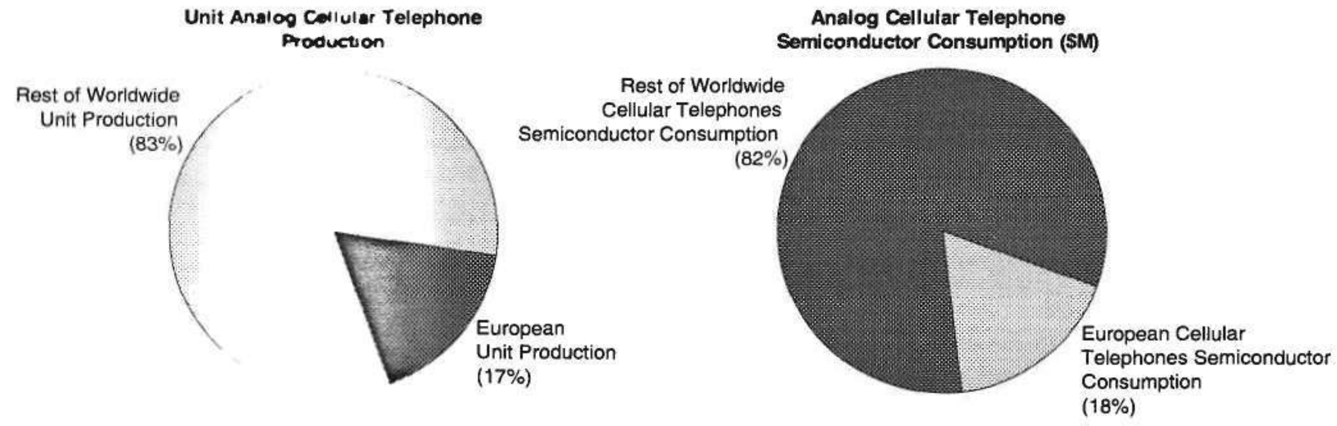
Source: Dataquest (November 1996 Estimates)

Table 3-10
High-Volume Electronic Equipment Production
Region: Europe
Category: Communications—Analog Cellular Telephones

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Units (K)	5,400	6,150	5,120	2,780	2,281	1,350	1,295	-26.8%
Factory ASP ($)	400	355	305	275	265	255	215	-9.5%
Factory Revenue ($M)	2,160	2,183	1,562	765	604	344	278	-33.8%
Semiconductor Content ($)	43	43	42	40	38	35	34	-4.6%
Semiconductor TAM ($M)	232	264	215	111	87	47	44	-30.1%

Source: Dataquest (November 1996 Estimates)

Figure 3-10
1996 European Analog Cellular Telephone Production and Semiconductor Consumption as a Percentage of Worldwide Forecast



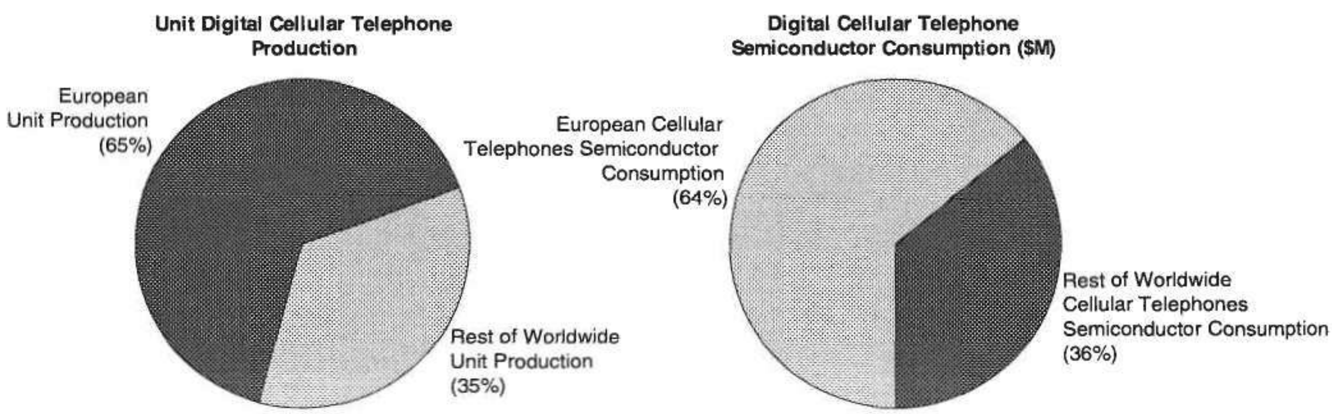
Source: Dataquest (November 1996 Estimates)

Table 3-11
High-Volume Electronic Equipment Production
Region: Europe
Category: Communications—Digital Cellular Telephones

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Units (K)	5,412	12,200	20,000	28,332	41,175	53,675	72,225	42.7%
Factory ASP ($)	480	420	380	340	300	260	230	-11.3%
Factory Revenue ($M)	2,598	5,124	7,600	9,633	12,353	13,956	16,612	26.5%
Semiconductor Content ($)	120	105	95	88	84	75	71	-7.4%
Semiconductor TAM ($M)	649	1,281	1,900	2,505	3,459	4,047	5,150	32.1%

Source: Dataquest (November 1996 Estimates)

Figure 3-11
1996 European Digital Cellular Telephone Production and Semiconductor Consumption as a Percentage of Worldwide Forecast



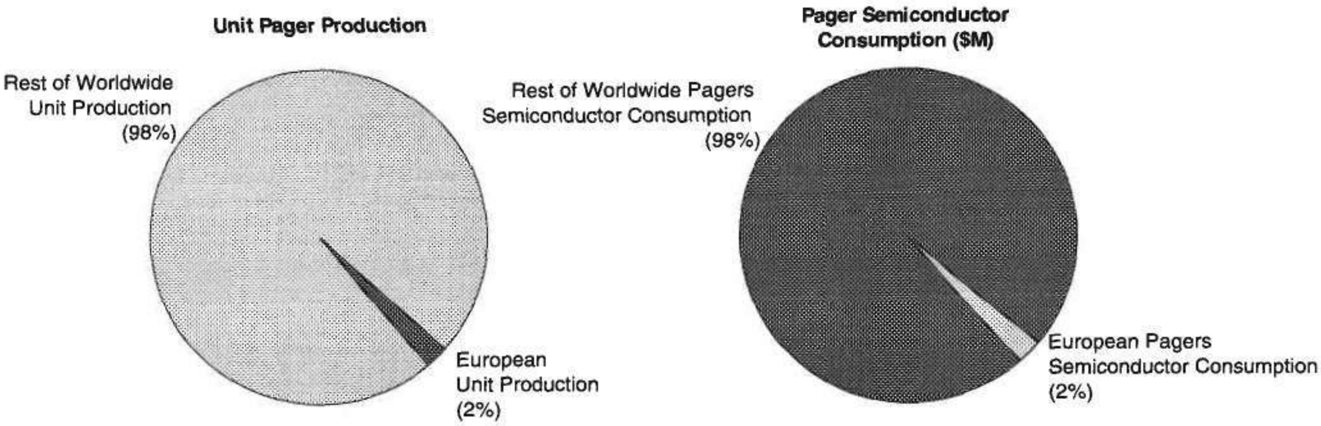
Source: Dataquest (November 1996 Estimates)

Table 3-12
High-Volume Electronic Equipment Production
Region: Europe
Category: Communications—Pagers

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Units (K)	765	887	1,046	1,218	1,406	1,588	2,009	17.8%
Factory ASP ($)	129	124	120	116	113	109	105	-3.3%
Factory Revenue ($M)	99	110	126	142	158	173	211	13.9%
Semiconductor Content ($)	13	13	13	13	14	14	14	0.9%
Semiconductor TAM ($M)	10	12	14	16	19	22	27	18.9%

Source: Dataquest (November 1996 Estimates)

Figure 3-12
1996 European Pager Production and Semiconductor Consumption as a Percentage of Worldwide Forecast



Source: Dataquest (November 1996 Estimates)

Chapter 4

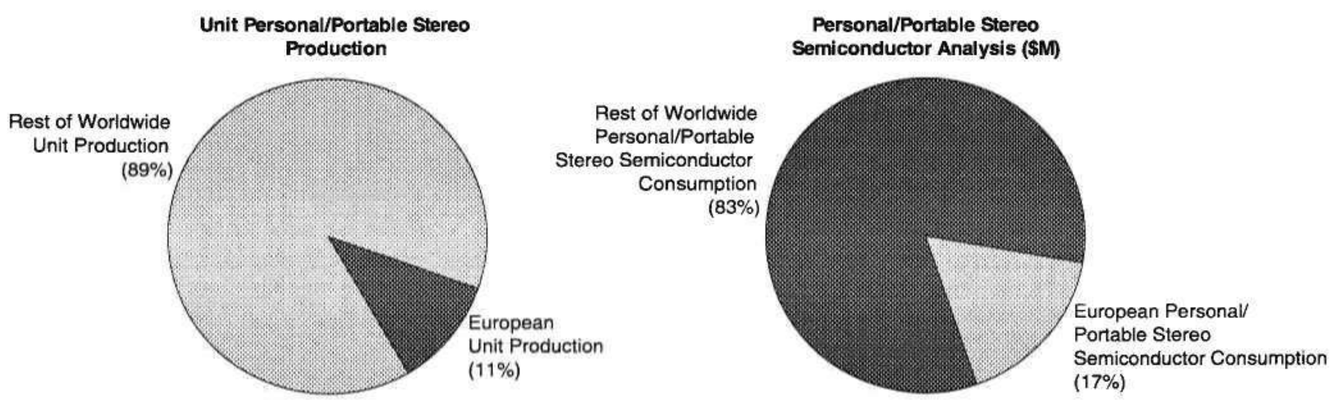
Consumer

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

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Units (K)	15,366	15,383	15,400	15,396	15,398	16,014	16,050	0.9%
Factory ASP ($)	21	21	21	21	21	21	21	0.0%
Factory Revenue ($M)	323	323	323	323	323	336	337	0.9%
Semiconductor Content ($)	12	12	12	13	13	13	13	1.1%
Semiconductor TAM ($M)	184	188	191	192	194	203	207	2.0%

Source: Dataquest (November 1996 Estimates)

Figure 4-1
1996 European Personal/Portable Stereo Production and Semiconductor Consumption as a Percentage of Worldwide Forecast



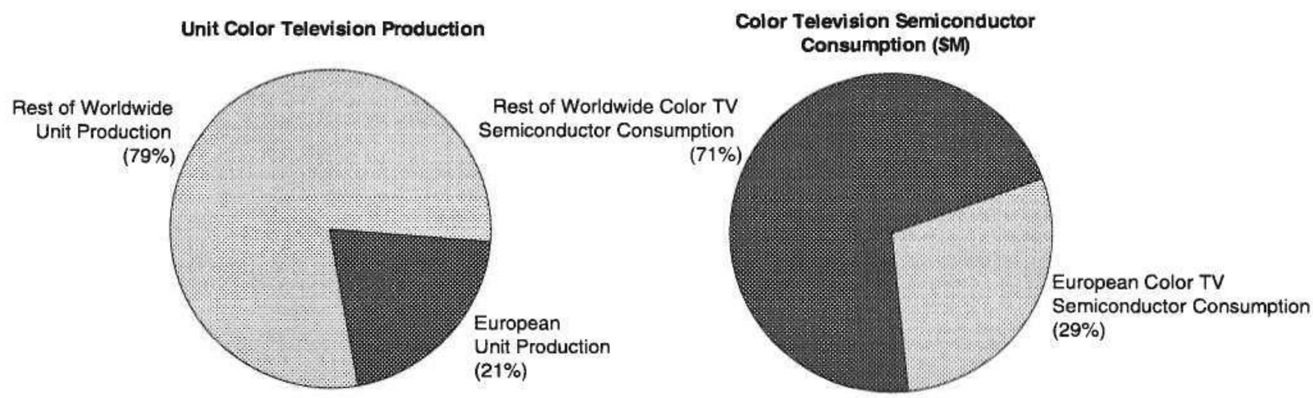
Source: Dataquest (November 1996 Estimates)

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

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Units (K)	22,768	24,701	25,850	26,507	27,431	28,882	30,288	4.2%
Factory ASP ($)	130	135	145	150	160	170	180	5.9%
Factory Revenue ($M)	2,960	3,335	3,748	3,976	4,389	4,910	5,452	10.3%
Semiconductor Content ($)	39	38	40	42	43	44	45	3.3%
Semiconductor TAM ($M)	888	942	1,032	1,102	1,178	1,285	1,360	7.6%

Source: Dataquest (November 1996 Estimates)

Figure 4-2
1996 European Color Television Production and Semiconductor Consumption as a Percentage of Worldwide Forecast



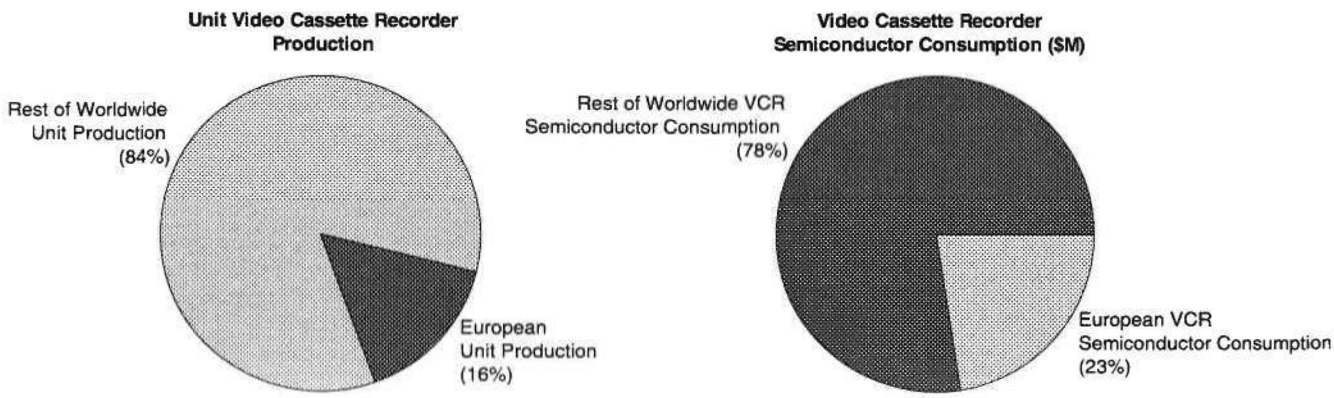
Source: Dataquest (November 1996 Estimates)

Table 4-3
High-Volume Electronic Equipment Production
Region: Europe
Category: Consumer—Video Cassette Recorders

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Units (K)	7,410	8,610	9,417	10,530	11,040	12,384	13,300	9.1%
Factory ASP ($)	165	160	158	158	158	158	158	-0.3%
Factory Revenue ($M)	1,223	1,378	1,488	1,664	1,744	1,957	2,101	8.8%
Semiconductor Content ($)	56	59	60	60	60	60	60	0.3%
Semiconductor TAM ($M)	416	510	565	632	663	744	799	9.4%

Source: Dataquest (November 1996 Estimates)

Figure 4-3
1996 European Video Cassette Recorder Production and Semiconductor Consumption as a Percentage of Worldwide Forecast



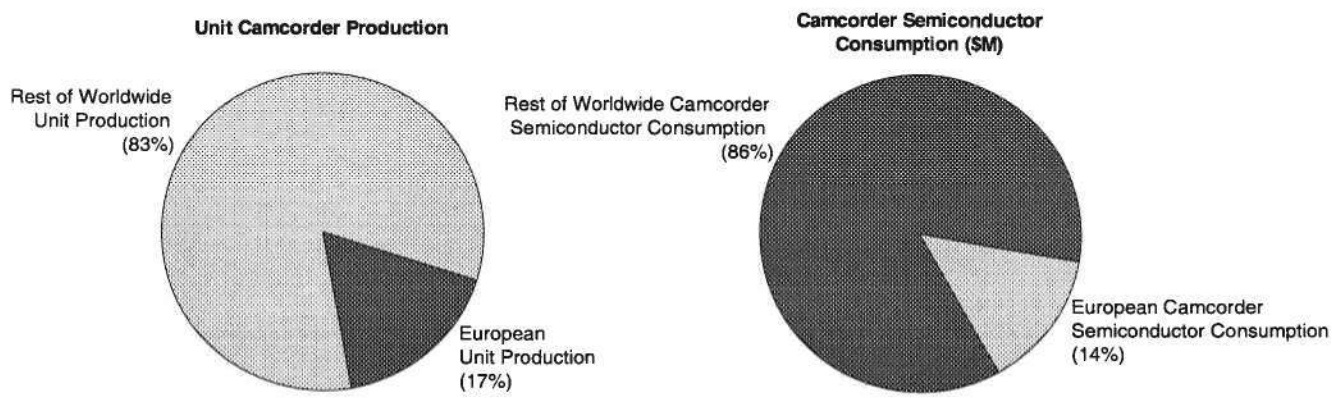
Source: Dataquest (November 1996 Estimates)

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

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Units (K)	1,377	1,572	1,979	2,177	2,373	2,634	2,805	12.3%
Factory ASP ($)	350	340	335	330	320	315	310	-1.8%
Factory Revenue ($M)	482	534	663	718	759	829	870	10.2%
Semiconductor Content ($)	91	92	94	96	96	98	99	1.6%
Semiconductor TAM ($M)	125	144	186	208	228	257	278	14.0%

Source: Dataquest (November 1996 Estimates)

Figure 4-4
1996 European Camcorder Production and Semiconductor Consumption as a Percentage of Worldwide Forecast



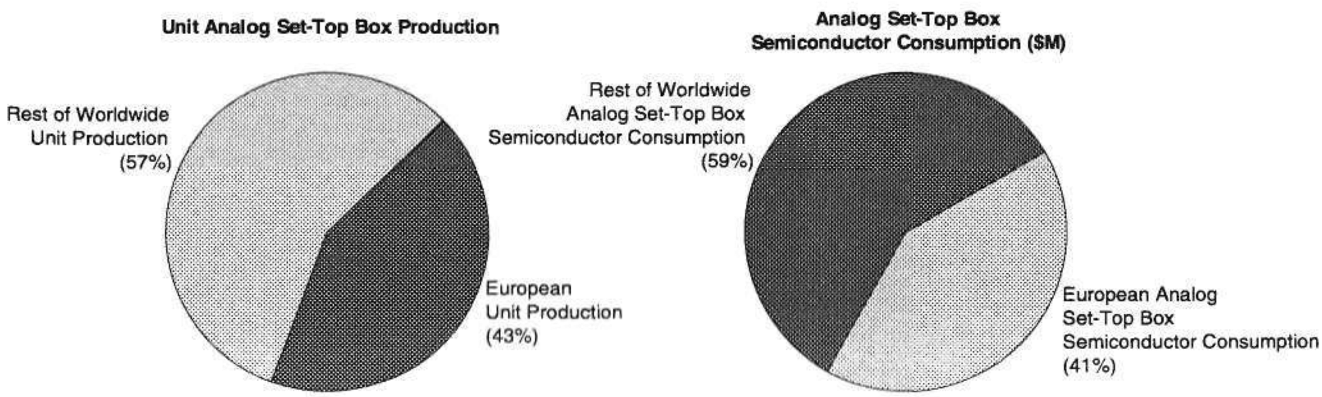
Source: Dataquest (November 1996 Estimates)

Table 4-5
High-Volume Electronic Equipment Production
Region: Europe
Category: Consumer—Analog Set-Top Boxes

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Units (K)	4,993	5,100	4,890	4,200	2,850	1,550	975	-28.2%
Factory ASP ($)	118	119	107	95	88	87	86	-6.2%
Factory Revenue ($M)	587	605	522	400	251	135	84	-32.6%
Semiconductor Content ($)*	41	40	39	38	36	37	38	-1.2%
Semiconductor TAM ($M)	203	204	191	158	102	57	37	-29.1%

* Includes satellite, cable, terrestrial and MMDS
Source: Dataquest (November 1996 Estimates)

Figure 4-5
1996 European Analog Set-Top Box Production and Semiconductor Consumption as a Percentage of Worldwide Forecast



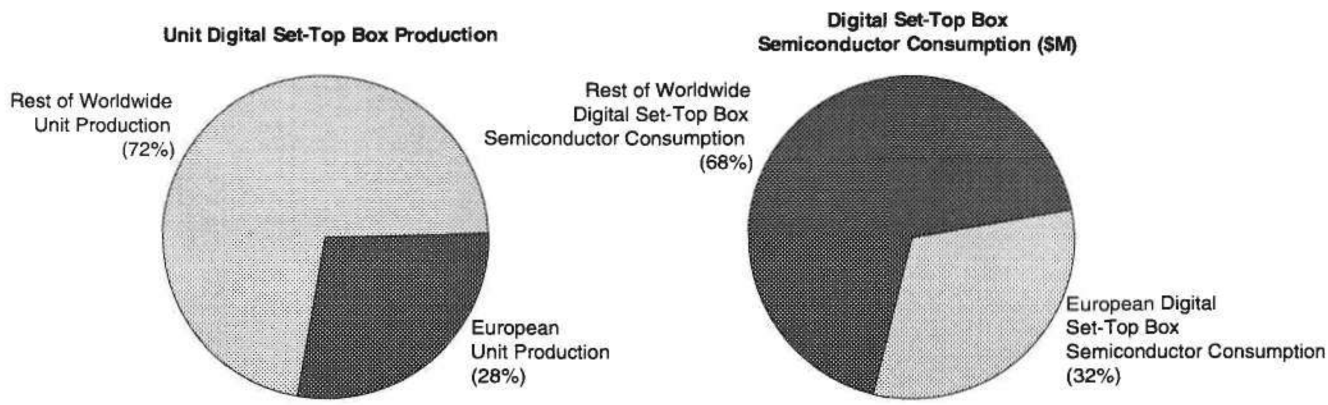
Source: Dataquest (November 1996 Estimates)

Table 4-6
High-Volume Electronic Equipment Production
Region: Europe
Category: Consumer—Digital Set-Top Boxes

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Units (K)	17	335	1,980	4,350	7,130	9,550	10,800	100.3%
Factory ASP ($)	838	746	526	386	316	283	232	-20.8%
Factory Revenue ($M)	14	250	1,041	1,679	2,253	2,703	2,506	58.6%
Semiconductor Content ($)*	345	298	206	151	122	115	107	-18.5%
Semiconductor TAM ($M)	6	100	408	657	870	1,097	1,156	63.2%

* Includes satellite, cable, terrestrial and MMDS
Source: Dataquest (November 1996 Estimates)

Figure 4-6
1996 European Digital Set-Top Box Production and Semiconductor Consumption as a Percentage of Worldwide Forecast



Source: Dataquest (November 1996 Estimates)

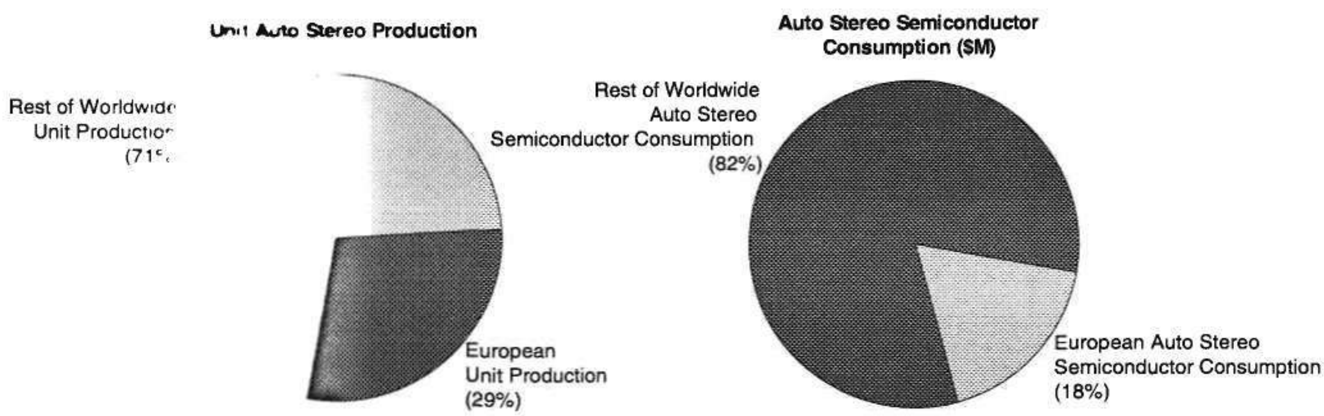
Chapter 5
Automotive

Table 5-1
High-Volume Electronic Equipment Production
Region: Europe
Category: Automotive—Auto Stereos

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Units (K)	14,160	14,600	15,073	15,420	15,600	16,014	16,100	2.0%
Factory ASP ($)	36	37	38	40	45	50	55	8.3%
Factory Revenue ($M)	508	539	571	617	702	801	886	10.5%
Semiconductor Content ($)	8	9	9	11	12	14	15	10.3%
Semiconductor TAM ($M)	111	130	135	164	189	220	234	12.4%

Source: Dataquest (November 1996 Estimates)

Figure 5-1
1996 European Auto Stereo Production and Semiconductor Consumption as a Percentage of Worldwide Forecast



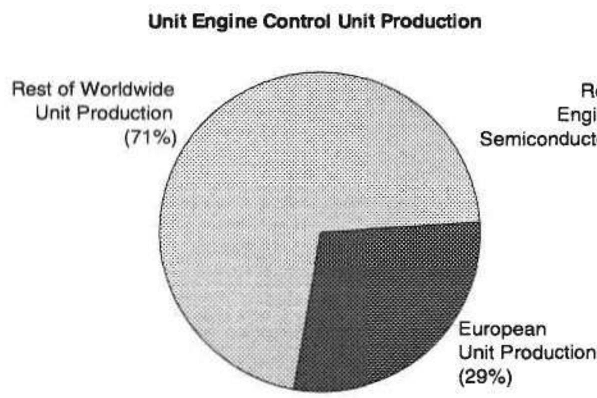
Source: Dataquest (November 1996 Estimates)

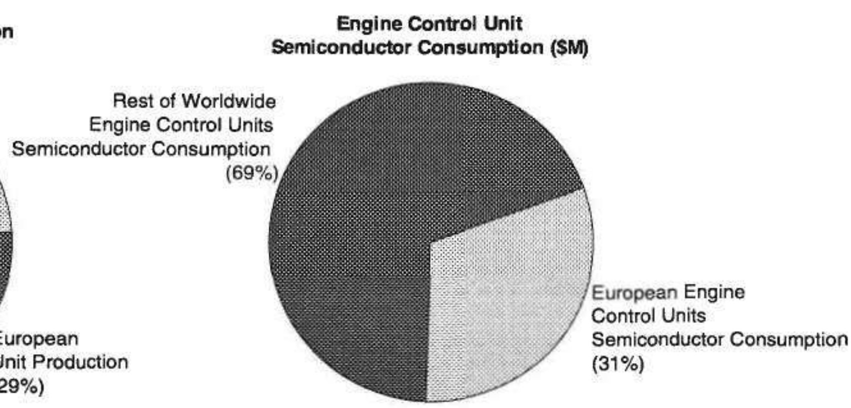
Table 5-2
High-Volume Electronic Equipment Production
Region: Europe
Category: Automotive—Engine Control Units

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Units (K)	9,500	10,350	10,999	11,650	12,200	12,650	13,100	4.8%
Factory ASP ($)	240	215	210	205	200	200	193	-2.2%
Factory Revenue ($M)	2,280	2,225	2,310	2,388	2,440	2,530	2,522	2.5%
Semiconductor Content ($)	36	36	36	36	37	37	37	0.2%
Semiconductor TAM ($M)	344	377	396	423	446	465	483	5.1%

Source: Dataquest (November 1996 Estimates)

Figure 5-2
1996 European Engine Control Unit Production and Semiconductor Consumption as a Percentage of Worldwide Forecast





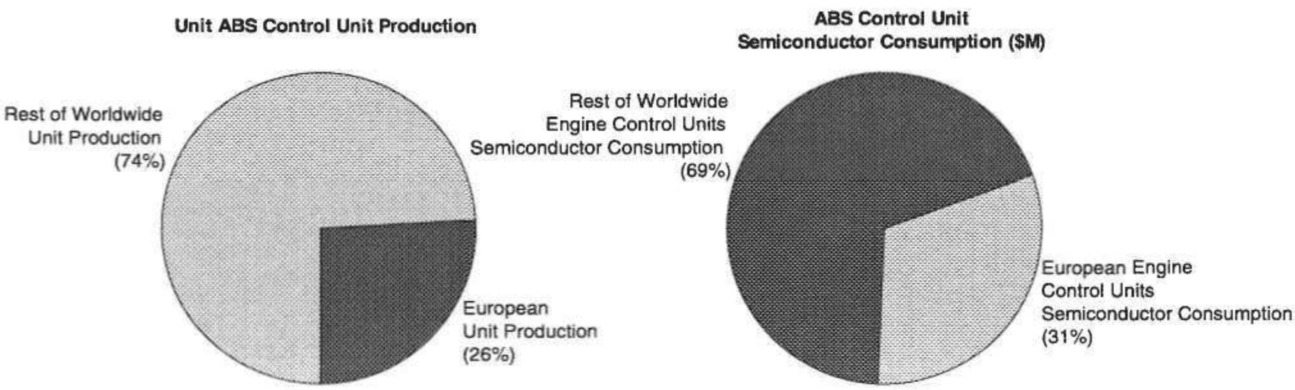
Source: Dataquest (November 1996 Estimates)

Table 5-3
High-Volume Electronic Equipment Production
Region: Europe
Category: Automotive—ABS Control Units

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Units (K)	3,773	4,241	5,185	5,623	6,317	7,156	8,033	13.6%
Factory ASP ($)	200	195	180	175	170	165	150	-5.1%
Factory Revenue ($M)	755	827	933	984	1,074	1,181	1,205	7.8%
Semiconductor Content ($)	44	42	39	38	37	36	33	-4.7%
Semiconductor TAM ($M)	166	178	202	214	234	258	265	8.3%

Source: Dataquest (November 1996 Estimates)

Figure 5-3
1996 European ABS Control Unit Production and Semiconductor Consumption as a Percentage of Worldwide Forecast



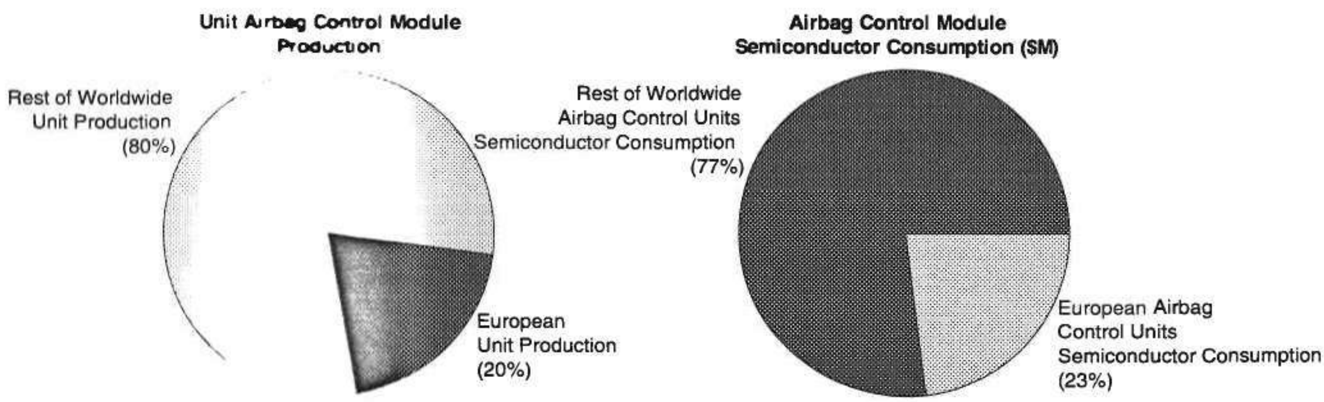
Source: Dataquest (November 1996 Estimates)

Table 5-4
High-Volume Electronic Equipment Production
Region: Europe
Category: Automotive—Airbag Control Modules

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Units (K)	2,900	3,630	4,550	5,700	7,100	8,900	11,150	25.2%
Factory ASP ($)	70	68	68	65	63	63	60	-2.3%
Factory Revenue ($M)	203	245	307	371	444	556	669	22.2%
Semiconductor Content ($)	19	20	22	23	25	28	30	8.2%
Semiconductor TAM ($M)	56	74	101	133	178	250	335	35.4%

Source: Dataquest (November 1996 Estimates)

Figure 5-4
1996 European Airbag Control Module Production and Semiconductor Consumption as a Percentage of Worldwide Forecast



Source: Dataquest (November 1996 Estimates)

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Perspectives

Electronic Equipment Production Monitor

Market Analysis

This quarterly industry review looks at production of electronic equipment in Europe during the fourth quarter of 1995 (October to December).

Quarterly Industry Review

Digital Cellular Handsets–Production Forecast

GSM and DCS-1800 digital cellular handsets currently are a key consumer of electronic components within Europe. Table 1 and Figure 1 show Dataquest's forecast for European digital cellular handset production from 1993 to 2000. This forecast is higher than the figures published as part of the digital cellular handset report (SAPM-EU-FR-9501) in June 1995. Although the compound annual growth rate (CAGR) remains similar at 43 percent (compared with 42 percent reported in June), it is the forecast for 1995 production onwards which has altered.

Some concern exists about lower-than-expected production during the fourth quarter of 1995 and the implications for production during the first quarter of 1996. This stems from several factors including the growth in demand which, while strong, was not as strong as that seen in the fourth quarter of 1994; together with the possibility that some producers may have over-ordered components (in order to ensure an adequate supply), or over-built handsets (which has implications for production in the first quarter of 1996).

Dataquest is in the process of collecting data about 1995 production, and may revise its forecast in the light of this information. Any changes to the forecast will be reported in the next quarterly review.

Dataquest

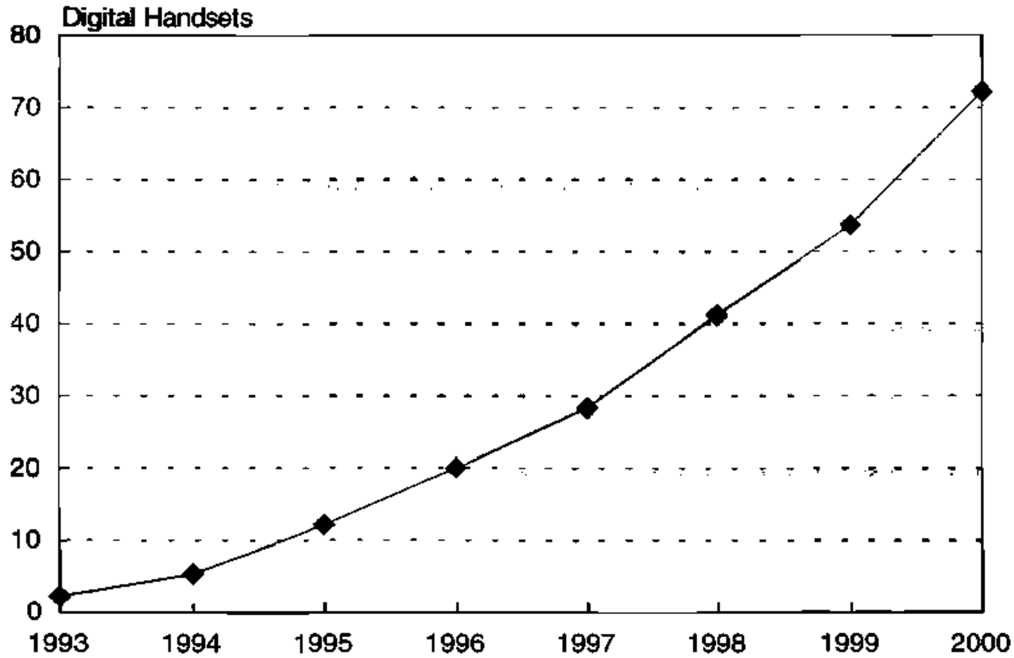
Program: Electronic Equipment Production Monitor
Product Code: SAPM-EU-DP-9601
Publication Date: January 31, 1996
Filing: Perspectives

Table 1
European Digital Cellular Handset Production, 1993 to 2000
(Millions of Units)

	1993	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Digital Handsets	2.31	5.41	12.12	19.96	28.33	41.18	53.67	72.22	43%

Source: Dataquest (September 1995 Estimates)

Figure 1
European Digital Cellular Handset Production, 1993 to 2000
(Millions of Units)



Source: Dataquest (September 1995 Estimates)

1996 European Union Import Tariffs

The start of a new year brings with it changes in the tariff rates (import duties) for goods imported into the European Union (EU). The tariff rates generally change twice a year, on January 1 and July 1. The tariff regulations appear in the *Official Journal of the European Communities* (OJ) "L" series. The most recent information is contained in L318 and L319, both published on December 30, 1995. L319 contains the rates of duty, and L318 contains tariff suspension information.

EU Tariff Rates

Products are classified by a hierarchical eight-digit combined nomenclature (CN) code, which can be followed by a two-digit TARIC code to identify a specific product. L319 lists products in CN code order, together with a description relevant to a product's position in the hierarchy (an eight-digit code will be more specific than a four-digit code), and the autonomous and conventional tariff rates.

The "conventional duties" generally apply to products imported from countries that are signatories to the general agreement on tariffs and trade (GATT), or countries with most-favored-nation (MFN) trading agreements with the EU. The "autonomous duty" applies when it is lower than the conventional duty for a specific product. However, other rates can be applied by individual member countries, or the EU as a whole, if they are legal under community law. Effectively, this gives both member countries and the EU as a whole, almost total flexibility to offer lower import tariffs than those negotiated.

Tariff Suspension

Tariffs are set by negotiation, and tend to cover broad classes of product; many of these are manufactured within the EU, as well as being imported. However, if a product is not manufactured within the EU, or an importer can support a case based on other factors, then it is possible to suspend the import tariff. These suspensions usually last for six or twelve months, and can then be renewed or "rolled over." In many cases tariff suspensions are rolled over until the importer of a product no longer requires it, or until a manufacturer of the product within the EU emerges and objects.

World Trade

The background to the latest tariff rate adjustments is to stimulate and increase world trade, which has been helped by the completion of the Uruguay round of GATT negotiations in 1994. However, in addition to general rate cuts agreed under GATT, further rate cuts have been caused by the accession of Austria, Finland and Sweden to the EU in January 1995.

Before their membership of the EU, Austria, Finland and Sweden had lower import tariffs than the EU for certain products. By joining the EU, they were forced to increased their import tariffs on these products. The United States has negotiated tariff reductions with the EU (which should benefit all GATT and MFN trading partners) as broad compensation for the accession of Austria, Finland and Sweden. These concessions mainly deal with IT products and semiconductor devices. In general, tariffs of 7 percent or more (usually up to 14 percent) will fall to 7 percent for a range of products, and those tariffs of 7 percent or less will fall to zero.

General System of Preferences

The general system of preferences (GSP) is a scheme that allows products imported from "developing countries" to qualify for reduced import tariffs (which vary, depending upon the sensitivity of the product). The definition of a developing country is one with a per capita gross national product (GNP) of $6,000 or less. Historically, countries which have benefited from GSP include Hong Kong, Malaysia, Singapore and South Korea. However, both Singapore and South Korea have lost their GSP status from the beginning of 1996, while Hong Kong receives GSP on a limited number of products classified under codes prefixed 84- and 85-. Malaysia will start to lose some GSP benefits from January 1997.

Tariff Rates for Selected Products

Selected products, together with their previous duty rates which were introduced on July 1, 1995, and the new rates introduced on January 1, 1996, are shown in Table 2. The products chosen are a cross-section of electronic components and applications.

The duty rates from July 1, 1995, were published on June 26, 1995, and are from OJ-L142; the duty rates from January 1, 1996 were published on December 30, 1995, and are from OJ-L319; the tariff suspension rates published on December 30, 1995, are from OJ-L318. The rates published in the OJ publications are specified by European Commission regulations, which are detailed in the respective OJ publications.

Table 2
European Customs Codes, Product Descriptions, Tariff Rates and Tariff Suspension for Selected Products

Customs Code	Product Description	Tariff Rate (%) from July 1, 1995	Tariff Rate (%) from January 1, 1996	Suspension Rate
8516-50-00	Microwave Ovens	5.0	4.0	
8528-12	Color Televisions	14.0	14.0	
8532-21-00	Tantalum Capacitors	6.3	5.0	
8532-24	Multilayer Ceramic Capacitors	4.5	3.6	
8533	Resistors	4.8	3.7	
8534	Printed Circuits	5.9	5.2	Some products
8542-13-13	4-Mbit to (but not including) 16-Mbit DRAMs	14.0	7.0	Some products
8521-90-00	CD-ROM Drives	3.9	14.0	0.0%
8471-70-53	Rigid Disk Drives	3.9	1.6	0.0%

Source: European Commission Legislation/Dataquest (January 1996)

In Table 2, where the suspension rate refers to "some products," these are specific products (within the broader category) which have been granted suspension. In these cases, the product is described to the extent that it should be unambiguous which specific part from which specific manufacturer is exempt.

CD-ROM Drives

In the case of CD-ROM drives, these products were reclassified from CN code 8471-93-51 (data reproduction) to 8521-90-00 (image reproduction) under EC regulation 2564/95, dated October 27, 1995. By reclassifying the CD-ROM drives (due to their dual use of providing IT and entertainment functionality), the tariff rate increased from 3.9 percent to 14.0 percent.

Although the formal reclassification was a technical issue, this classification case generated strong interest with extensive consultation and lobbying prior to the regulation. It also indicated that the decision might have far-reaching implications. It could be argued that a CD-ROM drive is a component used in a computer application and should retain an IT component classification.

If that argument is expanded, the use of CD-ROM drives (and other sound- and image-enabling technology/components) for non-professional multimedia may be regarded as products with a CN code starting with 85, and attracting the relevant tariffs. However, although the longer term issues around this subject remain, CD-ROM drives have had their tariffs suspended entirely (that is, 0 percent) from November 22, 1995; initially until June 30, 1996.

Recommendations

The whole subject of import tariff rates, tariff suspension, and the implications for trade is both detailed and complicated; it has not been possible to cover this subject in the required depth to satisfy all readers. Clients are advised to obtain the required level of detail and information appropriate to their business activities (for example, copies of appropriate regulations, specialist professional advice), and to ascertain their eligibility for any temporary tariff suspension during 1996.

OEM News

Acer has announced plans for a PC assembly plant in Finland, which it intends to use to supply the Commonwealth of Independent States (CIS) and other parts of the former Soviet Union. Acer set up a sales office in Moscow in 1994 and has since experienced rapid growth in shipments to the region; currently, the company has the second-largest market share. The new facility in Lappeenranta is a joint venture with Wilson Finland Oy, and is scheduled to start operation early in 1996. Initial production capacity is about 4,000 units per month, which is forecast to rise to about 6,000 units per month during 1996.

Acer's decision to site its new facility in Finland was partly due to its reluctance to assemble within the CIS or Russia, due to continuing economic and political instability. Finland's historically strong trading links with the former Soviet Union have helped to develop stable shipping routes into the CIS. Also, the act of assembling parts imported into the EU, prior to export outside the EU (a process known as inward processing), ensures that Acer gains relief from customs duty.

Wilson Finland Oy is not an electronics company, but has been managing distribution and logistics on behalf of third parties for more than five years. Acer plans to use a build-to-order production system to ensure that it can deliver PCs within short lead times; for this reason it has chosen to work with a partner which can add value using its experience in cost-effective just-in-time materials logistics.

APC

After announcing in June 1995 that it was seeking sites for expansion, American Power Conversion (APC) has revealed its plans to support future growth in Ireland. The maker of uninterruptible power supplies (UPS) is investing $3.2 million in setting up research and development (R&D) and telemarketing functions for Europe at its existing production site in Galway.

As well as investment in an existing site, APC is also setting up three distinct manufacturing operations: the company is investing $23.5 million at Drogheda to manufacture UPS products for PCs, workstations and LAN servers; $24.3 million at Gillogue to set up a distribution center, and to manufacture higher-power UPS products; and $13.8 million at Castlebar for the manufacture of higher-powered surge-protection devices.

APC has made the decision that each manufacturing facility will focus on a particular type of product, aimed at a specific part of the market. This can ensure that the cost to manufacture is supported by the sales price, and manufacturing similar products at the same plant should cause less disruption to production lines. However, lessons learnt from manufacturing one product could benefit another, and it is up to APC's management to spread good practice throughout the organization.

APC's phenomenal growth is fuelled by the continuing migration away from centralized data processing towards distributed networks, which typically are based around LAN servers. These servers, in both large companies and small businesses, can be as critical as the traditional mainframe, and require intelligent-UPS support. The low UPS installed base on PCs, coupled with the explosive growth of Internet and other communication servers, should ensure that these new facilities mirror the success of the Galway plant.

Apple

Apple is increasing production of Power Macintosh computers at its plant at Cork in Ireland. The company already has started to recruit additional production personnel, and announced that it will be creating up to 600 new jobs by 1998. Although there is no new capital investment, the additional personnel will be used to increase the utilization of production equipment through additional shifts and other working practises.

While Apple has declared that it can meet demand for lower-specification Power Macintosh machines, it is still experiencing difficulties in supplying enough higher-specification machines. Moreover, although many of the supply issues are related to component shortages, any expansion in production capacity demonstrates that demand for Power Macintosh machines continues to grow.

Apple's recent announcement about restructuring (following the company's loss during the first quarter of its 1996 financial year) should not immediately affect production at the plant in Cork.

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The new operation will assemble 38-cm and 43-cm monitors using cathode-ray tubes (CRTs) from a Philips plant in Austria, and electronic components kitted by KDS in Korea. Two production lines have been installed in the Aquarius factory at Sommerda, with an annual capacity of about 240,000 monitors.

This plan to manufacture monitors was hatched two years ago, and the strong demand for monitors in 1995 should help to offset the relatively low demand for Aquarius-branded PCs. Although Aquarius PC shipments have risen during 1995 compared with 1994, current PC production does not seem to match the factory's significant manufacturing capacity. While the CRTs are now sourced from Europe, the electronic components are still being imported from Korea. Until the components are sourced locally, KDS Multivision will have to keep an inventory of imported electronic kits in order to offer the manufacturing flexibility needed.

Chung Hwa Picture Tube/Tatung

Taiwan-based Chung Hwa Picture Tube has announced that it is investing $411 million in a CRT manufacturing plant in Scotland. The company is controlled by Tatung, which owns more than 90 percent, and which currently manufactures televisions in relatively low quantities in Telford, England.

The new facility at Mossend will join existing plants in China, Malaysia and Taiwan. The three plants currently in production are forecast to produce about 20 million CRTs during 1995. The first output from Mossend, using two production lines, currently is scheduled for 1997; and total capacity using six lines is expected to be about 10 million CRTs annually.

This is one of a number of announcements made over the past few months by monitor and CRT manufacturers. The monitor market is forecast to grow with a CAGR of just over 13 percent until 1999, and there are also time-to-market

factors associated with production in Europe for the regional market (including Central and Eastern Europe, the Middle East and Africa).

The decision to site the plant in Scotland (in preference to alternative locations in France and Ireland), was due to many factors. As well as the skilled work force, low tax rate and lower total cost-of-labor factors—which are now habitually quoted in connection with the United Kingdom—several product-specific factors also have to be considered.

Transportation costs from the Asia/Pacific region now have a significant effect on the cost of CRTs and monitors. As CRTs are relatively heavy, the plant's location close to a EuroTunnel terminal should prove useful. The remaining factors relate to the two main ingredients in CRT manufacture, namely plenty of inexpensive water and electricity. It may well be that a deal with one of the Scottish electricity generators and a water-supply utility has helped to site the plant in Scotland.

Hewlett-Packard/Solectron

Hewlett-Packard (HP) and Solectron have made a joint announcement about new computer and PCB assembly plants in Germany. HP is expanding its production of workstation and server products by investing in a new facility at Herrenberg. The total investment is about $49 million, and allows the company to implement more flexible production processes in order to satisfy the increasing customer demand in a more focused and timely manner. Construction is due to start during 1996, with the completed facility ready for production in 1997.

Solectron has announced that it is investing about $10.5 million in a new PCB assembly plant at Herrenberg. This follows an agreement between the two parties which led to Solectron taking control of one of HP's facilities at nearby Böblingen in November 1995. The acquisition was a PCB assembly site, and Solectron has continued to manufacture PCBs for Hewlett-Packard.

HP has decided to site its computer assembly plants close to its distribution facilities in order to reduce delivery times to customers. In addition, the company has outsourced PCB assembly activity to a contract manufacturer (in this case Solectron). Solectron is using its existing production facility to expand into the German market. As well as gaining additional business from HP, Solectron has the opportunity to diversify its customer base in a country which has few specialist contract manufacturers to match Solectron.

IBM

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The new Hungarian factory is owned by Videoton and leased to IBM on a long-term basis, with IBM investing and installing clean-room facilities and manufacturing equipment. Operations control, logistics management and engineering support will be provided by IBM's operations in Mainz, Germany.

This announcement underlines IBM's effort to gain a significant share of the rigid disk drive business, especially in the European market, where more than one in four disk drives consumed are made locally. Even with this new facility, IBM will still be constrained by manufacturing capacity.

The industry is planning its migration to entry-level drives with at least 1GB of capacity during 1996. These capacities now often require advanced recording technology; and it is access to enabling technologies (IBM's area of strength) which is of prime importance.

Optimus/Seikosha

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Although the agreement was announced in December 1995, production had already started, and Optimus expects to have manufactured about 15,000 printers by the end of 1995. The expected production capacity is forecast to reach about 2,000 printers per week during 1996.

Dot matrix printers are coming to the end of their life cycle in Western Europe and, although the printers produced by Optimus will supply the whole of Europe, it is likely that the majority will remain in Eastern Europe. This is the first agreement of its kind in Eastern Europe, and makes Optimus the first printer manufacturer in the region. Manufacturing printers offers Central and Eastern European PC manufacturers an opportunity to diversify their production activities, as well as the option of bundling printers with PCs.

In this particular case, Seikosha certainly chose one of the best possible partners, since Optimus is the largest PC manufacturer in the region and will help Seikosha's penetration of the Polish market. Optimus used to badge OEM printers, and this move is its next logical step.

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Rank Xerox claims that quality systems, labor flexibility and improved manufacturing processes have improved productivity significantly at Mitcheldean over the last few years, such that the plant now boasts a lower cost base than other Rank Xerox production facilities in both France and the Netherlands. In reality, it is likely to be a combination of improved customer satisfaction due to operational improvements and the lower total cost of employment in the United Kingdom, which has helped to secure this contract.

Silicon Graphics

Computer manufacturer Silicon Graphics has announced an expansion of its manufacturing and applications development facility at Cortaillod in Switzerland. The site has been open since 1992, and will receive an additional investment of $26 million for manufacturing-technology and advanced-technology development, as well as support functions.

The Swiss site currently manufactures Indy and Indigo workstations. Increased demand for server and supercomputer products worldwide has led it to manufacture these high-end products in Europe for local consumption; in turn, this frees production capacity in Japan and the United States to supply their local markets.

Silicon Graphics has products which can support the long-term growth in demand for digital content-creation and manipulation systems used in film and television production, as well as other graphical and design applications. It is also benefiting from the very strong demand for high-end Internet servers.

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Perspectives

Electronic Equipment Production Monitor

Market Analysis

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Quarterly Industry Review

Digital Cellular Handsets–Production Forecast

GSM and DCS-1800 digital cellular handsets currently are a key consumer of electronic components within Europe. Table 1 and Figure 1 show Dataquest's forecast for European digital cellular handset production from 1993 to 2000. This forecast is higher than the figures published as part of the digital cellular handset report (SAPM-EU-FR-9501) in June 1995. Although the compound annual growth rate (CAGR) remains similar at 43 percent (compared with 42 percent reported in June), it is the forecast for 1995 production onwards which has altered.

Some concern exists about lower-than-expected production during the fourth quarter of 1995 and the implications for production during the first quarter of 1996. This stems from several factors including the growth in demand which, while strong, was not as strong as that seen in the fourth quarter of 1994; together with the possibility that some producers may have over-ordered components (in order to ensure an adequate supply), or over-built handsets (which has implications for production in the first quarter of 1996).

Dataquest is in the process of collecting data about 1995 production, and may revise its forecast in the light of this information. Any changes to the forecast will be reported in the next quarterly review.

Dataquest

Program: Electronic Equipment Production Monitor
Product Code: SAPM-EU-DP-9601
Publication Date: January 31, 1996
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Table 1
European Digital Cellular Handset Production, 1993 to 2000
(Millions of Units)

	1993	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Digital Handsets	2.31	5.41	12.12	19.96	28.33	41.18	53.67	72.22	43%

Source: Dataquest (September 1995 Estimates)

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European Digital Cellular Handset Production, 1993 to 2000
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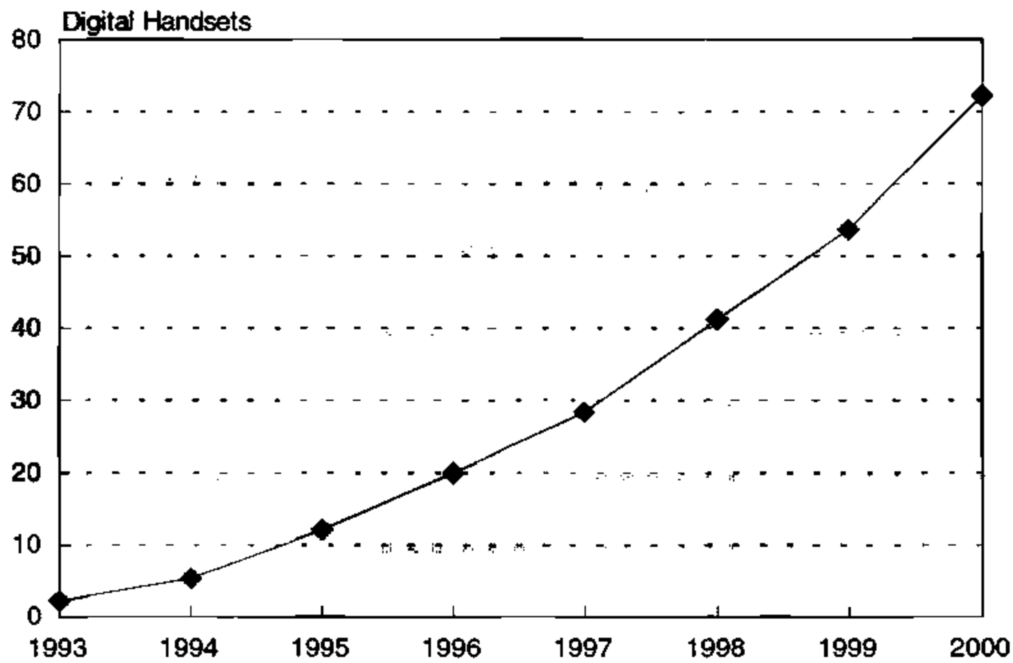

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1996 European Union Import Tariffs

The start of a new year brings with it changes in the tariff rates (import duties) for goods imported into the European Union (EU). The tariff rates generally change twice a year, on January 1 and July 1. The tariff regulations appear in the *Official Journal of the European Communities* (OJ) "L" series. The most recent information is contained in L318 and L319, both published on December 30, 1995. L319 contains the rates of duty, and L318 contains tariff suspension information.

EU Tariff Rates

Products are classified by a hierarchical eight-digit combined nomenclature (CN) code, which can be followed by a two-digit TARIC code to identify a specific product. L319 lists products in CN code order, together with a description relevant to a product's position in the hierarchy (an eight-digit code will be more specific than a four-digit code), and the autonomous and conventional tariff rates.

The "conventional duties" generally apply to products imported from countries that are signatories to the general agreement on tariffs and trade (GATT), or countries with most-favored-nation (MFN) trading agreements with the EU. The "autonomous duty" applies when it is lower than the conventional duty for a specific product. However, other rates can be applied by individual member countries, or the EU as a whole, if they are legal under community law. Effectively, this gives both member countries and the EU as a whole, almost total flexibility to offer lower import tariffs than those negotiated.

Tariff Suspension

Tariffs are set by negotiation, and tend to cover broad classes of product; many of these are manufactured within the EU, as well as being imported. However, if a product is not manufactured within the EU, or an importer can support a case based on other factors, then it is possible to suspend the import tariff. These suspensions usually last for six or twelve months, and can then be renewed or "rolled over." In many cases tariff suspensions are rolled over until the importer of a product no longer requires it, or until a manufacturer of the product within the EU emerges and objects.

World Trade

The background to the latest tariff rate adjustments is to stimulate and increase world trade, which has been helped by the completion of the Uruguay round of GATT negotiations in 1994. However, in addition to general rate cuts agreed under GATT, further rate cuts have been caused by the accession of Austria, Finland and Sweden to the EU in January 1995.

Before their membership of the EU, Austria, Finland and Sweden had lower import tariffs than the EU for certain products. By joining the EU, they were forced to increased their import tariffs on these products. The United States has negotiated tariff reductions with the EU (which should benefit all GATT and MFN trading partners) as broad compensation for the accession of Austria, Finland and Sweden. These concessions mainly deal with IT products and semiconductor devices. In general, tariffs of 7 percent or more (usually up to 14 percent) will fall to 7 percent for a range of products, and those tariffs of 7 percent or less will fall to zero.

General System of Preferences

The general system of preferences (GSP) is a scheme that allows products imported from "developing countries" to qualify for reduced import tariffs (which vary, depending upon the sensitivity of the product). The definition of a developing country is one with a per capita gross national product (GNP) of $6,000 or less. Historically, countries which have benefited from GSP include Hong Kong, Malaysia, Singapore and South Korea. However, both Singapore and South Korea have lost their GSP status from the beginning of 1996, while Hong Kong receives GSP on a limited number of products classified under codes prefixed 84- and 85-. Malaysia will start to lose some GSP benefits from January 1997.

Tariff Rates for Selected Products

Selected products, together with their previous duty rates which were introduced on July 1, 1995, and the new rates introduced on January 1, 1996, are shown in Table 2. The products chosen are a cross-section of electronic components and applications.

The duty rates from July 1, 1995, were published on June 26, 1995, and are from OJ-L142; the duty rates from January 1, 1996 were published on December 30, 1995, and are from OJ-L319; the tariff suspension rates published on December 30, 1995, are from OJ-L318. The rates published in the OJ publications are specified by European Commission regulations, which are detailed in the respective OJ publications.

Table 2
European Customs Codes, Product Descriptions, Tariff Rates and Tariff Suspension for Selected Products

Customs Code	Product Description	Tariff Rate (%) from July 1, 1995	Tariff Rate (%) from January 1, 1996	Suspension Rate
8516-50-00	Microwave Ovens	5.0	4.0	
8528-12	Color Televisions	14.0	14.0	
8532-21-00	Tantalum Capacitors	6.3	5.0	
8532-24	Multilayer Ceramic Capacitors	4.5	3.6	
8533	Resistors	4.8	3.7	
8534	Printed Circuits	5.9	5.2	Some products
8542-13-13	4-Mbit to (but not including) 16-Mbit DRAMs	14.0	7.0	Some products
8521-90-00	CD-ROM Drives	3.9	14.0	0.0%
8471-70-53	Rigid Disk Drives	3.9	1.6	0.0%

Source: European Commission Legislation/Dataquest (January 1996)

In Table 2, where the suspension rate refers to "some products," these are specific products (within the broader category) which have been granted suspension. In these cases, the product is described to the extent that it should be unambiguous which specific part from which specific manufacturer is exempt.

CD-ROM Drives

In the case of CD-ROM drives, these products were reclassified from CN code 8471-93-51 (data reproduction) to 8521-90-00 (image reproduction) under EC regulation 2564/95, dated October 27, 1995. By reclassifying the CD-ROM drives (due to their dual use of providing IT and entertainment functionality), the tariff rate increased from 3.9 percent to 14.0 percent.

Although the formal reclassification was a technical issue, this classification case generated strong interest with extensive consultation and lobbying prior to the regulation. It also indicated that the decision might have far-reaching implications. It could be argued that a CD-ROM drive is a component used in a computer application and should retain an IT component classification.

If that argument is expanded, the use of CD-ROM drives (and other sound- and image-enabling technology/components) for non-professional multimedia may be regarded as products with a CN code starting with 85, and attracting the relevant tariffs. However, although the longer term issues around this subject remain, CD-ROM drives have had their tariffs suspended entirely (that is, 0 percent) from November 22, 1995; initially until June 30, 1996.

Recommendations

The whole subject of import tariff rates, tariff suspension, and the implications for trade is both detailed and complicated; it has not been possible to cover this subject in the required depth to satisfy all readers. Clients are advised to obtain the required level of detail and information appropriate to their business activities (for example, copies of appropriate regulations, specialist professional advice), and to ascertain their eligibility for any temporary tariff suspension during 1996.

OEM News

Acer has announced plans for a PC assembly plant in Finland, which it intends to use to supply the Commonwealth of Independent States (CIS) and other parts of the former Soviet Union. Acer set up a sales office in Moscow in 1994 and has since experienced rapid growth in shipments to the region; currently, the company has the second-largest market share. The new facility in Lappeenranta is a joint venture with Wilson Finland Oy, and is scheduled to start operation early in 1996. Initial production capacity is about 4,000 units per month, which is forecast to rise to about 6,000 units per month during 1996.

Acer's decision to site its new facility in Finland was partly due to its reluctance to assemble within the CIS or Russia, due to continuing economic and political instability. Finland's historically strong trading links with the former Soviet Union have helped to develop stable shipping routes into the CIS. Also, the act of assembling parts imported into the EU, prior to export outside the EU (a process known as inward processing), ensures that Acer gains relief from customs duty.

Wilson Finland Oy is not an electronics company, but has been managing distribution and logistics on behalf of third parties for more than five years. Acer plans to use a build-to-order production system to ensure that it can deliver PCs within short lead times; for this reason it has chosen to work with a partner which can add value using its experience in cost-effective just-in-time materials logistics.

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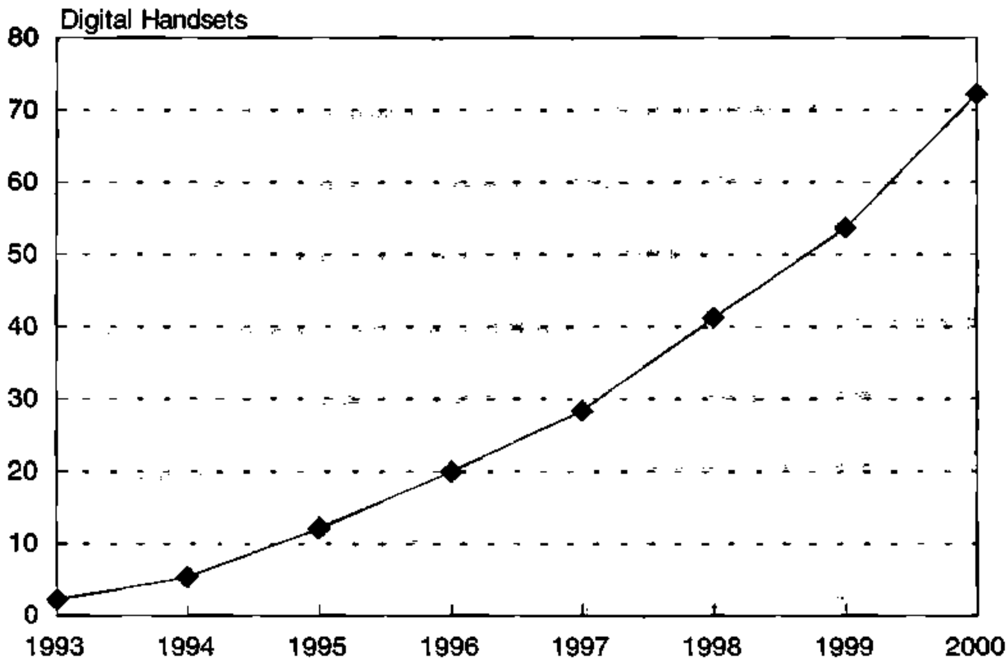
European Digital Cellular Handset Production, 1993 to 2000
(Millions of Units)



Source: Dataquest (September 1995 Estimates)

1996 European Union Import Tariffs

The start of a new year brings with it changes in the tariff rates (import duties) for goods imported into the European Union (EU). The tariff rates generally change twice a year, on January 1 and July 1. The tariff regulations appear in the *Official Journal of the European Communities* (OJ) "L" series. The most recent information is contained in L318 and L319, both published on December 30, 1995. L319 contains the rates of duty, and L318 contains tariff suspension information.

EU Tariff Rates

Products are classified by a hierarchical eight-digit combined nomenclature (CN) code, which can be followed by a two-digit TARIC code to identify a specific product. L319 lists products in CN code order, together with a description relevant to a product's position in the hierarchy (an eight-digit code will be more specific than a four-digit code), and the autonomous and conventional tariff rates.

The "conventional duties" generally apply to products imported from countries that are signatories to the general agreement on tariffs and trade (GATT), or countries with most-favored-nation (MFN) trading agreements with the EU. The "autonomous duty" applies when it is lower than the conventional duty for a specific product. However, other rates can be applied by individual member countries, or the EU as a whole, if they are legal under community law. Effectively, this gives both member countries and the EU as a whole, almost total flexibility to offer lower import tariffs than those negotiated.

Tariff Suspension

Tariffs are set by negotiation, and tend to cover broad classes of product; many of these are manufactured within the EU, as well as being imported. However, if a product is not manufactured within the EU, or an importer can support a case based on other factors, then it is possible to suspend the import tariff. These suspensions usually last for six or twelve months, and can then be renewed or "rolled over." In many cases tariff suspensions are rolled over until the importer of a product no longer requires it, or until a manufacturer of the product within the EU emerges and objects.

World Trade

The background to the latest tariff rate adjustments is to stimulate and increase world trade, which has been helped by the completion of the Uruguay round of GATT negotiations in 1994. However, in addition to general rate cuts agreed under GATT, further rate cuts have been caused by the accession of Austria, Finland and Sweden to the EU in January 1995.

Before their membership of the EU, Austria, Finland and Sweden had lower import tariffs than the EU for certain products. By joining the EU, they were forced to increased their import tariffs on these products. The United States has negotiated tariff reductions with the EU (which should benefit all GATT and MFN trading partners) as broad compensation for the accession of Austria, Finland and Sweden. These concessions mainly deal with IT products and semiconductor devices. In general, tariffs of 7 percent or more (usually up to 14 percent) will fall to 7 percent for a range of products, and those tariffs of 7 percent or less will fall to zero.

General System of Preferences

The general system of preferences (GSP) is a scheme that allows products imported from "developing countries" to qualify for reduced import tariffs (which vary, depending upon the sensitivity of the product). The definition of a developing country is one with a per capita gross national product (GNP) of $6,000 or less. Historically, countries which have benefited from GSP include Hong Kong, Malaysia, Singapore and South Korea. However, both Singapore and South Korea have lost their GSP status from the beginning of 1996, while Hong Kong receives GSP on a limited number of products classified under codes prefixed 84- and 85-. Malaysia will start to lose some GSP benefits from January 1997.

Tariff Rates for Selected Products

Selected products, together with their previous duty rates which were introduced on July 1, 1995, and the new rates introduced on January 1, 1996, are shown in Table 2. The products chosen are a cross-section of electronic components and applications.

The duty rates from July 1, 1995, were published on June 26, 1995, and are from OJ-L142; the duty rates from January 1, 1996 were published on December 30, 1995, and are from OJ-L319; the tariff suspension rates published on December 30, 1995, are from OJ-L318. The rates published in the OJ publications are specified by European Commission regulations, which are detailed in the respective OJ publications.

Table 2
European Customs Codes, Product Descriptions, Tariff Rates and Tariff Suspension for Selected Products

Customs Code	Product Description	Tariff Rate (%) from July 1, 1995	Tariff Rate (%) from January 1, 1996	Suspension Rate
8516-50-00	Microwave Ovens	5.0	4.0	
8528-12	Color Televisions	14.0	14.0	
8532-21-00	Tantalum Capacitors	6.3	5.0	
8532-24	Multilayer Ceramic Capacitors	4.5	3.6	
8533	Resistors	4.8	3.7	
8534	Printed Circuits	5.9	5.2	Some products
8542-13-13	4-Mbit to (but not including) 16-Mbit DRAMs	14.0	7.0	Some products
8521-90-00	CD-ROM Drives	3.9	14.0	0.0%
8471-70-53	Rigid Disk Drives	3.9	1.6	0.0%

Source: European Commission Legislation/Dataquest (January 1996)

In Table 2, where the suspension rate refers to "some products," these are specific products (within the broader category) which have been granted suspension. In these cases, the product is described to the extent that it should be unambiguous which specific part from which specific manufacturer is exempt.

CD-ROM Drives

In the case of CD-ROM drives, these products were reclassified from CN code 8471-93-51 (data reproduction) to 8521-90-00 (image reproduction) under EC regulation 2564/95, dated October 27, 1995. By reclassifying the CD-ROM drives (due to their dual use of providing IT and entertainment functionality), the tariff rate increased from 3.9 percent to 14.0 percent.

Although the formal reclassification was a technical issue, this classification case generated strong interest with extensive consultation and lobbying prior to the regulation. It also indicated that the decision might have far-reaching implications. It could be argued that a CD-ROM drive is a component used in a computer application and should retain an IT component classification.

If that argument is expanded, the use of CD-ROM drives (and other sound- and image-enabling technology/components) for non-professional multimedia may be regarded as products with a CN code starting with 85, and attracting the relevant tariffs. However, although the longer term issues around this subject remain, CD-ROM drives have had their tariffs suspended entirely (that is, 0 percent) from November 22, 1995; initially until June 30, 1996.

Recommendations

The whole subject of import tariff rates, tariff suspension, and the implications for trade is both detailed and complicated; it has not been possible to cover this subject in the required depth to satisfy all readers. Clients are advised to obtain the required level of detail and information appropriate to their business activities (for example, copies of appropriate regulations, specialist professional advice), and to ascertain their eligibility for any temporary tariff suspension during 1996.

OEM News

Acer has announced plans for a PC assembly plant in Finland, which it intends to use to supply the Commonwealth of Independent States (CIS) and other parts of the former Soviet Union. Acer set up a sales office in Moscow in 1994 and has since experienced rapid growth in shipments to the region; currently, the company has the second-largest market share. The new facility in Lappeenranta is a joint venture with Wilson Finland Oy, and is scheduled to start operation early in 1996. Initial production capacity is about 4,000 units per month, which is forecast to rise to about 6,000 units per month during 1996.

Acer's decision to site its new facility in Finland was partly due to its reluctance to assemble within the CIS or Russia, due to continuing economic and political instability. Finland's historically strong trading links with the former Soviet Union have helped to develop stable shipping routes into the CIS. Also, the act of assembling parts imported into the EU, prior to export outside the EU (a process known as inward processing), ensures that Acer gains relief from customs duty.

Wilson Finland Oy is not an electronics company, but has been managing distribution and logistics on behalf of third parties for more than five years. Acer plans to use a build-to-order production system to ensure that it can deliver PCs within short lead times; for this reason it has chosen to work with a partner which can add value using its experience in cost-effective just-in-time materials logistics.

APC

After announcing in June 1995 that it was seeking sites for expansion, American Power Conversion (APC) has revealed its plans to support future growth in Ireland. The maker of uninterruptible power supplies (UPS) is investing $3.2 million in setting up research and development (R&D) and telemarketing functions for Europe at its existing production site in Galway.

As well as investment in an existing site, APC is also setting up three distinct manufacturing operations: the company is investing $23.5 million at Drogheda to manufacture UPS products for PCs, workstations and LAN servers; $24.3 million at Gillogue to set up a distribution center, and to manufacture higher-power UPS products; and $13.8 million at Castlebar for the manufacture of higher-powered surge-protection devices.

APC has made the decision that each manufacturing facility will focus on a particular type of product, aimed at a specific part of the market. This can ensure that the cost to manufacture is supported by the sales price, and manufacturing similar products at the same plant should cause less disruption to production lines. However, lessons learnt from manufacturing one product could benefit another, and it is up to APC's management to spread good practice throughout the organization.

APC's phenomenal growth is fuelled by the continuing migration away from centralized data processing towards distributed networks, which typically are based around LAN servers. These servers, in both large companies and small businesses, can be as critical as the traditional mainframe, and require intelligent-UPS support. The low UPS installed base on PCs, coupled with the explosive growth of Internet and other communication servers, should ensure that these new facilities mirror the success of the Galway plant.

Apple

Apple is increasing production of Power Macintosh computers at its plant at Cork in Ireland. The company already has started to recruit additional production personnel, and announced that it will be creating up to 600 new jobs by 1998. Although there is no new capital investment, the additional personnel will be used to increase the utilization of production equipment through additional shifts and other working practises.

While Apple has declared that it can meet demand for lower-specification Power Macintosh machines, it is still experiencing difficulties in supplying enough higher-specification machines. Moreover, although many of the supply issues are related to component shortages, any expansion in production capacity demonstrates that demand for Power Macintosh machines continues to grow.

Apple's recent announcement about restructuring (following the company's loss during the first quarter of its 1996 financial year) should not immediately affect production at the plant in Cork.

Aquarius Robotron/ICL

Aquarius Robotron, the German PC manufacturer controlled by ICL, is setting up a joint venture with Korean Data Systems (KDS) called KDS Multivision to manufacture PC monitors. The new venture builds on a previous agreement under which Aquarius assembled monitors from KDS kits imported from Korea.

The new operation will assemble 38-cm and 43-cm monitors using cathode-ray tubes (CRTs) from a Philips plant in Austria, and electronic components kitted by KDS in Korea. Two production lines have been installed in the Aquarius factory at Sommerda, with an annual capacity of about 240,000 monitors.

This plan to manufacture monitors was hatched two years ago, and the strong demand for monitors in 1995 should help to offset the relatively low demand for Aquarius-branded PCs. Although Aquarius PC shipments have risen during 1995 compared with 1994, current PC production does not seem to match the factory's significant manufacturing capacity. While the CRTs are now sourced from Europe, the electronic components are still being imported from Korea. Until the components are sourced locally, KDS Multivision will have to keep an inventory of imported electronic kits in order to offer the manufacturing flexibility needed.

Chung Hwa Picture Tube/Tatung

Taiwan-based Chung Hwa Picture Tube has announced that it is investing $411 million in a CRT manufacturing plant in Scotland. The company is controlled by Tatung, which owns more than 90 percent, and which currently manufactures televisions in relatively low quantities in Telford, England.

The new facility at Mossend will join existing plants in China, Malaysia and Taiwan. The three plants currently in production are forecast to produce about 20 million CRTs during 1995. The first output from Mossend, using two production lines, currently is scheduled for 1997; and total capacity using six lines is expected to be about 10 million CRTs annually.

This is one of a number of announcements made over the past few months by monitor and CRT manufacturers. The monitor market is forecast to grow with a CAGR of just over 13 percent until 1999, and there are also time-to-market

factors associated with production in Europe for the regional market (including Central and Eastern Europe, the Middle East and Africa).

The decision to site the plant in Scotland (in preference to alternative locations in France and Ireland), was due to many factors. As well as the skilled work force, low tax rate and lower total cost-of-labor factors—which are now habitually quoted in connection with the United Kingdom—several product-specific factors also have to be considered.

Transportation costs from the Asia/Pacific region now have a significant effect on the cost of CRTs and monitors. As CRTs are relatively heavy, the plant's location close to a EuroTunnel terminal should prove useful. The remaining factors relate to the two main ingredients in CRT manufacture, namely plenty of inexpensive water and electricity. It may well be that a deal with one of the Scottish electricity generators and a water-supply utility has helped to site the plant in Scotland.

Hewlett-Packard/Solectron

Hewlett-Packard (HP) and Solectron have made a joint announcement about new computer and PCB assembly plants in Germany. HP is expanding its production of workstation and server products by investing in a new facility at Herrenberg. The total investment is about $49 million, and allows the company to implement more flexible production processes in order to satisfy the increasing customer demand in a more focused and timely manner. Construction is due to start during 1996, with the completed facility ready for production in 1997.

Solectron has announced that it is investing about $10.5 million in a new PCB assembly plant at Herrenberg. This follows an agreement between the two parties which led to Solectron taking control of one of HP's facilities at nearby Böblingen in November 1995. The acquisition was a PCB assembly site, and Solectron has continued to manufacture PCBs for Hewlett-Packard.

HP has decided to site its computer assembly plants close to its distribution facilities in order to reduce delivery times to customers. In addition, the company has outsourced PCB assembly activity to a contract manufacturer (in this case Solectron). Solectron is using its existing production facility to expand into the German market. As well as gaining additional business from HP, Solectron has the opportunity to diversify its customer base in a country which has few specialist contract manufacturers to match Solectron.

IBM

IBM announced the official opening of its new rigid disk drive plant in Hungary during November 1995. The new manufacturing facility is located just south of Budapest in Szekesfehervar. Production started in October 1995 and is projected to exceed 1 million disk drives during 1996. The plant capacity is believed to be 2 million units annually. The facility provides IBM with additional manufacturing capacity, and the output is expected to be sold primarily in the European market.

The new Hungarian factory is owned by Videoton and leased to IBM on a long-term basis, with IBM investing and installing clean-room facilities and manufacturing equipment. Operations control, logistics management and engineering support will be provided by IBM's operations in Mainz, Germany.

This announcement underlines IBM's effort to gain a significant share of the rigid disk drive business, especially in the European market, where more than one in four disk drives consumed are made locally. Even with this new facility, IBM will still be constrained by manufacturing capacity.

The industry is planning its migration to entry-level drives with at least 1GB of capacity during 1996. These capacities now often require advanced recording technology; and it is access to enabling technologies (IBM's area of strength) which is of prime importance.

Optimus/Seikosha

Seikosha has announced that it has granted Optimus, the Polish PC manufacturer, the rights to assemble three models of dot matrix printers: the SP-1900, SP-2400 and SP-2415. Optimus will manufacture under license on behalf of Seikosha, and the products will be sold using the Seikosha brand name. However, Optimus also has the right to sell the printers using its own brand name.

Although the agreement was announced in December 1995, production had already started, and Optimus expects to have manufactured about 15,000 printers by the end of 1995. The expected production capacity is forecast to reach about 2,000 printers per week during 1996.

Dot matrix printers are coming to the end of their life cycle in Western Europe and, although the printers produced by Optimus will supply the whole of Europe, it is likely that the majority will remain in Eastern Europe. This is the first agreement of its kind in Eastern Europe, and makes Optimus the first printer manufacturer in the region. Manufacturing printers offers Central and Eastern European PC manufacturers an opportunity to diversify their production activities, as well as the option of bundling printers with PCs.

In this particular case, Seikosha certainly chose one of the best possible partners, since Optimus is the largest PC manufacturer in the region and will help Seikosha's penetration of the Polish market. Optimus used to badge OEM printers, and this move is its next logical step.

Rank Xerox

Rank Xerox has increased the factory sales revenue of its plant in Mitcheldean, England, to about $411 million annually, by moving production for desktop copiers (initially worth about $15 million annually) from Fuji-Xerox plants in Japan to the United Kingdom. The Mitcheldean plant assembles PCBs for copiers manufactured in Europe, Japan and the United States. The UK site announced the purchase of a $1.2 million surface-mount production line in May 1995, as part of a $4-million investment program.

Rank Xerox claims that quality systems, labor flexibility and improved manufacturing processes have improved productivity significantly at Mitcheldean over the last few years, such that the plant now boasts a lower cost base than other Rank Xerox production facilities in both France and the Netherlands. In reality, it is likely to be a combination of improved customer satisfaction due to operational improvements and the lower total cost of employment in the United Kingdom, which has helped to secure this contract.

Silicon Graphics

Computer manufacturer Silicon Graphics has announced an expansion of its manufacturing and applications development facility at Cortaillod in Switzerland. The site has been open since 1992, and will receive an additional investment of $26 million for manufacturing-technology and advanced-technology development, as well as support functions.

The Swiss site currently manufactures Indy and Indigo workstations. Increased demand for server and supercomputer products worldwide has led it to manufacture these high-end products in Europe for local consumption; in turn, this frees production capacity in Japan and the United States to supply their local markets.

Silicon Graphics has products which can support the long-term growth in demand for digital content-creation and manipulation systems used in film and television production, as well as other graphical and design applications. It is also benefiting from the very strong demand for high-end Internet servers.

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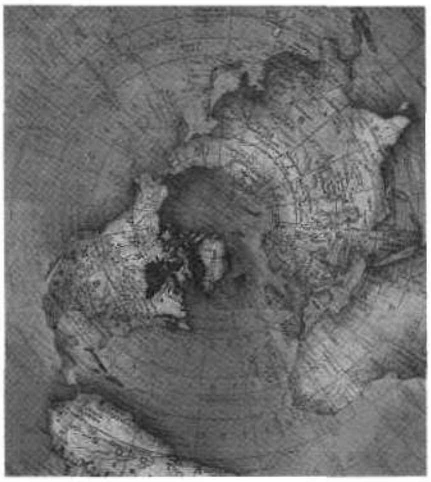

Dataquest

High-Volume Electronic Equipment Manufacturing Locations—Europe

Market Statistics

1996

Program: Electronic Equipment Production Monitor Europe
Product Code: SAPM-EU-MS-9601
Publication Date: May 3, 1996
Filing: Market Statistics

High-Volume Electronic Equipment Manufacturing Locations—Europe

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1996

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Table of Contents

List of Tables

Chapter 1
Introduction and Definitions

This market statistics report contains information taken from Dataquest's European electronic-equipment manufacturing locations database. For this report, Dataquest has selected key application systems that have high-volume production in Europe and worldwide. These systems are identified by Dataquest as leading indicators of electronic-component consumption trends by end-application market segment.

The 22 systems selected are leading indicators of electronic equipment production in the following product subsegments: electronic data processing, communications, consumer, and automotive.

The systems are as follows:

- Electronic Data Processing:
  - Personal computers (PC)
  - Workstations
  - Rigid disk drives (RDD)
  - Optical disk drives (ODD)
  - Page (laser) printers
  - Serial printers
- Communications:
  - Fax machines
  - LAN cards
  - Modems
  - Answering machines
  - Corded telephones
  - Cordless telephones
  - Central office (CO)/premise (PBX) line cards
  - Cellular telephones
  - Pagers
- Consumer:
  - Personal/portable stereos
  - Color televisions
  - Videocassette recorders (VCRs)
  - Camcorders
  - Set-top boxes
- Automotive:
  - Auto stereos
  - Engine control units

The report contains tables detailing equipment-production locations within Europe by product (ordered by company) and by country (ordered by product).

Regional Definitions

Western Europe: Includes Benelux (Belgium, Netherlands, Luxembourg), France, Italy, Germany (including former East Germany), Scandinavia (Denmark, Finland, Norway, Sweden, and Iceland), United Kingdom and Eire (Ireland), and Rest of Western Europe (Austria, Gibraltar, Greece, Liechtenstein, Malta, Monaco, Portugal, San Marino, Spain, Switzerland, Turkey, Andorra and Vatican City).

Eastern Europe: Includes Albania, Bulgaria, Czech Republic, Slovakia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, republics of former Yugoslavia, Ukraine, Belarus, Georgia, Russian Federation, Moldova, Armenia, Azerbaijan, Kazakhstan, Uzbekistan, Tadjikistan, Kyrgyzstan, Turkmenistan.

Data Sources

The information stored in the database has been consolidated from a variety of sources. From time to time, we conduct production surveys for specific types of electronic equipment and the data gathered are incorporated into the database. Our other sources include the following:

- Public domain information
- Company news releases
- Trade association data
- Other Dataquest research groups (including Computer Systems, Telecommunications and Document Management)

In summary, this report contains Dataquest's best intelligence about volume-production facilities in 1995.

Chapter 2

Electronic Data Processing

Table 2-1
PC Manufacturing Locations—Europe

Company	City	Country
Acer	's Hertogenbosch	Netherlands
Acorn	Cambridge	England
Actebis	Soest	Germany
Add-x/Normerel	Granville	France
Alif	Montreuil	France
Altec	Athens	Greece
Amstrad	Shoeburyness	England
APD	Aranjuez	Spain
Apple	Cork City	Ireland
Apricot	Glenrothes	Scotland
Aquarius	Bad Homburg	Germany
Asem	Buia	Italy
AST	Limerick	Ireland
Bull	Angers	France
Compaq	Erskine	Scotland
Computer Elektrik Dresden	Dresden	Germany
Dell	Limerick	Ireland
Digital Equipment Corporation	Ayr	Scotland
Donatec	Ivry-sur-Seine	France
Elonex	London	England
Escom	Heppenheim	Germany
First Development	Allerod	Denmark
Fujitsu	Málaga	Spain
Gateway 2000	Dublin	Ireland
Hewlett-Packard	Grenoble	France
Hewlett-Packard	Lyon	France
IBM	Greenock	Scotland
ICL	Kilo	Finland
Intel	Leixlip	Ireland
Investrónica	Madrid	Spain
Itos	Konstanz	Germany
NCR (AT&T)	Augsburg	Germany
Norsk Computer Industries	Sandnes	Norway
Olidata	Cesena	Italy
Olivetti	Scarmagno	Italy
Olivetti	Barcelona	Spain
Opus	Redhill	England

(continued)

Table 2-1 (Continued)
PC Manufacturing Locations—Europe

Company	City	Country
Packard Bell	Wijchen	Netherlands
Panatek	Breukelen	Netherlands
PC Warehouse	Val-de-Reuif	France
Peacock Computer	Wünnenberg-Haaren	Germany
Psion	Greenford	England
Research Machines	Abingdon	England
Siemens-Nixdorf	Haubourdin	France
Siemens-Nixdorf	Dresden	Germany
Siemens-Nixdorf	Augsburg	Germany
Tiki-Data	Oslo	Norway
Toshiba	Regensburg	Germany
Triumph-Adler (Olivetti)	Dresden	Germany
Triumph-Adler (Olivetti)	Nürnberg	Germany
Tulip	's Hertogenbosch	Netherlands
Unibit	Rome	Italy
Unisys	Barentin	France
Viglen	Alperton	England
Vobis	Aachen	Germany

Source: Dataquest (May 1996)

Table 2-2
Workstation Manufacturing Locations—Europe

Company	City	Country
Digital Equipment Corporation	Ayr	Scotland
Hewlett-Packard	Böblingen	Germany
IBM	Montpellier	France
IBM	Santa Palomba	Italy
IBM	Greenock	Scotland
Intergraph	Nijmegen	Netherlands
Siemens-Nixdorf	Augsburg	Germany
Silicon Graphics	Cortaillod	Switzerland
Sun Microsystems	Linlithgow	Scotland
Tapdole Technology	Cambridge	England
Tekelec/Themis	Gièvres	France

Source: Dataquest (May 1996)

Table 2-3
Rigid Disk Drive Manufacturing Locations—Europe

Company	City	Country
Calluna Technology	Glenrothes	Scotland
Gigastorage	Belfort	France
Hitachi	Orléans	France
IBM	Mainz	Germany
IBM	Székesfehérvár	Hungary
Matsushita-Kotobuki Electronic	Dundalk	Ireland
Nomai	Velizy Villacoublay	France
Seagate	Clonmel	Ireland
Seagate	Pont-Saint-Martin	Italy
Storage Technology	Toulouse	France
Xyratex	Havant	England

Source: Dataquest (May 1996)

Table 2-4
Optical Disk Drive Manufacturing Locations—Europe

Company	City	Country
ATG Cygnet	Toulouse	France
Philips	Hasselt	Belgium

Source: Dataquest (May 1996)

Table 2-5
Page (Laser) Printer Manufacturing Locations—Europe

Company	City	Country
Bull	Turin	Italy
Canon	Liffre	France
Dataproducts (Hitachi)	Dublin	Ireland
Hewlett-Packard	Bergamo	Italy
Hewlett-Packard	Amstelveen	Netherlands
Kyocera	Le Grand Quevilly	France
Lexmark	Orléans	France
NEC	Telford	England
Nipson Printing Systems (Bull)	Belfort	France
Océ	Venlo	Netherlands
Olivetti	San Bernardo	Italy
Rank Xerox	Venray	Netherlands
Rank Xerox	Coslada	Spain
Rank Xerox	Mitcheldean	England
SNI	Poing	Germany
Texas Instruments	Utrecht	Netherlands
Wenger	Therwil	Switzerland

Source: Dataquest (May 1996)

Table 2-6
Serial Printer Manufacturing Locations—Europe

Company	City	Country
Bull	Turin	Italy
Citizen	Scunthorpe	England
Dataproducts (Hitachi)	Dublin	Ireland
Epson	Bonneuil-sur-Marne	France
Epson	Telford	England
Fujitsu	Dublin	Ireland
Fujitsu	Málaga	Spain
Hewlett-Packard	Barcelona	Spain
Jarfalla	Jarfalla	Sweden
Kyushu Matsushita Electric	Newport	England
Mannesmann Tally	Elchingen	Germany
Mitsubishi Electric	Etrelles	France
NEC	Telford	England
Newbury Data	Winsford	England
Oki	Cumbernauld	England
Olivetti	San Bernardo	Italy
Olivetti	Scarmagno	Italy
Olivetti	Barcelona	Spain
Olivetti-Canon	Agliè	Italy
Printer Systems International	Slegan	Germany
Seikosha	Neumünster	Germany
SNI	Paderborn	Germany
Walther	Gerstetten	Germany
Wenger	Therwil	Switzerland

Source: Dataquest (May 1996)

Table 3-1
Fax Machine Manufacturing Locations—Europe

Company	City	Country
Canon	Liffre	France
Italtel	Santa Maria Capua Vetere	Italy
Matra	Douarnenez	France
Matra	Rennes	France
Matsushita	Reading	England
Mitsubishi	Etrelles	France
Murata	Genk	Belgium
Murata	Longwy	France
NEC	Telford	England
Ricoh	Wettolsheim	France
Sagem	Fougères	France
SAT (Dr Neuhaus)	Hamburg	Germany
Sharp	Alsace	France
Siemens	Berlin	Germany

Source: Dataquest (May 1996)

Table 3-2
LAN Card Manufacturing Locations—Europe

Company	City	Country
3Com	Blanchardstown	Ireland
Cray Networks	Herlev	Denmark
Madge	High Wycombe	England
Necsy (Italtel)	Padua	Italy
Nokia	Aanekoski	Finland
Nortel	Marne-la-Vallée	France
Olicom	Copenhagen	Denmark
Syskonnekt	Ettlingen	Germany

Source: Dataquest (May 1996)

Table 3-3
Modem Manufacturing Locations—Europe

Company	City	Country
ARE (Racal)	Castellanza	Italy
3X	Paris	France
AE Telecommunicazioni	Turin	Italy
Amper Telematica	Madrid	Spain
Anchor Datacomm	Amstelveen	Germany
COM 1	Cestas	France
Communicate (Motorola)	Ascot	England
Controlware	Dietzenbach	Germany
Cornel Electronics	Dublin	Ireland
Cray Communications	Watford	England
Creatix	Saarbrücken	Germany
Dataconsyst	Vimodrone	Italy
Dataflex Design (Amstrad)	London	England
Elsa	Aachen	Germany
Ericsson	Stockholm	Sweden
Fujitsu	Málaga	Spain
Kortex International	Paris	France
Lasat	Svenstrup	Denmark
Leitha Datentechnik	Neufeld	Austria
Memotec Datacom	Brussels	Belgium
Modular Technology	Bicester	England
Motorola ISG	Crawley	England
Olitec	Nancy	France
Pahldata	Barcelona	Spain
Philips	Rouen	France
PNB (US Robotics)	Suresnes	France
Psion Dacom	Milton Keynes	England
Racal	Warrington	England
SAT (Dr Neuhaus)	Hamburg	Germany
Schrack Telecom (Ericsson)	Kindberg	Austria
Sofracin	Puteaux	France
Sonix Communications (3Com)	Cirencester	England
Teldat	Madrid	Spain
Telemation	Kronberg	Germany
Telena Data	Milan	Italy
Telindus	Heverlee	Belgium
Uniautomation	Milan	Italy

Source: Dataquest (May 1996)

Table 3-4
Answering Machine Manufacturing Locations—Europe

Company	City	Country
Ascom	Solothurn	Switzerland
Dancall (Amstrad)	Pandrup	Denmark
DeTeWe	Berlin	Germany
Grundig	Bayreuth	Germany
Hagenuk	Kiel	Germany
Matra	Pont-de-Buis	France
Philips	Le Mans	France
Sagem	Fougères	France
Sony	Colmar	France

Source: Dataquest (May 1996)

Table 3-5
Corded Telephone Manufacturing Locations—Europe

Company	City	Country
Alcatel	Zaventum	Belgium
Alcatel	Ilkirch	France
Alcatel	Strasbourg	France
Alcatel	Stuttgart	Germany
Alcatel	Bari	Italy
Alcatel	Milan	Italy
Alcatel	Málaga	Spain
Amper Telematica	Madrid	Spain
Ascom	Hombrechtikon	Switzerland
Ascom	Cardiff	Wales
AT&T	Saumur	France
ATEA	Mons	Belgium
Bang & Olufsen	Struer	Denmark
Brondi Telefonica	Turin	Italy
Ericsson	Pagani	Italy
Ericsson	Rijen	Netherlands
Ericsson	Stockholm	Sweden
Fitre	Milan	Italy
Hagenuk	Kiel	Germany
HPF (Ascom)	Bonneville	France
Italtel	Santa Maria Capua Vetere	Italy
Italtel	Milan	Italy
Kirk Telecom	Horsens	Denmark
Matra	Douarnenez	France
Matra	Pont-de-Buis	France
Matra	Marburg	Germany

(continued)

Table 3-5 (Continued)
Corded Telephone Manufacturing Locations—Europe

Company	City	Country
Nortel	Cwmcarn	Wales
Philips	Le Mans	France
Safnat	Milan	Italy
Schrack (Ericsson)	Kindberg	Austria
Siemens	Bocholt	Germany
Sony	Colmar	France
Teldico	Bavikhov	Belgium
Telenorma (Robert Bosch)	Frankfurt	Germany
Tesla Stropkov	Stropkov	Slovakia

Source: Dataquest (May 1996)

Table 3-6
Cordless Telephone Manufacturing Locations—Europe

Company	City	Country
AEG	Berlin	Germany
Alcatel	Málaga	Spain
Ascom	Solothurn	Switzerland
AT&T	Saumur	France
Brondi Telefonica	Turin	Italy
Dancall (Amstrad)	Pandrup	Denmark
DeTeWe	Berlin	Germany
Ericsson	Kumla	Sweden
Ericsson	Emmen	Netherlands
Grundig	Furth	Germany
Grundig	Braga	Portugal
Hagenuk	Kiel	Germany
HPF (Ascom)	Bonneville	France
Matra	Douarnenez	France
Matsushita	Thatcham	England
Nokia	Salo	Finland
Philips	Le Mans	France
Philips	Nürnberg	Germany
Sagem	Fougères	France
Siemens	Bocholt	Germany
Sony	Colmar	France
Sony	Colmar	France

Source: Dataquest (May 1996)

Table 3-7
CO Line Card Manufacturing Locations—Europe

Company	City	Country
Alcatel	Vienna	Austria
Alcatel	Geel	Belgium
Alcatel	Brest	France
Alcatel	Cherbourg	France
Alcatel	Eu	France
Alcatel	Gunzenhausen	Germany
Alcatel	Stuttgart	Germany
Alcatel	Bandon	Ireland
Alcatel	Milan	Italy
Alcatel	The Hague	Netherlands
Alcatel	Halden	Norway
Alcatel	Kongsvinger	Norway
Alcatel	Cascais	Portugal
Alcatel	Madrid	Spain
Alcatel	Wadenswil	Switzerland
Ascom	Bern	Switzerland
AT&T	Donegal	Ireland
AT&T	Huizen	Netherlands
AT&T	Madrid	Spain
AT&T	Malmesbury	England
Bosch	Limburg	Germany
Bosch	Offenburg	Germany
Budavox	Budapest	Hungary
DeTeWe	Berlin	Germany
Ericsson	Jorvas	Finland
Ericsson	Longuenesse	France
Ericsson	Budapest	Hungary
Ericsson	Athlone	Ireland
Ericsson	Avezzano	Italy
Ericsson	Pagani	Italy
Ericsson	Hisoy	Norway
Ericsson	Madrid	Spain
Ericsson	Norrkoping	Sweden
Ericsson	Stockholm	Sweden
Ericsson	Scunthorpe	England
GPT	Coventry	England
GPT	Liverpool	England
Intracom	Athens	Greece
Italtel	Milan	Italy
Italtel	Palermo	Italy

(continued)

Table 3-7
CO Line Card Manufacturing Locations—Europe

Company	City	Country
Nortel	Vienna	Austria
Nortel	Istanbul	Turkey
Nortel	Monkstown	UK
Philips	Nürnberg	Germany
Sagem	St-Etienne-du-Rouvray	France
Seimens	Prague	Czech Rep.
Siemens	Vienna	Austria
Siemens	Colfontaine	Belgium
Siemens	Herentals	Belgium
Siemens	Oostkamp	Belgium
Siemens	Helsinki	Finland
Siemens	Bruchsal	Germany
Siemens	Munich	Germany
Siemens	Thessaloniki	Greece
Siemens	Milan	Italy
Siemens	Warsaw	Poland
Siemens	Alfragide	Portugal
Siemens	Zurich	Switzerland
Siemens	Kartal	Turkey
Telettra	Vimercate	Italy
Tesla Stropkov	Stropkov	Slovakia

Source: Dataquest (May 1996)

Table 3-8
PBX Line Card Manufacturing Locations—Europe

Company	City	Country
Alcatel	Vienna	Austria
Alcatel	Colfontaine	Belgium
Alcatel	Horsens	Denmark
Alcatel	Espoo	Finland
Alcatel	Orvault	France
Alcatel	Tréguier	France
Alcatel	Avezzano	Italy
Alcatel	Madrid	Spain
Alcatel	Málaga	Spain
AT&T	Saumur	France
Bosch	Montceau-les-Mines	France
Bosch	Rodermark	Germany
Ericsson	Kindberg	Austria
Ericsson	Jorvas	Finland
Ericsson	Amsterdam	Netherlands
Ericsson	Madrid	Spain
Ericsson	Katrineholm	Sweden
Ericsson	Stockholm	Sweden
Ericsson	Stockholm	Sweden
Fujitsu	Málaga	Spain
GPT	Beeston	England
Italtel	Caseta	Italy
KME Information Sys.	Cwmbran	Wales
Matsushita	Newport	Wales
Nortel	Verdun	France
Nortel	Galway	Ireland
Nortel	Istanbul	Turkey
Philips	Hilversum	Netherlands
Philips	Hoorn	Netherlands
Philips	Airdrie	Scotland
Siemens	Bocholt	Germany
Siemens	Witten	Germany
Telequipo	Monte Da Caparica	Portugal
Tesla Stropkov	Stropkov	Slovakia

Source: Dataquest (May 1996)

Table 3-9
Cellular Telephone Manufacturing Locations—Europe

Company	City	Country
AEG	Ulm	Germany
AEG/Matra	Madrid	Spain
Alcatel	Laval	France
Benefone	Salo	Finland
Bosch (Blaupunkt)	Hildesheim	Germany
Cetelco	Stovring	Denmark
Dancall (Amstrad)	Pandrup	Denmark
Ericsson	Kumla	Sweden
Indelec	Zamudio	Spain
Italtel	Milan	Italy
Matsushita	Thatcham	England
Mitsubishi	Etrelles	France
Motorola	Flensburg	Germany
Motorola	Easter Inch	UK
NEC	Telford	England
Nokia	Oulu	Finland
Nokia	Salo	Finland
Nokia	Bochum	Germany
Oki	Cumbernauld	England
Orbitel (Ericsson)	Worksop	England
Philips	Le Mans	France
Sagem	Fougères	France
Siemens	Kamp Linsfort	Germany
Telital	Trieste	Italy

Source: Dataquest (May 1996)

Table 3-10
Pager Manufacturing Locations—Europe

Company	City	Country
Philips	Cambridge	England
Motorola	Swords	Ireland
Nokia	Salo	Finland
Philips	Eindhoven	Netherlands
Swatch	Grenchen	Switzerland
Swissphone	Samstagern	Switzerland

Source: Dataquest (May 1996)

Table 4-1
Personal/Portable Stereo Manufacturing Locations—Europe

Company	City	Country
Aiwa	Newport	Wales
Grundig	Braga	Portugal
JVC	Villers-la-Montagne	France
Matsushita	Longwy Haut	France
Panasonic (Matsushita)	Gerona	Spain
Philips	Louvain	Belgium
Pioneer	Wakefield	England
Sony	Colmar	France

Source: Dataquest (May 1996)

Table 4-2
Color TV Manufacturing Locations—Europe

Company	City	Country
Amstrad	Shoeburyness	England
Daewoo	Fameck	France
Daewoo	Frankfurt	Germany
Daewoo	Barcelona	Spain
DNP	Copenhargen	Denmark
First Development	Allerod	Denmark
Goldstar	Worms	Germany
Grundig	Vienna	Austria
Grundig	Creutzwald	France
Grundig	Nürnberg	Germany
Grundig	Miesau	Germany
Grundig	Furth	Germany
Hinari-Shinton	Glasgow	Scotland
Hitachi	Athens	Greece
Hitachi	Aberdare	Scotland
JVC	East Kilbride	Scotland
Korea Electronics Co	Frankfurt	Germany
Loewe	Kronach	Germany
Matsushita	Lüneburg	Germany
Matsushita	Cardiff	Wales
Matsushita	Port Talbot	Wales
Mitsubishi	Haddington	Scotland
Mitsumi	Jarrow	England
Mivar	Milan	Italy

(continued)

Table 4-2
Color TV Manufacturing Locations—Europe

Company	City	Country
Nokia	Turku	Finland
Nokia	Esslingen	Germany
Nokia	Bochum	Germany
Orion Electric	Port Talbot	Wales
Ortadogu	Izmir	Turkey
Panasonic (Matsushita)	Gerona	Spain
Philips	Lebring	Austria
Philips	Brugge	Belgium
Philips	Angers	France
Philips	Dreux	France
Philips	Aachen	Germany
Philips	Monza	Italy
Philips	Barcelona	Spain
Philips	Barcelona	Spain
Philips	Durham	England
Salo Iberica	Cascais	Portugal
Samsung	Budapest	Hungary
Samsung	Alcoitão	Portugal
Samsung	Izmir	Turkey
Samsung	Billingham	England
Sanyo	Barcelona	Spain
Sanyo	Lowestoft	England
Seleco	Pordenone	Italy
Selectronic	Budapest	Hungary
Sharp	Barcelona	Spain
Sharp	Wrexham	Wales
Siemens	Vienna	Austria
Sony	Stuttgart	Germany
Sony	Barcelona	Spain
Sony	Pencoed	Wales
Sony	Bridgend	Wales
Tabuchi Electric	Thornaby	England
Tatung	Telford	England
Thomson	Angers	France
Thomson	Celle	Germany
Thomson	Anagni	Italy
Toshiba	Plymouth	England
Vestel	Çorlu	Turkey

Source: Dataquest (May 1996)

Table 4-3
VCR Manufacturing Locations—Europe

Company	City	Country
Aiwa	Newport	Wales
Akai	Honfleur	France
Amstrad	Shoeburyness	England
Bang & Olufsen	Struer	Denmark
Daewoo	Frankfurt	Germany
Daewoo	Barcelona	Spain
Daewoo	Antrim	Northern Ireland
First Development	Allerod	Denmark
Fisher Industries	Nordlingen	Germany
Funai Electric	Lüneburg	Germany
Goldstar	Worms	Germany
Grundig	Furth	Germany
Hitachi	Landsberg	Germany
Hitachi	Aberdare	UK
J2T Video	Berlin	Germany
J2T Video	Newhaven	UK
Matsushita	Longwy Haut	France
Matsushita	Peine	Germany
Matsushita	Hesebergweg	Germany
Matsushita	Port Talbot	Wales
Mitsubishi	Livingston	Scotland
NEC	Telford	England
Orion Electric	Port Talbot	Wales
Panasonic	Gerona	Spain
Philips	Vienna	Austria
Philips	Dordrecht	Netherlands
Samsung	Barcelona	Spain
Sanyo	Nördlingen	Germany
Sanyo	Barcelona	Spain
Seleco	Pordenone	Italy
Sharp	Wrexham	Wales
Siemens	Vienna	Austria
Sony	Colmar	France
Tabuchi Electric	Thornaby	England
Thomson	Tonnerre	France
Toshiba	Mönchengladbach	Germany

Source: Dataquest (May 1996)

Table 4-4
Camcorder Manufacturing Locations—Europe

Company	City	Country
Orion	Frankfurt	Germany
Sony	Colmar	France
Thomson	Moulins	France

Source: Dataquest (May 1996)

Table 4-5
Set-Top Box Manufacturing Locations—Europe

Company	City	Country
Bang & Olufsen	Struer	Denmark
Grundig	Furth	Germany
Grundig	Llantrisant	Wales
Luxor (Nokia)	Motala	Sweden
Mitsubishi	Haddington	Scotland
Nokia	Salo	Finland
Pace	Shipley	England
Philips	Krefeld	Germany
Philips	Hamburg	Germany
Pioneer	Erpe-Mere	Belgium
Pioneer	Bristol	England
Sagem	Fougères	France
Seleco	Pordenone	Italy
Sony	Pencoed	Wales
Tatung	Telford	England
Thomson	Strasbourg	France
Wolsey (AB Electronics)	Pontypridd	Wales

Source: Dataquest (May 1996)

Table 5-1
Auto Stereo Manufacturing Locations—Europe

Company	City	Country
Alps	Soissons	France
Becker	Karlsbad	Germany
Blaupunkt	Hildesheim	Germany
Clarion	Custines	France
Clarion	Swindon	England
Daewoo	Frankfurt	Germany
Ford	Pamela	Portugal
Grundig	Braga	Portugal
Haitai	Longwy	France
HEA	Vienna	Austria
Inkel	Schwalbach	Germany
Inkel	Cramlington	England
Matsushita	Neumünster	Germany
Motometer	Leonberg	Germany
Philips	Termonde	Belgium
Philips	Rambouillet	France
Philips	Wetzler	Germany
Pioneer	Swindon	England
Samsung	Aulmay	France
Secere Alpine Electronics	Soissons	France
Sofrec Deltadore	Janze Rennes	France
Sony	Colmar	France
Toho	Dublin	Ireland
Trio Kenwood	Janz	France

Source: Dataquest (May 1996)

Table 5-2
Engine Control Unit Manufacturing Locations—Europe

Company	City	Country
AB Electronics	Abercynon	Wales
AB Electronics	Cardiff	Wales
AB Mikroelektronik	Salzburg	Austria
Automotive Products	Leamington Spa	England
Delco	Kirby	England
Deutsche Vergaser Gessellschaft	Berlin	Germany
Ford	Cadiz	Spain
GM Delco Moraine	Ande	France
Hitachi	Munich	Germany
Hughes Microelectronics	Málaga	Spain
Lucas	Stonehouse	England
Marelli Autronica	Bologna	Italy
Marelli Autronica	Pavia	Italy
Motometer	Leonberg	Germany
Motorola AIEG	Angers	France
Motorola AIEG	Stotfold	England
Oki	Cumbernauld	Scotland
Robert Bosch	Reutlingen	Germany
Robert Bosch	Stuttgart	Germany
Saab	Trollhatton	Sweden
Sagem	Fougères	France
Siemens	Regensburg	Germany
Siemens	Piero A Grado	Italy
Temic Telefunken (AEG/Dasa)	Heilbronn	Germany
TRW Messmer	Radolfzell	Germany
Valeo	Beugency	France
Valeo	Brassac	France
Valeo	Grosmenil	France
Valeo	Sainte-Florine	France
VDO Adolf Schindling (Mannesmann)	Hannover	Germany
VDO Adolf Schindling (Mannesmann)	Frankfurt	Germany
Zytec Autmotive	Sutton Coldfield	England

Source: Dataquest (May 1996)

Chapter 6

Manufacturing Locations by Country

Table 6-1
Manufacturing Locations—France

Product	Company	City
Answering Machine	Matra	Pont-de-Buis
Answering Machine	Philips	Le Mans
Answering Machine	Sagem	Fougères
Answering Machine	Sony	Colmar
Camcorder	Sony	Colmar
Camcorder	Thomson	Moulins
Cellular Telephone	Alcatel	Laval
Cellular Telephone	Mitsubishi	Etrelles
Cellular Telephone	Philips	Le Mans
Cellular Telephone	Sagem	Fougères
CO Line Card	Alcatel	Brest
CO Line Card	Alcatel	Cherbourg
CO Line Card	Alcatel	Eu
CO Line Card	Ericsson	Longuenesse
CO Line Card	Sagem	St-Etienne-du-Rouvray
Color TV	Daewoo	Fameck
Color TV	Grundig	Creutzwald
Color TV	Philips	Angers
Color TV	Philips	Dreux
Color TV	Thomson	Angers
Corded Telephone	Alcatel	Ilkirch
Corded Telephone	Alcatel	Strasbourg
Corded Telephone	AT&T	Saumur
Corded Telephone	HPF (Ascom)	Bonneville
Corded Telephone	Matra	Douarnenez
Corded Telephone	Matra	Pont-de-Buis
Corded Telephone	Philips	Le Mans
Corded Telephone	Sony	Colmar
Engine Control Unit	GM Delco Moraine	Ande
Engine Control Unit	Motorola AIEG	Angers
Engine Control Unit	Sagem	Fougères
Engine Control Unit	Valeo	Beugency
Engine Control Unit	Valeo	Brassac
Engine Control Unit	Valeo	Grosmenil
Engine Control Unit	Valeo	Sainte-Florine

(continued)

Table 6-1 (Continued)
Manufacturing Locations—France

Product	Company	City
Fax Machine	Canon	Liffre
Fax Machine	Matra	Douarnenez
Fax Machine	Matra	Rennes
Fax Machine	Mitsubishi	Etrelles
Fax Machine	Murata	Longwy
Fax Machine	Ricoh	Wettolsheim
Fax Machine	Sagem	Fougeres
Fax Machine	Sharp	Alsace
In-car Entertainment	Alps	Soissons
In-car Entertainment	Clarion	Custines
In-car Entertainment	Haitai	Longwy
In-car Entertainment	Philips	Rambouillet
In-car Entertainment	Samsung	Aulmay
In-car Entertainment	Secere Alpine Electronics	Soissons
In-car Entertainment	Sofrec Deltadore	Janze Rennes
In-car Entertainment	Sony	Colmar
In-car Entertainment	Trio Kenwood	Janz
LAN Card	Nortel	Marne-la-Vallée
Modem	3X	Paris
Modem	COM 1	Cestas
Modem	Kortex International	Paris
Modem	Olitec	Nancy
Modem	Philips	Rouen
Modem	PNB (US Robotics)	Suresnes
Modem	Sofracin	Puteaux
Odd	ATG Cygnet	Toulouse
Page Printer	Canon	Liffre
Page Printer	Kyocera	Le Grand Quevilly
Page Printer	Lexmark	Orléans
Page Printer	Nipson Printing Systems (Bull)	Belfort
PBX Line Card	Alcatel	Orvault
PBX Line Card	Alcatel	Tréguier
PBX Line Card	AT&T	Saumur
PBX Line Card	Bosch	Montceau-les-Mines
PBX Line Card	Nortel	Verdum
PC	Add-x/Normerel	Granville
PC	Alif	Montreuil
PC	Bull	Angers
PC	Donatec	Ivry-sur-Seine
PC	Hewlett-Packard	Grenoble
PC	Hewlett-Packard	Lyon
PC	PC Warehouse	Val-de-Reuif
PC	Siemens-Nixdorf	Haubourdin
PC	Unisys	Barentin

(continued)

Table 6-1 (Continued)
Manufacturing Locations—France

Product	Company	City
Personal Hi-Fi	JVC	Villers-la-Montagne
Personal Hi-Fi	Matsushita	Longwy Haut
Personal Hi-Fi	Sony	Colmar
RDD	Gigastorage	Belfort
RDD	Hitachi	Orléans
RDD	Nomai	Velizy Villacoublay
RDD	Storage Technology	Toulouse
Serial Printer	Epson	Bonneuil-sur-Marne
Serial Printer	Mitsubishi Electric	Etrelles
Set-Top Box	Sagem	Fougères
Set-Top Box	Thomson	Strasbourg
VCR	Akai	Honfleur
VCR	Matsushita	Longwy Haut
VCR	Sony	Colmar
VCR	Thomson	Tonnerre
Workstation	IBM	Montpellier
Workstation	Tekelec/Themis	Gièvres

Source: Dataquest (May 1996)

Table 6-2
Manufacturing Locations—Germany

Product	Company	City
Answering Machine	DeTeWe	Berlin
Answering Machine	Grundig	Bayreuth
Answering Machine	Hagenuk	Kiel
Camcorder	Orion	Frankfurt
Cellular Telephone	AEG	Ulm
Cellular Telephone	Bosch (Blaupunkt)	Hildesheim
Cellular Telephone	Motorola	Flensburg
Cellular Telephone	Nokia	Bochum
Cellular Telephone	Siemens	Kamp Linsfort
CO Line Card	Alcatel	Gunzenhausen
CO Line Card	Alcatel	Stuttgart
CO Line Card	Bosch	Limburg
CO Line Card	Bosch	Offenburg
CO Line Card	DeTeWe	Berlin
CO Line Card	Philips	Nürnberg
CO Line Card	Siemens	Bruchsal
CO Line Card	Siemens	Munich
Color TV	Daewoo	Frankfurt
Color TV	Goldstar	Worms
Color TV	Grundig	Nürnberg
Color TV	Grundig	Miesau
Color TV	Grundig	Furth
Color TV	Korea Electronics Co	Frankfurt
Color TV	Loewe	Kronach
Color TV	Matsushita	Lüneburg
Color TV	Nokia	Esslingen
Color TV	Nokia	Bochum
Color TV	Philips	Aachen
Color TV	Sony	Stuttgart
Color TV	Thomson	Celle
Corded Telephone	Alcatel	Stuttgart
Corded Telephone	Hagenuk	Kiel
Corded Telephone	Matra	Marburg
Corded Telephone	Siemens	Bocholt
Corded Telephone	Telenorma (Robert Bosch)	Frankfurt

(continued)

Table 6-2 (Continued)
Manufacturing Locations—Germany

Product	Company	City
Engine Control Unit	Deutsche Vergaser Gessellschaft	Berlin
Engine Control Unit	Hitachi	Munich
Engine Control Unit	Motometer	Leonberg
Engine Control Unit	Robert Bosch	Reutlingen
Engine Control Unit	Robert Bosch	Stuttgart
Engine Control Unit	Siemens	Regensburg
Engine Control Unit	Temic Telefunken (AEG/Dasa)	Heilbronn
Engine Control Unit	TRW Messmer	Radolfzell
Engine Control Unit	VDO Adolf Schindling (Mannesmann)	Hannover
Engine Control Unit	VDO Adolf Schindling (Mannesmann)	Frankfurt
Fax Machine	SAT (Dr Neuhaus)	Hamburg
Fax Machine	Siemens	Berlin
In-car Entertainment	Becker	Karlsbad
In-car Entertainment	Blaupunkt	Hildescheim
In-car Entertainment	Daewoo	Frankfurt
In-car Entertainment	Inkel	Schwalbach
In-car Entertainment	Matsushita	Neumünster
In-car Entertainment	Motometer	Leonberg
In-car Entertainment	Philips	Wetzler
LAN Card	Syskonnekt	Ettlingen
Modem	Anchor Datacomm	Amstelveen
Modem	Controlware	Dietzenbach
Modem	Creatix	Saarbrucken
Modem	SAT (Dr Neuhaus)	Hamberg
Modem	Elsa	Aachen
Modem	Telemation	Kronberg
Page Printer	SNI	Poing
PBX Line Card	Bosch	Rodermark
PBX Line Card	Siemens	Bocholt
PBX Line Card	Siemens	Witten
PC	Actebis	Soest
PC	Aquarius	Bad Homburg
PC	Computer Elektrik Dresden	Dresden
PC	Escom	Heppenheim
PC	ITOS	Konstanz
PC	NCR (AT&T)	Augsburg
PC	Peacock Computer	Wünnenberg-Haaren
PC	Siemens-Nixdorf	Dresden
PC	Siemens-Nixdorf	Augsburg
PC	Toshiba	Regensburg
PC	Triumph-Adler (Olivetti)	Dresden
PC	Triumph-Adler (Olivetti)	Nürnberg
PC	Vobis	Aachen

(continued)

Table 6-2 (Continued)
Manufacturing Locations—Germany

Product	Company	City
RDD	IBM	Mainz
Serial Printer	Mannesmann Tally	Elchingen
Serial Printer	Printer Systems International	Slegan
Serial Printer	Seikosha	Neumünster
Serial Printer	SNI	Paderborn
Serial Printer	Walther	Gerstetten
Set-Top Box	Grundig	Furth
Set-Top Box	Philips	Krefeld
Set-Top Box	Philips	Hamburg
VCR	Daewoo	Frankfurt
VCR	Fisher Industries	Nördlingen
VCR	Funai Electric	Lüneburg
VCR	Goldstar	Worms
VCR	Grundig	Furth
VCR	Hitachi	Landsberg
VCR	J2T Video	Berlin
VCR	Matsushita	Peine
VCR	Matsushita	Hesebergweg
VCR	Sanyo	Nördlingen
VCR	Toshiba	Mönchengladbach
Workstation	Hewlett-Packard	Böblingen
Workstation	Siemens-Nixdorf	Augsburg

Source: Dataquest (May 1996)

Table 6-3
Manufacturing Locations—Italy

Product	Company	City
Cellular Telephone	Italtel	Milan
Cellular Telephone	Telital	Trieste
Color TV	Mivar	Milan
Color TV	Philips	Monza
Color TV	Seleco	Pordenone
Color TV	Thomson	Anagni
Corded Telephone	Alcatel	Bari
Corded Telephone	Alcatel	Milan
Corded Telephone	Brondi Telefonica	Turin
Corded Telephone	Ericsson	Pagani
Corded Telephone	Fitre	Milan
Corded Telephone	Italtel	Santa Maria Capua Vetere
Corded Telephone	Italtel	Milan
Corded Telephone	Safnat	Milan
Engine Control Unit	Marelli Autronica	Bologna
Engine Control Unit	Marelli Autronica	Pavia
Engine Control Unit	Siemens	Piero A Grado
Fax Machine	Italtel	Santa Maria Capua Vetere
LAN Card	Necsy (Italtel)	Padua
Modem	ARE (Racal)	Castellanza
Modem	AE Telecommunicazioni	Torino
Modem	Dataconsyst	Vimodrone
Modem	Telena Data	Milan
Modem	Uniautomation	Milan
Page Printer	Bull	Turin
Page Printer	Hewlett-Packard	Bergamo
Page Printer	Olivetti	San Bernardo
PC	Asem	Buia
PC	Olidata	Cesena
PC	Olivetti	Scarmagno
PC	Unibit	Rome
RDD	Seagate	Pont Saint Martin
Serial Printer	Bull	Turin
Serial Printer	Olivetti	San Bernardo
Serial Printer	Olivetti	Scarmagno
Serial Printer	Olivetti-Canon	Agliè
Set-Top Box	Seleco	Pordenone
VCR	Seleco	Pordenone
Workstation	IBM	Santa Palomba

Source: Dataquest (May 1996)

Table 6-4
Manufacturing Locations—United Kingdom and Ireland

Product	Company	City	Country
Cellular Telephone	Matsushita	Thatcham	England
Cellular Telephone	Motorola	Easter Inch	UK
Cellular Telephone	NEC	Telford	England
Cellular Telephone	Oki	Cumbernauld	England
Cellular Telephone	Orbitel (Ericsson)	Worksop	England
CO Line Card	AT&T	Malmesbury	England
CO Line Card	Ericsson	Scunthorpe	England
CO Line Card	GPT	Coventry	England
CO Line Card	GPT	Liverpool	England
CO Line Card	Nortel	Monkstown	UK
Color TV	Amstrad	Shoeburyness	England
Color TV	Hinari-Shinton	Glasgow	Scotland
Color TV	Hitachi	Aberdare	Wales
Color TV	JVC	East Kilbride	Scotland
Color TV	Matsushita	Cardiff	Wales
Color TV	Matsushita	Port Talbot	Wales
Color TV	Mitsubishi	Haddington	Scotland
Color TV	Mitsumi	Jarrow	England
Color TV	Orion Electric	Port Talbot	Wales
Color TV	Philips	Durham	England
Color TV	Samsung	Billingham	England
Color TV	Sanyo	Lowestoft	England
Color TV	Sharp	Wrexham	Wales
Color TV	Sony	Pencoed	Wales
Color TV	Sony	Bridgend	England
Color TV	Tabuchi Electric	Thornaby	England
Color TV	Tatung	Telford	England
Color TV	Toshiba	Plymouth	England
Corded Telephone	Ascom	Cardiff	Wales
Corded Telephone	Nortel	Cwmcarn	Wales
Engine Control Unit	AB Electronics	Abercynon	Wales
Engine Control Unit	AB Electronics	Cardiff	Wales
Engine Control Unit	Automotive Products	Leamington Spa	England
Engine Control Unit	Delco	Kirby	England
Engine Control Unit	Lucas	Stonehouse	England
Engine Control Unit	Motorola AIEG	Stotfold	England
Engine Control Unit	Oki	Cumbernauld	Scotland
Engine Control Unit	Zytec Autmotive	Sutton Coldfield	England
Fax Machine	Matsushita	Reading	England
Fax Machine	NEC	Telford	England
In-car Entertainment	Clarion	Swindon	England
In-car Entertainment	Inkel	Cramlington	England
In-car Entertainment	Pioneer	Swindon	England

(continued)

Table 6-4 (Continued)
Manufacturing Locations—United Kingdom and Ireland

Product	Company	City	Country
LAN Card	Madge	High Wycombe	England
Modem	Communicate (Motorola)	Ascot	England
Modem	Cray Communications	Watford	England
Modem	Dataflex Design (Amstrad)	London	England
Modem	Modular Technology	Bicester	England
Modem	Motorola ISG	Crawley	England
Modem	Psion Dacom	Milton Keynes	England
Modem	Racal	Warrington	England
Modem	Sonix Communications (3Com)	Cirenchester	England
Page Printer	NEC	Telford	England
Page Printer	Rank Xerox	Mitcheldean	England
Pager	Philips	Cambridge	England
PBX Line Card	GPT	Beeston	England
PBX Line Card	KME Information Sys.	Cwmbran	Wales
PBX Line Card	Matsushita	Newport	Wales
PBX Line Card	Philips	Airdrie	Scotland
PC	Acorn	Cambridge	England
PC	Amstrad	Shoeburyness	England
PC	Apricot	Glenrothes	Scotland
PC	Compaq	Erskine	Scotland
PC	Digital Equipment Corporation	Ayr	Scotland
PC	Elonex	London	England
PC	IBM	Greenock	Scotland
PC	Opus	Redhill	England
PC	Psion	Greenford	England
PC	Research Machines	Abingdon	England
PC	Viglen	Alperton	England
Personal Hi-Fi	Aiwa	Newport	Wales
Personal Hi-Fi	Pioneer	Wakefield	England
RDD	Calluna Technology	Glenrothes	Scotland
RDD	Xyratex	Havant	England
Serial Printer	Citizen	Scunthorpe	England
Serial Printer	Epson	Telford	England
Serial Printer	Kyushu Matsushita Electric	Newport	Wales
Serial Printer	NEC	Telford	England
Serial Printer	Newbury Data	Winsford	England
Serial Printer	Oki	Cumbernauld	England
Set-Top Box	Grundig	Llantrisant	Wales
Set-Top Box	Mitsubishi	Haddington	Scotland
Set-Top Box	Pace	Shipley	England
Set-Top Box	Pioneer	Bristol	England
Set-Top Box	Sony	Pencoed	Wales
Set-Top Box	Tatung	Telford	England
Set-Top Box	Wolsey (AB Electronics)	Pontypridd	Wales

(continued)

Table 6-4 (Continued)
Manufacturing Locations—United Kingdom and Ireland

Product	Company	City	Country
VCR	Aiwa	Newport	Wales
VCR	Amstrad	Shoeburyness	England
VCR	Daewoo	Antrim	Northern Ireland
VCR	Hitachi	Aberdare	Wales
VCR	J2T Video	Newhaven	England
VCR	Matsushita	Port Talbot	Wales
VCR	Mitsubishi	Livingston	Scotland
VCR	NEC	Telford	England
VCR	Orion Electric	Port Talbot	Wales
VCR	Sharp	Wrexham	Wales
VCR	Tabuchi Electric	Thornaby	UK
Workstation	Digital Equipment Corporation	Ayr	Scotland
Workstation	IBM	Greenock	Scotland
Workstation	Sun Microsystems	Linlithgow	Scotland
Workstation	Tapdole Technology	Cambridge	England
CO Line Card	Alcatel	Bandon	Ireland
CO Line Card	AT&T	Donegal	Ireland
CO Line Card	Ericsson	Athlone	Ireland
In-car Entertainment	Toho	Dublin	Ireland
LAN Card	3Com	Blanchardstown	Ireland
Modem	Cornel Electronics	Dublin	Ireland
Page Printer	Dataproducts (Hitachi)	Dublin	Ireland
Pager	Motorola	Swords	Ireland
PBX Line Card	Nortel	Galway	Ireland
PC	Apple	Cork City	Ireland
PC	AST	Limerick	Ireland
PC	Dell	Limerick	Ireland
PC	Gateway 2000	Dublin	Ireland
PC	Intel	Leixlip	Ireland
RDD	Matsushita-Kotobuki Electronic	Dundalk	Ireland
RDD	Seagate	Clonmel	Ireland
Serial Printer	Dataproducts (Hitachi)	Dublin	Ireland
Serial Printer	Fujitsu	Dublin	Ireland

Source: Dataquest (May 1996)

Table 6-5
Manufacturing Locations—Austria and Switzerland

Product	Company	City	Country
CO Line Card	Alcatel	Vienna	Austria
CO Line Card	Nortel	Vienna	Austria
CO Line Card	Siemens	Vienna	Austria
Color TV	Grundig	Vienna	Austria
Color TV	Philips	Lebring	Austria
Color TV	Siemens	Vienna	Austria
Corded Telephone	Schrack (Ericsson)	Kindberg	Austria
Engine Control Unit	AB Mikroelektronik	Salzburg	Austria
In-car Entertainment	HEA	Vienna	Austria
Modem	Leitha Datentechnik	Neufeld	Austria
Modem	Schrack Telecom (Ericsson)	Kindberg	Austria
PBX Line Card	Alcatel	Vienna	Austria
PBX Line Card	Ericsson	Kindberg	Austria
VCR	Philips	Vienna	Austria
VCR	Siemens	Vienna	Austria
Answering Machine	Ascom	Solothurn	Switzerland
CO Line Card	Alcatel	Wadenswil	Switzerland
CO Line Card	Ascom	Bern	Switzerland
CO Line Card	Siemens	Zurich	Switzerland
Corded Telephone	Ascom	Hombrechtikon	Switzerland
Page Printer	Wenger	Therwil	Switzerland
Pager	Swatch	Grenchen	Switzerland
Pager	Swissphone	Samstagern	Switzerland
Serial Printer	Wenger	Therwil	Switzerland
Workstation	Silicon Graphics	Cortaillod	Switzerland

Source: Dataquest (May 1996)

Table 6-6
Manufacturing Locations—Belgium and The Netherlands

Product	Company	City	Country
CO Line Card	Alcatel	Geel	Belgium
CO Line Card	Siemens	Colfontaine	Belgium
CO Line Card	Siemens	Herentals	Belgium
CO Line Card	Siemens	Oostkamp	Belgium
Color TV	Philips	Brugge	Belgium
Corded Telephone	Alcatel	Zaventum	Belgium
Corded Telephone	ATEA	Mons	Belgium
Corded Telephone	Teldico	Bavikhov	Belgium
Fax Machine	Murata	Genk	Belgium
In-car Entertainment	Philips	Termonde	Belgium
Modem	Memotec Datacom	Brussels	Belgium
Modem	Telindus	Heverlee	Belgium
ODD	Philips	Hasselt	Belgium
PBX Line Card	Alcatel	Colfontaine	Belgium
Personal Hi-Fi	Philips	Louvain	Belgium
Set-Top Box	Pioneer	Erpe-Mere	Belgium
CO Line Card	Alcatel	Hague	Netherlands
CO Line Card	AT&T	Huizen	Netherlands
Corded Telephone	Ericsson	Rijen	Netherlands
Page Printer	Hewlett-Packard	Amstelveen	Netherlands
Page Printer	Océ	Venlo	Netherlands
Page Printer	Rank Xerox	Venray	Netherlands
Page Printer	Texas Instruments	Utrecht	Netherlands
Pager	Philips	Eindhoven	Netherlands
PBX Line Card	Ericsson	Amsterdam	Netherlands
PBX Line Card	Philips	Hilversum	Netherlands
PBX Line Card	Philips	Hoorn	Netherlands
PC	Acer	's Hertogenbosch	Netherlands
PC	Packard Bell	Wijchen	Netherlands
PC	Panatek	Breukelen	Netherlands
PC	Tulip	's Hertogenbosch	Netherlands
VCR	Philips	Dordrecht	Netherlands
Workstation	Intergraph	Nijmegen	Netherlands

Source: Dataquest (May 1996)

Table 6-7
Manufacturing Locations—Denmark, Finland, Norway and Sweden

Product	Company	City	Country
Answering Machine	Dancall (Amstrad)	Pandrup	Denmark
Cellular Telephone	Cetelco	Stovring	Denmark
Cellular Telephone	Dancall (Amstrad)	Pandrup	Denmark
Color TV	DNP	Copenhargen	Denmark
Color TV	First Development	Allerod	Denmark
Corded Telephone	Bang & Olufsen	Struer	Denmark
Corded Telephone	Kirk Telecom	Horsens	Denmark
LAN Card	Cray Networks	Herlev	Denmark
LAN Card	Olicom	Copenhagen	Denmark
Modem	Lasat	Svenstrup	Denmark
PBX Line Card	Alcatel	Horsens	Denmark
PC	First Development	Allerod	Denmark
Set-Top Box	Bang & Olufsen	Struer	Denmark
VCR	Bang & Olufsen	Struer	Denmark
VCR	First Development	Allerod	Denmark
Cellular Telephone	Benefone	Salo	Finland
Cellular Telephone	Nokia	Oulu	Finland
Cellular Telephone	Nokia	Salo	Finland
CO Line Card	Ericsson	Jorvas	Finland
CO Line Card	Siemens	Helsinki	Finland
Color TV	Nokia	Turku	Finland
LAN Card	Nokia	Aanekoski	Finland
Pager	Nokia	Salo	Finland
PBX Line Card	Alcatel	Espoo	Finland
PBX Line Card	Ericsson	Jorvas	Finland
PC	ICL	Kilo	Finland
Set-Top Box	Nokia	Salo	Finland
CO Line Card	Alcatel	Halden	Norway
CO Line Card	Alcatel	Kongsvinger	Norway
CO Line Card	Ericsson	Hisoy	Norway
PC	Norsk Computer Industries	Sandes	Norway
PC	TIKI-Data	Oslo	Norway
Cellular Telephone	Ericsson	Kumla	Sweden
CO Line Card	Ericsson	Norrkoping	Sweden
CO Line Card	Ericsson	Stockholm	Sweden
Corded Telephone	Ericsson	Stockholm	Sweden
Engine Control Unit	Saab	Trollhatton	Sweden
Modem	Ericsson	Stockholm	Sweden
PBX Line Card	Ericsson	Katrineholm	Sweden
PBX Line Card	Ericsson	Stockholm	Sweden
PBX Line Card	Ericsson	Stockholm	Sweden
Serial Printer	Jarfalla	Jarfalla	Sweden
Set-Top Box	Luxor (Nokia)	Motala	Sweden

Source: Dataquest (May 1996)

Table 6-8
Manufacturing Locations—Portugal and Spain

Product	Company	City	Country
Color TV	Salo Iberica	Cascais	Portugal
Color TV	Samsung	Alcoitão	Portugal
In-car Entertainment	Ford	Pamela	Portugal
In-car Entertainment	Grundig	Braga	Portugal
Personal Hi-Fi	Grundig	Braga	Portugal
Personal Hi-Fi	Grundig	Braga	Portugal
Cellular Telephone	AEG/Matra	Madrid	Spain
Cellular Telephone	Indelec	N/A	Spain
Color TV	Daewoo	Barcelona	Spain
Color TV	Panasonic (Matsushita)	Gerona	Spain
Color TV	Philips	Barcelona	Spain
Color TV	Philips	Barcelona	Spain
Color TV	Sanyo	Barcelona	Spain
Color TV	Sharp	Barcelona	Spain
Color TV	Sony	Barcelona	Spain
Corded Telephone	Alcatel	Málaga	Spain
Corded Telephone	Amper Telemática	Madrid	Spain
Engine Control Unit	Ford	Cadiz	Spain
Engine Control Unit	Hughes Microelectronics	Málaga	Spain
Modem	Amper Telemática	Madrid	Spain
Modem	Fujitsu	Málaga	Spain
Modem	Pahldata	Barcelona	Spain
Modem	Teldat	Madrid	Spain
Page Printer	Rank Xerox	Coslada	Spain
PC	APD	Aranavez	Spain
PC	Fujitsu	Málaga	Spain
PC	Investrónica	Madrid	Spain
PC	Olivetti	Barcelona	Spain
Personal Hi-Fi	Panasonic (Matsushita)	Gerona	Spain
Serial Printer	Fujitsu	Málaga	Spain
Serial Printer	Hewlett-Packard	Barcelona	Spain
Serial Printer	Olivetti	Barcelona	Spain
VCR	Daewoo	Barcelona	Spain
VCR	Panasonic	Gerona	Spain
VCR	Samsung	Barcelona	Spain
VCR	Sanyo	Barcelona	Spain

N/A= not available
Source: Dataquest (May 1996)

Table 6-9
Manufacturing Locations—Rest of Europe

Product	Company	City	Country
CO Line Card	Intracom	Athens	Greece
CO Line Card	Siemens	Thessaloniki	Greece
Color TV	Hitachi	Athens	Greece
PC	Altec	Athens	Greece
CO Line Card	Nortel	Istanbul	Turkey
CO Line Card	Siemens	Kartal	Turkey
Color TV	Ortadogu	Izmir	Turkey
Color TV	Samsung	Izmir	Turkey
Color TV	Vestel	Çorlu	Turkey
PBX Line Card	Nortel	Istanbul	Turkey
Color TV	Samsung	Budapest	Hungary
Color TV	Selectronic	Budapest	Hungary
RDD	IBM	Székesfehérvár	Hungary
Corded Telephone	Tesla Stropkov	Stropkov	Slovakia

Source: Dataquest (May 1996)

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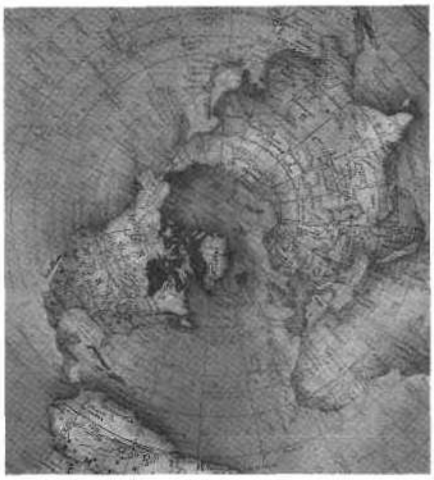

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Telephone Linecard Production in Europe—Teardown of an Ericsson MD110 PBX-Linecard

Focus Report
1996

Program: Electronic Equipment Production Monitor
Product Code: SAPM-EU-FR-9602
Publication Date: May 11, 1996
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Table of Contents

List of Figures

List of Tables

Chapter 1

Executive Summary and Introduction

Central Office Analog Averview

- Central office analog telephone linecard production in Europe in 1995 is estimated to be 27.8 million lines and is forecast to rise to 29.4 million lines by 2000, representing a CAGR (1995-2000) of 1 percent
- In 1994 the leading producers (by lines) were:
  - Alcatel: 33 percent
  - Ericsson: 23 percent
  - Siemens: 21 percent
- In 1994 an estimated 40 percent of production was exported outside Europe
- The average factory selling price per line is estimated at $216 in 1995 and is forecast to fall to $181 in 2000

Central Office ISDN Overview

- Central office ISDN telephone linecard production in Europe in 1995 is estimated at 4.2 million lines and is forecast to rise to 8.1 million lines in 2000, representing a CAGR (1995-2000) of 14 percent
- In 1994 the leading producers (by lines) were:
  - Alcatel: 39 percent
  - Ericsson: 33 percent
  - Siemens: 12 percent
- In 1994 an estimated 18 percent of production was exported outside Europe
- The average factory selling price per-line is estimated at $240 in 1995 and is forecast to fall to $210 in 2000

Premise Telephone Overview

- Premise telephone linecard production in Europe in 1995 is estimated to be 11.6 million lines and is forecast to rise to 14.0 million lines in 2000, representing a CAGR (1995-2000) of 4 percent
- In 1994 the leading producers (by lines) were:
  - Alcatel: 22 percent
  - Siemens: 18 percent
- In 1994 an estimated 7 percent of production was exported outside Europe
- The average factory selling price per-line is estimated at $162 in 1995, forecast to rise to $172 in 2000

Component Market Overview

- 1996 average component-sector costs per line (component volume of 100,000 for pricing purposes) are:
  - ICs: $8.858
  - Discretes: $2.737
  - Passives: $1.841
  - RF/Passives and Miscellaneous: $1.828

- 1996 average component sector costs per line (component volume of 1 million for pricing purposes) are:
  - ICs: $7.905
  - Discretes: $2.357
  - Passives: $1.421
  - RF/Passives and Miscellaneous: $1.523
- 2000 average component sector costs per line (component volume of 1 million for pricing purposes) are:
  - IC: $7.747
  - Discretes: $2.169
  - Passives: $1.350
  - RF/Passives and Miscellaneous: $1.416
- 1996 market values (component volume of 100,000 for pricing purposes) are:
  - IC: $858 million
  - Discretes: $265 million
  - Passives: $178 million
  - RF/Passives and Miscellaneous: $177 million
- 2000 market values (component volume of 1 million for pricing purposes) are:
  - IC: $868 million
  - Discretes: $243 million
  - Passives: $138 million
  - RF/Passives: $159 million
  - Miscellaneous: $159 million

Introduction

This *Focus Report* is one in a series of evaluations of key types of electronic equipment, manufactured in Europe. These items of equipment are leading indicators of electronic market production within Europe. For each product type, the report lists the 10 largest producers (OEMs: the brand owners), or those that make up 75 percent of European production. The reports detail manufacturing, including contract electronics manufacture (CEM) and design (R&D) locations, unit production, equipment bill of materials and typical high-volume component pricing.

Evaluation Methodology

Representative high-volume, typically configured, models are acquired for review. All the electronic components are listed. Appropriate descriptive information, such as part number, manufacturer (where known), and package type, is recorded. A destructive analysis is often performed on the ASICs to determine the foundry source, technology and gate count.

Pricing Methodology

Once an exhaustive list of components is compiled, a price is determined for each line item. Each item has a price forecast, to give the reader some idea of how the cost of each element could vary. Pricing is derived from the following sources:

- Dataquest's Semiconductor Pricing and Supply Service
- Dataquest's Mass Storage Service
- Cost models
- Press releases
- Industry quotes and surveys
- Catalogs and distributor information
- Industry sources

Component prices are based on 100,000-component quantities (not product quantities). The prices are obtained from various sources, including component distributors (usually supported by the component vendor); discounted catalog prices; and industry sources. In addition, component prices based on 1 million-component quantities (not product quantities) are provided. These prices are based partly on prices supported by the component vendor, and partly on an empirical cost model.

The 100,000-component quantities may be considered single "spot" purchases. They are priced in accordance with the prevailing lead time for that component. They do not, and cannot, take account of specific long-term partnerships between component-vendors and equipment manufacturers which may result in further discounts, delivery within lead-time, and other arrangements.

Component databases are updated throughout the year, depending upon the price volatility of the particular element. Basic ASIC pricing is derived from Scanning Electron Microscope (SEM) analysis and Dataquest's proprietary ASIC cost-model. Bare PCB prices are derived from Dataquest's pricing survey and industry sources.

Chapter 2
The Telephone Linecard Market in Europe

Introduction

Before electronic mail, the greatest productivity improvement in personal and business communications was the introduction of the telephone. It is now a ubiquitous part of life for millions of people in the developed world, where it is almost always taken for granted. While in rapidly developing economies, whether in Central and Eastern Europe, Asia, or South America, the telephone is no longer a status symbol, but a basic requirement, and the demand for telephone lines is growing rapidly.

For many years, telephones and the companies that provided the connection, offered basic services; usually consisting of being able to dial nationally or internationally, either direct or via an operator. However, as the telephone network has been upgraded (often with little publicity), telephone-network operating companies now offer many new services, and have the capability to carry a variety of non-voice traffic.

The telephone linecard is where the line from the home or desk meets the high-bandwidth, digital, global telephone network. The linecard has the dual function of communicating with and supervising the operation of your telephone (often over relatively long distances), and communicating with a high-speed network which provides worldwide connectivity. And because every telephone is connected to a card, and the number of telephones in use continues to rise, so does the requirement for linecards.

Product Definition

This report deals with telephone linecards used in central-office (CO) exchanges that terminate and switch individual public telephone network lines originating from a conventional customer-terminal (telephone). It also covers telephone linecards installed in private branch exchanges (PBXs) that terminate and switch individual telephone lines originating from a desktop customer-terminal (telephone). It also makes reference to integrated services digital network (ISDN) technology.

Both the CO and PBX linecards are installed in systems which are controlled by computer software (digitally switched lines). However, the cards in both CO and PBX systems may use either a digital bitstream (usually ISDN), or conventional analog waveforms to carry information from the linecard to the telephone (or other terminal device).

Market Opportunity

Telephone linecards are designed and manufactured for a specific CO or PBX switching system. This means that each company produces linecards designed for the specific switching system in which the linecards are housed. Obviously, shipments of specific models of linecard are related to the level of orders for the exchange products in which they are used and the number of lines each of those exchange products is configured to support.

There are a number of drivers for linecard production:

- New exchange systems
- Additional lines for existing exchange systems
- Replacement lines for existing exchange systems

The replacement lines may be:

- Spares to replace faulty cards
- Upgrading an exchange from analog to digital switching
- Upgrading an exchange from analog to digital (ISDN) transmission

The transition from analog to digital switching in European CO systems has required significant linecard production over the past few years. And while it is now a mature market in Western Europe, there are other regions with a significant number of analog lines that could be upgraded.

ISDN: The Great Unknown

Digital transmission offers more immediate, and obvious, benefits to the user than digital switching. Basic rate ISDN typically offers two 64,000 bit/s digital channels. ISDN can be used on private networks, from a PBX exchange to the desktop; and from CO exchanges to either home or business premises.

ISDN traffic requires an ISDN-enabled linecard at the exchange, and an ISDN-compatible terminal at the customer end of the line. ISDN may be used purely for digitized voice traffic, but is more likely to be used for simultaneous data and digitized voice, or solely for data transfer. Computer users, particularly in the home and small office, are now demanding higher data transfer rates than the current maximum modem-to-modem rate of 28,800 bit/s. ISDN can support a significantly greater transfer rate than that currently offered by the analog local loop.

Although problems with technology and standards have largely been eliminated, the growth in ISDN over the public network is largely reliant on the tariffs charged by PTOs to use the service.

European Production

Europe has a strong manufacturing base of telecommunications equipment companies. In the past, these companies have benefited from limited competition in their home markets; which has allowed them to expand outside Europe. This has led to European production of linecards exceeding shipments in Europe.

However, as European markets for both CO and PBX equipment are deregulated, there is increased competitive pressure on manufacturers that has led to restructuring within the industry. And as markets outside Europe grow rapidly, there will be a tendency to move production to the regions that are consuming linecards.

Unit Production

A telephone linecard is designed and manufactured to serve a specific number of lines (for example 4, 8, 16 or more). This means that a linecard serving 16 lines is functionally equivalent to 2 linecards serving 8 lines each. Because there is no standard linecard, Dataquest measures linecard shipments and production by the number of lines, rather than the number of cards.

Table 2-1 and Figure 2-1 show the European production forecast for both CO and PBX linecards. Table 2-2 and Figure 2-2 split CO production between analog and ISDN. The CAGR from 1995 to 2000 for total linecard production is 3 percent; this is made up of a CAGR of 3 percent for CO cards and 4 percent for PBX linecards.

The forecast in Table 2-2 shows that in 1996 slightly more than 85 percent of the total production volume of CO linecards will be for analog lines; and the production of analog lines is growing at a rate of just 1 percent over the forecast period. However, the production of ISDN CO linecards is forecast to grow by 14 percent over the forecast period, reaching almost 22 percent of the total by 2000.

Table 2-1
CO/PBX Telephone Linecard Production in Europe—History and Forecast (Thousands of Lines)

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Total Production	42,335	43,683	45,246	46,424	47,898	49,642	51,455	3%
CO Production	31,005	32,043	33,190	33,899	34,892	36,163	37,500	3%
PBX Production	11,330	11,640	12,056	12,525	13,006	13,479	13,955	4%

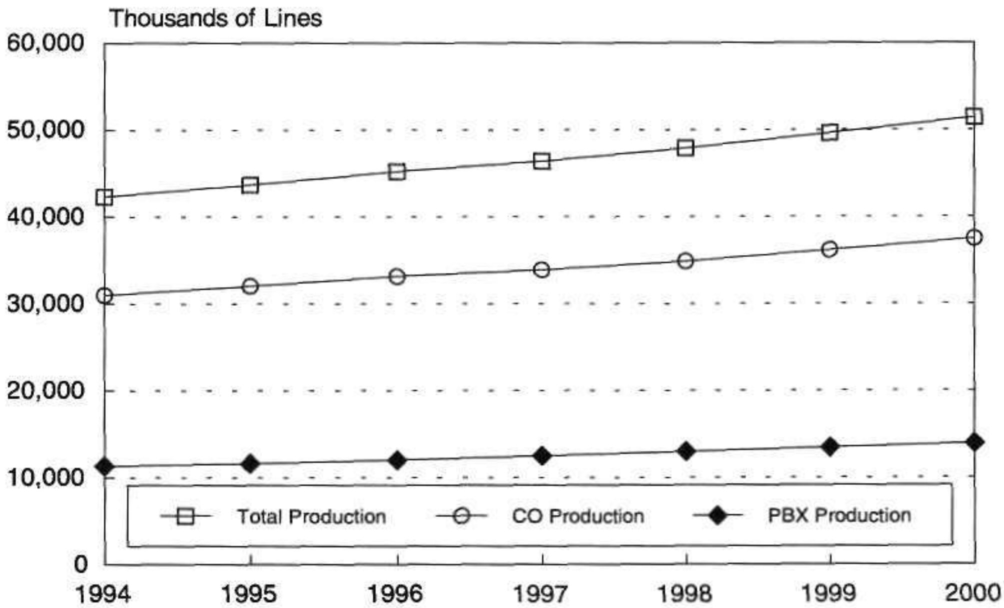
Source: Dataquest (May 1996 Estimates)

Table 2-2
CO Telephone Linecard Production in Europe—History and Forecast (Thousands of Lines)

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Total CO Production	31,005	32,043	33,190	33,899	34,892	36,163	37,500	3%
CO-Analog Production	27,650	27,843	28,438	28,229	28,244	28,915	29,417	1%
CO-ISDN Production	3,355	4,200	4,752	5,670	6,648	7,248	8,083	14%

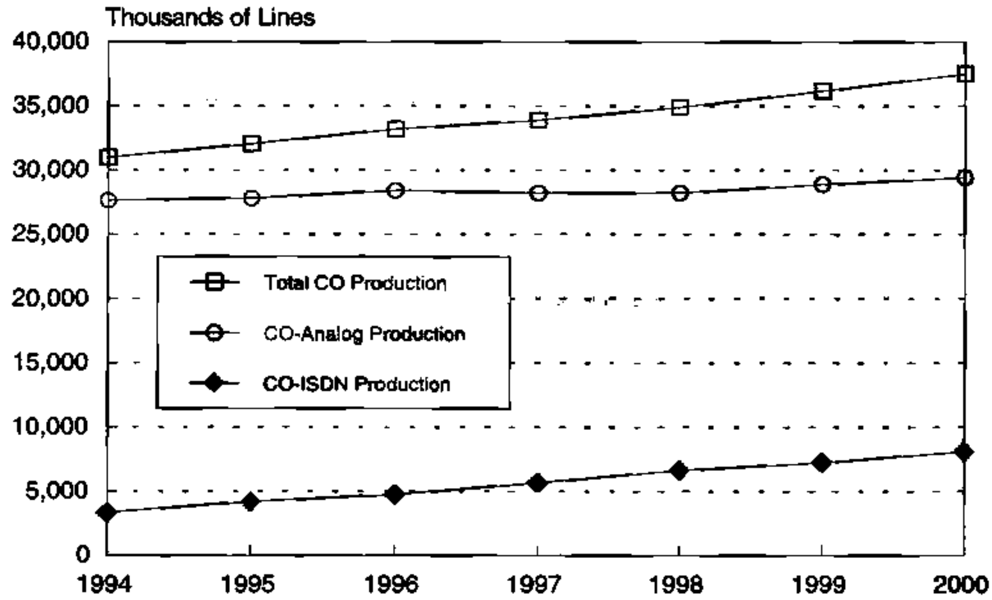
Source: Dataquest (May 1996 Estimates)

Figure 2-1
CO/PBX Telephone Linecard Production in Europe—History and Forecast (Thousands of Lines)



Source: Dataquest (May 1996 Estimates)

Figure 2-2
CO Telephone Linecard Production in Europe—History and Foreca
(Thousands of Lines)



Source: Dataquest (May 1996 Estimates)

Chapter 3
Telephone Linecard Technology

Introduction

The purpose of a telephone linecard is to convert information from multiple incoming telephone lines into a single pulse-code-modulated (PCM) digital bit-stream, for transmission and switching over national and international networks.

The linecard provides several basic functions: it must drive a telephone-line terminated with a handset (often a significant distance away), while coping with variations in line characteristics. The card must handle multiple simultaneous calls on typically 8 or 16 lines convert between the analog signals from each telephone line and the digital signals for the network, as well as having sufficient protection to prevent any high voltage surges from the telephone lines damaging the switching equipment.

Overview

Figure 3-1 is a block diagram of a telephone linecard, together with links to terminal devices (telephones) and the PCM-bus in the exchange system. The linecard itself is enclosed within a dotted line. Its functionality can be broken down into three parts: the line-interface, the line-access and the multiplex functions.

In almost all cases, the line-interface function is implemented using a group of components dedicated to each line (for example, 8 lines would require 8 individual line interface circuits). The line-access function is usually implemented by a single circuit (group of components) which communicates with all of the line-interface circuits. The multiplex function is now usually implemented within the same integrated circuit (IC) as the line-access function.

SLICs

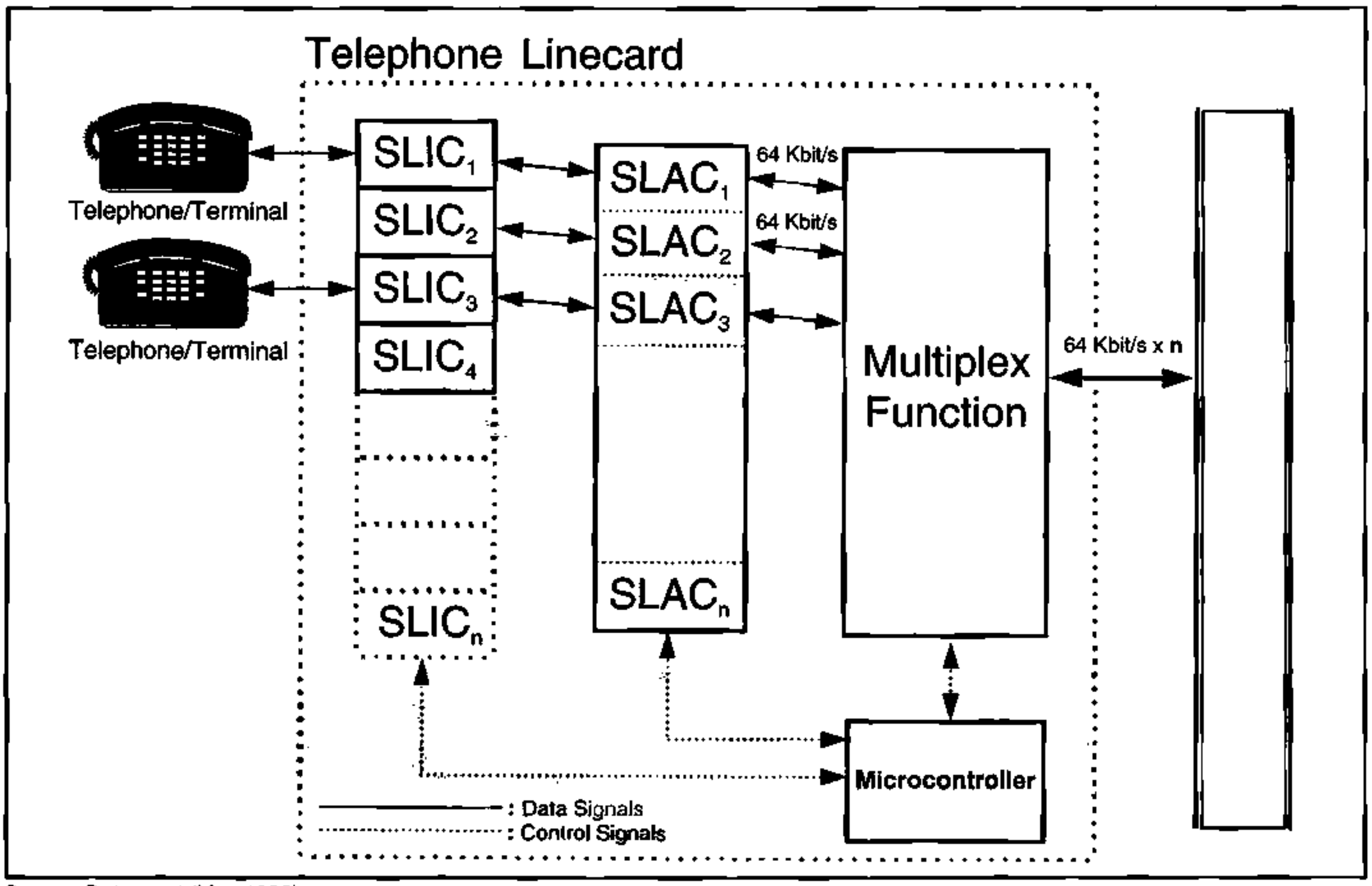
The initial interface between the incoming telephone line and the linecard is provided by a subscriber line-interface circuit (SLIC). The function of the SLIC is to provide basic line-interface features (collectively given the acronym BORSHT). These include:

- Battery feed
- Overvoltage protection
- Ringing
- Supervision/Signaling
- Hybrid conversion
- Test

The battery feed function is to provide power (when required) to the terminal device. This is either a constant current, or constant voltage source (depending upon the application).

Because the incoming subscriber lines can be subject to electrical surges (caused by lightning strikes for example) the linecard needs to protect both the card itself and the exchange in which it is installed. PBX lines are usually routed within buildings and tend to have relatively basic protection circuits. However, because CO subscriber lines may be routed outside buildings and above ground, the linecards are more likely to be affected by power surges, and therefore have more sophisticated protection circuits than their PBX equivalents.

Figure 3-1
Telephone Linecard



Source: Dataquest (May 1996)

The ringing function is self-explanatory; and the supervision (or signaling) function is to monitor and control the terminal-to-linecard link.

Hybrid conversion is the process of converting the conventional two-wire (usually copper twisted-pair) link from the subscriber, into a four-wire interface for the line-access circuit to manipulate. Finally, the test function (as it implies) allows the line (and line functions) to be tested from the exchange.

SLACs and Controllers

The signals from the SLICs pass to the subscriber line-access circuit (SLAC). For linecards connected to analog telephone lines, the SLAC filters the analog signals, and performs analog-to-digital and digital-to-analog conversion. The SLAC eliminates echoes from the telephone line, and the filtering process can adapt to temperature variation and line ageing.

The SLAC function produces a number of 2-way 64,000 bit/s PCM datastreams, depending on the number of SLICs on the linecard (typically 8 or 16 streams). The 64,000 bit/s PCM streams are then multiplexed (assigned a time-slot), to form a single PCM data-stream, running at 512,000 bit/s for 8 SLICs, and 1,024,000 bit/s for 16 SLICs. The PCM signal from the linecard is itself multiplexed (by the exchange system) with PCM signals from other linecards within the exchange system.

The multiplex function on the linecard is often implemented by the same IC which implements the SLAC function. The SLIC, SLAC and multiplex functions tend to be controlled using microcontrollers. ASICs can be used to implement or control exchange-specific multiplexing systems.

CO ISDN

For analog transmission, a 2-wire medium (typically copper twisted-pair) is used from the subscriber terminal (telephone) to the linecard. In comparison, ISDN terminals have an output with a minimum of 4 wires (and usually 8 wires); this must be converted to a signal suitable for 2-wire transmission via the local loop. This conversion from 4 (or more) wire to 2 wire, usually takes place at the point where the 2-wire local loop enters the building.

An ISDN linecard at the exchange uses SLICs to perform 2-wire to 4-wire (hybrid) conversion, and to handle the digital subscriber-line characteristics in a similar way to an analog subscriber line. The SLAC function in an ISDN linecard is concerned with successfully moving the incoming data from the SLICs onto the PCM bus in the exchange switch.

Digital PBX

ISDN from a CO exchange to an individual subscriber offers a standard ISDN termination to which you can connect a standard ISDN terminal. However, for PBX infrastructure it is more cost-effective to run 2 wires to each termination point; without specifying in advance what type of service that termination point will offer.

Digital PBX systems combine the line-termination for digital transmission within the digital (ISDN) terminal. By combining the 4-wire to 2-wire conversion within the terminal, the digital telephone can be connected as a "standard" phone anywhere on the network; with reconfiguration at the exchange-end only.

However, without offering a standard 4-wire ISDN termination point on the desktop, it allows PBX manufacturers to use proprietary digital transmission techniques over the 2-wire medium.

Chapter 4
Major Manufacturers

Alcatel Leads in CO and PBX; Ericsson and Siemens Challenge

The bulk of linecard production is for CO analog systems, and this market is dominated by Alcatel which, together with Ericsson and Siemens, accounts for just over 75 percent of European production. Table 4-1 shows how almost 27.7 million CO analog lines produced in 1994 were split by manufacturer.

Production of cards for CO ISDN is lower than for CO analog. Between them, Alcatel and Siemens manufactured 72 percent of the lines produced in 1994. Table 4-2 shows how the just over 3.3 million CO ISDN lines manufactured during 1994 were split by manufacturer.

The production of linecards for PBX is more fractured, with seven companies making up 75 percent of European production. Table 4-3 shows how the just over 11.3 million PBX lines manufactured in 1994 were split by manufacturer.

Table 4-1
1994 CO Analog Linecard Production by Manufacturer

Company	Production (Thousands of Lines)	Production Share (%)	Cumulative Share (%)
Alcatel	9,000	33%	33%
Ericsson	6,400	23%	56%
Siemens	5,800	21%	77%
Italtel	1,900	7%	84%
Matra-Ericsson	1,100	4%	88%
GPT	1,000	4%	92%
Nortel	650	2%	94%
Others	1,800	6%	100%
Total Production	**27,650**		

Source: Dataquest (May 1996 Estimates)

Table 4-2
1994 CO ISDN Linecard Production by Manufacturer

Company	Production (Thousands of Lines)	Production Share (%)	Cumulative Share (%)
Alcatel	1,300	39%	39%
Siemens	1,100	33%	72%
GPT	400	12%	84%
Ericsson	125	4%	88%
Italtel	110	3%	91%
Bosch	110	3%	94%
DeTeWe	110	3%	97%
Others	100	3%	100%
Total Production	**3,355**		

Source: Dataquest (May 1996 Estimates)

Table 4-3
1994 PBX Linecard Production by Manufacturer

Company	Production (Thousands of Lines)	Production Share (%)	Cumulative Share (%)
Alcatel	2,500	22%	22%
Siemens	2,000	18%	40%
Nortel	900	8%	48%
Philips	850	8%	56%
Ericsson	850	8%	64%
Bosch	700	6%	70%
Matra	690	6%	76%
Others	2,840	24%	100%
Total Production	**11,330**		

Source: Dataquest (May 1996 Estimates)

Other Manufacturers

Other manufacturers involved in production include companies formed through consolidation and joint ventures such as Matra Ericsson, and Siemens' stake in GPT and Italtel; telecommunications equipment companies including Nortel and Italtel; and general electronics companies such as Bosch and Philips.

Production in Europe

Most linecard producers use their own manufacturing facilities, rather than contract manufacturers. Only one company responding to Dataquest's production survey reported using a contract manufacturer. On average, about 40 percent of CO analog lines manufactured within Europe are exported for use outside Europe; this compares with 18 percent of CO ISDN lines exported. However, only 7 percent of PBX lines manufactured in Europe are exported.

European Locations

Table 4-4 shows the manufacturing and design locations of companies producing telephone linecards in Europe. Recent changes of ownership have resulted in Philips Business Communications (based in Scotland) being sold to Telecom Sciences Corporation, and parts of Philips Communications Industries (in continental Europe) being sold to AT&T Network Systems.

Table 4-4
Telephone Linecard OEM Locations in Europe

					Products	
Company	**City**	**Country**	**R&D**	**Production**	**CO**	**PBX**
Alcatel	Vienna	Austria		✔	✔	✔
Alcatel	Colfontaine	Belgium		✔		✔
Alcatel	Geel	Belgium		✔	✔	
Alcatel	Horsens	Denmark		✔		✔
Alcatel	Espoo	Finland		✔		✔
Alcatel	Brest	France		✔	✔	
Alcatel	Cherbourg	France		✔	✔	
Alcatel	Eu	France		✔	✔	
Alcatel	Orvault	France		✔		✔
Alcatel	Tréguier	France		✔		✔
Alcatel	Gunzenhausen	Germany		✔	✔	
Alcatel	Stuttgart	Germany		✔	✔	
Alcatel	Bandon	Ireland		✔	✔	
Alcatel	Avezzano	Italy		✔		✔
Alcatel	Colombes	Italy	✔			✔
Alcatel	Milan	Italy		✔	✔	
Alcatel	Hague	Netherlands		✔	✔	
Alcatel	Halden	Norway		✔	✔	
Alcatel	Kongsvinger	Norway		✔	✔	
Alcatel	Cascais	Portugal		✔	✔	
Alcatel	Madrid	Spain		✔	✔	
Alcatel	Málaga	Spain		✔		✔
Alcatel	Wadenswil	Switzerland		✔	✔	
Ascom	Milan	Italy	✔			✔
Ascom	Modena	Italy	✔			✔
Ascom	Bern	Switzerland		✔	✔	
AT&T	Saumur	France		✔		✔
AT&T	Donegal	Ireland		✔	✔	
AT&T	Huizen	Netherlands		✔	✔	
AT&T	Madrid	Spain		✔	✔	
AT&T	Malmesbury	England		✔	✔	
Bosch	Montceau-Les-Mines	France		✔		✔
Bosch	Limburg	Germany		✔	✔	
Bosch	Offenburg	Germany		✔	✔	
Bosch	Rodermark	Germany		✔		✔
Budavox	Budapest	Hungary		✔	✔	
DeTeWe	Berlin	Germany	✔	✔	✔	

(continued)

Table 4-4 (Continued)
Telephone Linecard OEM Locations in Europe

					Products	
Company	City	Country	R&D	Production	CO	PBX
Ericsson	Kindberg	Austria		✔		✔
Ericsson	Jorvas	Finland		✔	✔	✔
Ericsson	Budapest	Hungary		✔	✔	
Ericsson	Athlone	Ireland		✔	✔	
Ericsson	Avezzano	Italy		✔	✔	
Ericsson	Pagani	Italy		✔	✔	
Ericsson	Amsterdam	Netherlands		✔		✔
Ericsson	Hisoy	Norway		✔	✔	
Ericsson	Madrid	Spain		✔	✔	✔
Ericsson	Katrineholm	Sweden		✔		✔
Ericsson	Norrkoping	Sweden		✔	✔	
Ericsson	Stockholm	Sweden		✔	✔	✔
Ericsson	Stockholm	Sweden	✔		✔	✔
Ericsson	Scunthorpe	England		✔	✔	
Fujitsu	Málaga	Spain		✔		✔
GPT	Beeston	England	✔	✔		✔
GPT	Coventry	England	✔	✔	✔	
GPT	Liverpool	England		✔	✔	
Intracom	Athens	Greece		✔	✔	
Italtel	Caseta	Italy		✔		✔
Italtel	Milan	Italy	✔	✔	✔	
Italtel	Palermo	Italy		✔	✔	
Kme Information Systems	Cwmbran	Wales		✔		✔
Matra Ericsson	Longuenesse	France		✔	✔	
Matra	Bois D'arcy	France	✔			✔
Matra	Douarnenez	France		✔		✔
Nortel	Vienna	Austria		✔	✔	
Nortel	Verdum	France		✔		✔
Nortel	Galway	Ireland	✔	✔		✔
Nortel	Istanbul	Turkey		✔	✔	✔
Nortel	Maidenhead	England	✔		✔	
Nortel	Monkstown	N.Ireland		✔	✔	
Philips	Nürnberg	Germany	✔	✔	✔	
Philips	Hilversum	Netherlands	✔	✔		✔
Philips	Hoorn	Netherlands		✔		✔
Philips	Airdrie	Scotland	✔	✔		✔
Sagem	St-Etienne-du-Rouvray	France		✔	✔	

(continued)

Table 4-4 (Continued)
Telephone Linecard OEM Locations in Europe

					Products	
Company	**City**	**Country**	**R&D**	**Production**	**CO**	**PBX**
Siemens	Prague	Czech Republic		✔	✔	
Siemens	Vienna	Austria		✔	✔	
Siemens	Colfontaine	Belgium		✔	✔	
Siemens	Herentals	Belgium		✔	✔	
Siemens	Oostkamp	Belgium		✔	✔	
Siemens	Helsinki	Finland		✔	✔	
Siemens	Bocholt	Germany		✔		✔
Siemens	Bruchsal	Germany		✔	✔	
Siemens	Munich	Germany	✔	✔	✔	
Siemens	Witten	Germany		✔		✔
Siemens	Thessaloniki	Greece		✔	✔	
Siemens	Milan	Italy		✔	✔	
Siemens	Warsaw	Poland		✔	✔	
Siemens	Alfragide	Portugal		✔	✔	
Siemens	Zurich	Switzerland		✔	✔	
Siemens	Kartal	Turkey		✔	✔	
Telequipo	Monte Da Caparica	Portugal		✔		✔
Telettra	Vimercate	Italy		✔	✔	
Tesla		Croatia		✔	✔	✔

Source: Dataquest (May 1996)

Chapter 5

Teardown and Component Spend Analysis of an Ericsson MD110-PBX Linecard

The linecard chosen for teardown is from an Ericsson MD110 PBX exchange. The card manages eight lines from terminal devices (telephones), and provides digital transmission capabilities over copper twisted pair. The digital transmission system is known as ISDN-U channel, and offers two simultaneous channels in either direction at 64,000 bit/s.

Design and Manufacturing Aspects

- Double-sided PCB: mixture of surface-mount and through-hole components; through-hole components used for line interface functionality.
- Standard PCB rack-height based upon dual Eurocard/DIN41612 connectors.
- SLAC functionality implemented using an ASIC/microcontroller combination.

Component Spend Analysis

Component spend analysis uses the component pricing (from the BOM) and the forecast of telephone linecard production, to calculate the size of the market for each type of component. The BOM is shown in Appendix A. **In this specific case, the number of PBX lines manufactured in Europe is used to indicate the size of the market.**

Table 5-1 shows the production forecast for CO analog telephone linecard production in Europe from 1994 to 2000; together with a forecast of the ex-factory average selling price (ASP) per line. The ASP per line includes a proportion of both the exchange hardware cost, and cost of basic operating software, which is then attributed to each line (in addition to the cost of the linecard itself).

The forecast of ex-factory ASP and production can be combined to indicate the value of telephone linecard production. Table 5-2 provides the same information about CO ISDN linecards, and Table 5-3 relates to PBX linecards.

Figure 5-1 shows the cost distribution between the various component categories (based on component volumes of 100,000), for the PBX linecard teardown.

Table 5-1
CO Analog Linecard Production in Europe, Factory ASP and Factory Revenue—History and Forecast

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
CO Analog Production (Thousands of Lines)	27,650	27,843	28,438	28,229	28,244	28,915	29,417	1%
Factory ASP Per Line ($)	$224	$216	$211	$205	$195	$188	$181	-4%
Factory Revenue ($M)	6,206	6,014	6,000	5,787	5,516	5,436	5,310	-2%

Source: Dataquest (May 1996 Estimates)

Table 5-2
CO ISDN Linecard Production in Europe, Factory ASP and Factory Revenue—History and Forecast

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
CO ISDN Production (Thousands of Lines)	3,355	4,200	4,752	5,670	6,648	7,248	8,083	14%
Factory ASP Per Line ($)	$240	$240	$235	$230	$225	$220	$210	-3%
Factory Revenue ($M)	805	1,008	1,117	1,304	1,496	1,595	1,697	11%

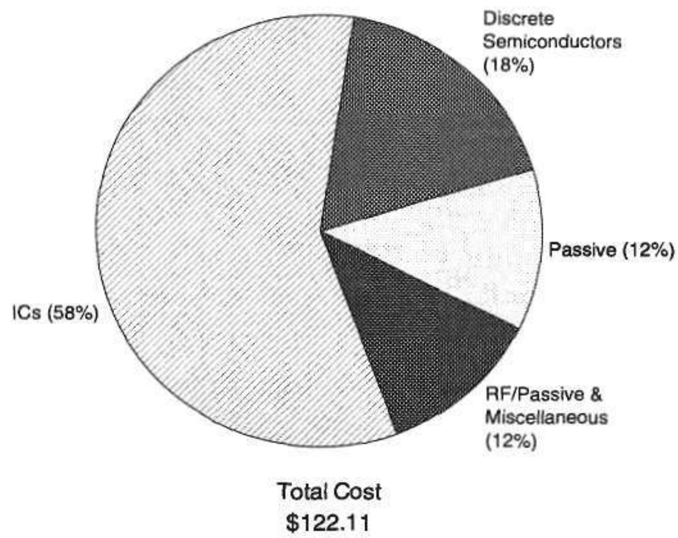
Source: Dataquest (May 1996 Estimates)

Table 5-3
PBX Linecard Production in Europe, Factory ASP and Factory Revenue—History and Forecast

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
PBX Production (Thousands of Lines)	11,330	11,640	12,056	12,525	13,006	13,479	13,955	4%
Factory ASP Per Line ($)	$158	$162	$164	$166	$168	$170	$172	1%
Factory Revenue ($M)	1,786	1,886	1,977	2,079	2,185	2,291	2,400	5%

Source: Dataquest (May 1996 Estimates)

Figure 5-1
Component Cost Distribution, Ericsson MD110-PBX Linecard Teardown (Based on Component Volumes of 100,000 Units)



Source: Dataquest (May 1996 Estimates)

Component Sector Analysis

The bill of materials is divided into component sectors. For the linecard, these sectors are:

- ICs: Table 5-4
- Discrete Semiconductors: Table 5-5
- Passives: Table 5-6
- RF/Passive and Miscellaneous: Table 5-7

For each component sector the following information is listed:

- Device reference, device type, quantity and manufacturer (where known)
- Average device cost for 1996 and 2000 (and percent cost change 1996 to 1997)
- Total cost of the parts in a linecard (device cost × quantity) for 1996 and 1997
- The total volume of parts required by the market, for 1996 and 1997
- The total value of the market for a specific part (and the component sector), for 1996 and 1997

For comparison purposes, both component sector values per line and total cost per line are included.

Integrated Circuits

The IC spend analysis is in Table 5-4. ICs represent about 58 percent of the linecard's material cost. Most of the cost is related to the subscriber loop transceiver devices and the microcontrollers.

Discrete Semiconductors

Table 5-5 shows the discrete semiconductor spend analysis. Slightly less than 20 percent of the linecard cost is consumed by relatively high-value International Rectifier (and other) transistors.

Passive Components

Table 5-6 shows the passive component spend analysis. These components include magnetic shield inductors and specialized resistors.

RF/Passive and Miscellaneous Components

Table 5-7 shows the RF/passive component spend analysis. This includes a crystal and a double-sided PCB.

High-Volume Pricing—PBX Linecards

The bill of materials pricing is based on component volumes of 100,000. However, major producers will buy in greater volume; in many cases direct from the component manufacturer. Besides avoiding distribution, an equipment manufacturer can source many part types from a single vendor, and negotiate further discounts.

Table 5-8 shows 1996 component pricing, based on quantities of 100,000 and 1 million units.

Table 5-4
Ericsson MD110-PBX Linecard—IC Spend Analysis

Device Reference	Device Type	Manufacturer	Quantity	Unit Cost ($) 1996 (Q2)	Unit Cost ($) 1997 (Q2)	Total Cost ($) 1996 (Q2)	Total Cost ($) 1997 (Q2)	Cost Change 1996 to 1997	Market Volume (M) 1996	Market Volume (M) 1997	Market Value ($M) 1996	Market Value ($M) 1997
SCX6B21EJU/V4	ASIC, 2058 2i/p gates, 0.65 ns gate delay	National Semiconductor	1	4.347	3.912	4.347	4.347	-10%	12.1	12.5	52.6	48.9
HPC46003V20	16-bit microcontroller (external ROM)	National Semiconductor	1	6.636	6.304	6.636	6.636	-5%	12.1	12.5	80.3	78.8
COP822DCSWM	8-bit microcontroller	National Semiconductor	1	2.504	2.379	2.504	2.504	-5%	12.1	12.5	30.3	29.7
TP3403V 3.11	Subscriber loop transceiver	National Semiconductor	8	6.151	5.536	49.208	49.208	-10%	96.8	100.0	595.4	553.6
MB8464A-10L	SRAM 8KX8 100 nS	Fujitsu	2	1.925	1.848	3.850	3.850	-4%	24.2	25.0	46.6	46.2
M27C256B-15C6	EPROM 32KX8 150 nS	SGS-Thomson	1	2.290	2.153	2.290	2.290	-6%	12.1	12.5	27.7	26.9
LP339	Quad comparator	Texas Instruments	2	0.398	0.386	0.796	0.796	-3%	24.2	25.0	9.6	9.7
HC373	Octal transparent, D-type	Texas Instruments	3	0.227	0.220	0.681	0.681	-3%	36.3	37.5	8.2	8.3
TL431C	Reference voltage, programmable	Texas Instruments	1	0.212	0.206	0.212	0.212	-3%	12.1	12.5	2.6	2.6
3086	NPN Transistor array	Harris	2	0.170	0.165	0.340	0.340	-3%	24.2	25.0	4.1	4.1
Total						**$70.864**	**$70.864**				**857.5**	**808.8**
Per Line						**$8.858**	**$8.858**					

Source: Dataquest (May 1996 Estimates)

Table 5-5
Ericsson MD110-PBX Linecard—Discrete Semiconductor Spend Analysis

Device Reference	Device Type	Manufacturer	Quantity	Unit Cost ($) 1996 (Q2)	Unit Cost ($) 1997 (Q2)	Total Cost ($) 1996 (Q2)	Total Cost ($) 1997 (Q2)	Cost Change 1996 to 1997	Market Volume (M) 1996	Market Volume (M) 1997	Market Value ($M) 1996	Market Value ($M) 1997
IRFD 8MI RIB 220	Transistor	International Rectifier	8	0.852	0.835	6.816	6.680	-2%	96.8	100.0	82.474	83.500
Transistor	Transistor		17	0.441	0.432	7.497	7.344	-2%	205.7	212.5	90.714	91.800
Transistor	Transistor		8	0.948	0.929	7.584	7.432	-2%	96.8	100.0	91.766	92.900
Total						**$21.897**	**$21.456**				**265.0**	**268.2**
Per Line						**$2.737**	**$2.682**					

Source: Dataquest (May 1996 Estimates)

Table 5-6
Ericsson MD110-PBX Linecard—Passive Component Spend Analysis

Device Reference	Device Type	Manufacturer	Quantity	Unit Cost ($) 1996 (Q2)	Unit Cost ($) 1997 (Q2)	Total Cost ($) 1996 (Q2)	Total Cost ($) 1997 (Q2)	Cost Change 1996 to 1997	Market Volume (M) 1996	Market Volume (M) 1997	Market Value (M) 1996	Market Value (M) 1997
Capacitor	Tantalum		1	0.065	0.064	0.065	0.064	-2%	12.1	12.5	0.787	0.800
Capacitor	MLCC		31	0.030	0.029	0.930	0.899	-2%	375.1	387.5	11.253	11.238
2.2K 9325 MMK 5	Capacitor		8	0.423	0.415	3.384	3.320	-2%	96.8	100.0	40.946	41.500
1.5K 63 MMK EVOX 9321	Capacitor	Evox	8	0.297	0.291	2.376	2.328	-2%	96.8	100.0	28.750	29.100
Magnetic Shield Inductor	33 MHz		16	0.355	0.348	5.680	5.568	-2%	193.6	200.0	68.728	69.600
Resistor	Resistor		63	0.005	0.005	0.315	0.315	-2%	762.3	787.5	3.812	3.938
8601456/2	Connecter, Eurocard, Male, 32 pins total		1	0.807	0.791	0.807	0.791	-2%	12.1	12.5	9.765	9.888
RNV 303 021 9929	Connecter, Eurocard, Male, 56 pins total	Berg/Dupont	1	1.170	1.147	1.170	1.147	-2%	12.1	12.5	14.157	14.338
Total						**$14.727**	**$14.432**				**178.2**	**180.4**
Per Line						**$1.841**	**$1.804**					

Source: Dataquest (May 1996 Estimates)

Table 5-7
Ericsson MD110-PBX Linecard—RF/Passive and Miscellaneous Component Spend Analysis

Device Reference	Device Type	Manufacturer	Quantity	Unit Cost ($) 1996 (Q2)	Unit Cost ($) 1997 (Q2)	Total Cost ($) 1996 (Q2)	Total Cost ($) 1997 (Q2)	Cost Change 1996 to 1997	Market Volume (M) 1996	Market Volume (M) 1997	Market Value ($M) 1996	Market Value ($M) 1997
Crystal	190NDK35	NDK	1	0.450	0.437	0.450	0.437	-3%	12.1	12.5	5.4	5.5
PCB	180 × 220mm double-sided		1	14.175	13.750	14.175	13.750	-3%	12.1	12.5	171.5	171.9
Total						**$14.625**	**$14.187**				**177.0**	**177.3**
Per Line						**$1.828**	**$1.773**					

Source: Dataquest (May 1996 Estimates)

Table 5-8
1996 High-Volume Component Pricing for PBX Telephone Linecards

Device Reference	Device Type	Manufacturer	Quantity	1996 (Q2) Total Cost ($) Vol. = 100,000	Vol. = 1 Million
ICs					
SCX6B21EJU/V4	ASIC, 2058 2i/p gates, 0.65 ns gate delay	National Semiconductor	1	4.347	3.810
HPC46003V20	16-bit microcontroller (external ROM)	National Semiconductor	1	6.636	6.226
COP822DCSWM	8-bit microcontroller	National Semiconductor	1	2.504	2.349
TP3403V 3.11	Subscriber loop transceiver	National Semiconductor	8	49.208	43.125
MB8464A-10L	SRAM, 8K × 8 100 ns	Fujitsu	2	3.850	3.660
M27C256B-15C6	EPROM, 32K × 8 150 ns	SGS-Thomson	1	2.290	2.120
LP339	Quad comparator	Texas Instruments	2	0.796	0.766
HC373	Octal transparent, D-type	Texas Instruments	3	0.681	0.656
TL431C	Reference voltage, programmable	Texas Instruments	1	0.212	0.204
3086	NPN Transistor array	Harris	2	0.340	0.327
			Subtotal	**$70.864**	**$63.243**
			Per Line	**$8.858**	**$7.905**
Discrete Semiconductors					
IRFD 8MI RIB 220	Transistor	International Rectifier	8	6.816	5.870
Transistor	Transistor		17	7.497	6.457
Transistor	Transistor		8	7.584	6.531
			Subtotal	**$21.897**	**$18.858**
			Per Line	**$2.737**	**$2.357**
Passive					
Capacitor	Tantalum		1	0.065	0.050
Capacitor	MLCC		31	0.930	0.718
2.2K 9325 MMK 5	Capacitor		8	3.384	2.612
1.5K 63 MMK EVOX 9321	Capacitor	Evox	8	2.376	1.834
Magnetic Shield Inductor	33 MHz		16	5.68	4.385
Resistor	Resistor		63	0.315	0.243
8601456/2	Connecter, Eurocard, Male, 32 pins total		1	0.807	0.623
RNV 303 021 9329	Connecter, Eurocard, Male, 56 pins total	Berg/Dupont	1	1.170	0.903
			Subtotal	**$14.727**	**$11.369**
			Per Line	**$1.841**	**$1.421**
RF/Passives & Miscellaneous					
Crystal	190NDK35	NDK	1	0.450	0.375
PCB	180 × 220 mm double-sided		1	14.175	11.809
			Subtotal	**$14.625**	**$12.184**
			Per Line	**$1.828**	**$1.523**
			Total	**$122.113**	**$105.654**
			Per Line	**$15.264**	**$13.207**

Source: Dataquest (May 1996 Estimates)

Market Value in 2000—PBX Linecards

The forecast for PBX linecard production and component-sector values in 2000, are used to predict the size of the European market for each component sector. The forecasts (per line) for 2000, in Table 5-9, are based on component quantities of 1 million. The fall in component costs is due to annual price reductions, component integration, improvements in component manufacturing efficiency and overall market conditions.

The value of components in 2000 is based on expectations of a modest fall in component costs, linked with increased functionality offered by PBX exchange vendors. Often, the provision of additional functionality to desktop terminals (telephones or otherwise) will postpone integration of an otherwise stable design.

Table 5-9
2000 High-Volume Component Pricing for PBX Telephone Linecards

	Linecard Content-8 Lines ($)		No. of Linecard Lines (M)		Component Market Value ($M)	
Component Type	**1996**	**2000**	**1996**	**2000**	**1996**	**2000**
ICs	63.243	61.978	12.1	14.0	765	868
Discrete-Semi.	18.858	17.349	12.1	14.0	228	243
Passives	11.369	10.801	12.1	14.0	138	151
RF/Passives & Miscellaneous	12.184	11.331	12.1	14.0	147	159
Total	**105.654**	**101.459**			**1,278**	**1,420**

Source: Dataquest (May 1996 Estimates)

Bill of Materials

Table A-1
Ericsson MD110 PBX-Linecard

Device Reference	Device Type	Manufacturer	Quantity	1996 (Q1) Unit Cost ($)	Package	1996 (Q1) Total Cost ($)
ICs						
SCX6B21EJU/V4	ASIC, 2058 2i/p gates, 0.65 ns gate delay	National Semiconductor	1	4.347	PLCC-68	4.347
HPC46003V20	16-bit microcontroller (external ROM)	National Semiconductor	1	6.636	PLCC-68	6.636
COP822DCSWM	8-bit microcontroller	National Semiconductor	1	2.504	SOP-20	2.504
TP3403V 3.11	Subscriber loop transceiver	National Semiconductor	8	6.151	PLCC-28	49.208
MB8464A-10L	SRAM 8K × 8 100 ns	Fujitsu	2	1.925	SOP-28	3.850
M27C256B-15C6	EPROM 32K × 8 150 ns	SGS-Thomson	1	2.290	PLCC-32	2.290
LP339	Quad comparator	Texas Instruments	2	0.398	SOP-14	0.796
HC373	Octal transparent, D-type	Texas Instruments	3	0.227	SOP-20	0.681
TL431C	Reference voltage, programmable	Texas Instruments	1	0.212	SOP-8	0.212
3086	NPN Transistor array	Harris	2	0.170	SOP-14	0.340
Discrete Semiconductors						
IRFD 8MI RIB 220	Transistor	International Rectifier	8	0.852	DIL-4	6.816
Transistor	Transistor		17	0.441	SOT23	7.497
Transistor	Transistor		8	0.948	PIH	7.584
Passive Components						
Capacitor	Tantalum		1	0.065	1210	0.065
Capacitor	MLCC		31	0.030	1008	0.930
2.2K 9325 MMK 5	Capacitor		8	0.423	PIH	3.384
1.5K 63 MMK EVOX 9321	Capacitor	Evox	8	0.297	PIH	2.376
Magnetic Shield Inductor	33 MHz		16	0.355	SMT	5.680
Resistor	Resistor		63	0.005	1206	0.315
8601456/2	Connecter, Eurocard, Male, 32 pins total		1	0.807	PIH	0.807
RNV 303 021 9329	Connecter, Eurocard, Male, 56 pins total	Berg/Dupont	1	1.170	PIH	1.170
RF/Passive & Miscellaneous Components						
Crystal	190NDK35	NDK	1	0.450	PIH	0.450
PCB	180 × 220 mm double-sided		1	14.175		14.175
					Total =	**$122.113**
					Per Line =	**$15.264**

Source: Dataquest (May 1996 Estimates)

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Digital IRD Production in Europe Teardown of a Pace DGT 400 DVB-Compliant IRD

Focus Report

1996

Program: Electronic Equipment Production Monitor
Product Code: SAPM-EU-FR-9601
Publication Date: May 8, 1996
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Table of Contents

List of Figures

List of Tables

Chapter 1

Executive Summary and Introduction

The following summarizes the key points of this *Focus Report*:

Digital IRDs: Market Overview

- In 1995 8 million analog and digital IRDs were shipped in Europe.
- Estimated European shipments of digital IRDs in 1995 totalled 210,000 units.
- Forecast European shipments of digital IRDs in 1996 will be 555,000 units.

Digital IRDs: Production Overview

- Digital IRD production in Europe is estimated at 335,000 units in 1995 and forecast to rise to 10.8 million units in 2000. This represents a compound annual growth rate (CAGR) of 100 percent.
- In 1995 the leading digital IRD producers (by units) were:
  - Pace: 79 percent
  - Nokia: 4 percent
  - Sagem: 3 percent
- The forecast average factory selling price of a digital IRD is:
  - 1996: $594
  - 2000: $290

Digital IRDs: Component Market Overview

- Average component-sector costs (component volume of 100,000 for pricing purposes) in 1996:
  - ICs: $250.30
  - Discretes: $4.90
  - Passives: $22.02
  - RF/Passive: $4.43
  - Miscellaneous: $41.11
- Average component-sector costs (component volume of 1 million for pricing purposes) in 1996:
  - ICs: $225.18
  - Discretes: $4.23
  - Passives: $19.69
  - RF/Passive: $3.90
  - Miscellaneous: $36.09
- Average component-sector costs (component volume of 1 million for pricing purposes) in 2000:
  - IC: $135.11
  - Discretes: $3.89
  - Passives: $16.54
  - RF/Passive: $2.34
  - Miscellaneous: $21.66

- Market Values (component volume of 100,000 for pricing purposes) in 1996:
  - IC: $500.6 million
  - Discretes: $9.8 million
  - Passives: $44.0 million
  - RF/Passive: $8.9 million
  - Miscellaneous: $82.2 million
- Market Values (component volume of 1 million for pricing purposes) in 2000:
  - IC: $1,439 million
  - Discretes: $42.0 million
  - Passives: $178.6 million
  - RF/Passive: $25.3 million
  - Miscellaneous: $233.9 million

Introduction

This *Focus Report* is one in a series of evaluations of key types of European-manufactured electronic equipment. These items of equipment are leading indicators of electronic market production in Europe. For each product type, the report lists the 10 largest producers (OEMs: the brand owners), or those that make up 75 percent of European production. The reports detail manufacturing—including contract electronics manufacture (CEM)—and R&D locations, unit production, equipment bill of materials and typical high-volume component pricing.

Evaluation Methodology

Representative high-volume, typically configured models are acquired for review. All the electronic components are listed. Appropriate descriptive information, such as part number, manufacturer (where known), and package type, is recorded. A destructive analysis is often performed on the ASICs to determine the foundry source, technology and gate count.

Pricing Methodology

Once an exhaustive list of components is compiled, a price is determined for each line item. Each item has a price forecast, to give the reader some idea of how the cost of each element could vary. Pricing is derived from the following sources:

- Dataquest's Semiconductor Pricing and Supply Service
- Dataquest's Mass Storage Service
- Cost models
- Press releases
- Industry quotes and surveys
- Catalogs and distributor information
- Industry sources

Component prices are based on 100,000-component quantities (not product quantities). Prices are obtained from various sources, including component distributors (usually supported by the component vendor), discounted catalog prices and industry sources. In addition, component prices based on 1 million-component quantities (not product quantities) are provided. These prices are based partly on prices supported by the component vendor and partly on an empirical cost model.

The 100,000-component quantities may be considered single "spot" purchases. They are priced in accordance with the prevailing lead time for that component. They do not, and cannot, take account of specific long-term partnerships between component vendors and equipment manufacturers, which may result in further discounts, delivery within lead-time and other arrangements.

Component databases are updated throughout the year, depending upon the price volatility of the particular element. Basic ASIC pricing is derived from Scanning Electron Microscope (SEM) analysis and Dataquest's proprietary ASIC cost model. Bare PCB prices are derived from Dataquest's pricing survey and industry sources.

Chapter 2

The Digital IRD Market in Europe

Introduction

The development of cable and satellite television has given European television viewers an unprecedented choice of entertainment programs including films, entertainment and sport. The multitude of available channels available via current analog technology, is about to be supplanted by an even greater number of channels delivered using digital technology.

Digital television not only can increase the number of channels available (because it is more spectrally efficient), but also allows media service operators (MSOs) to change the way people choose their programming. Instead of deciding what to watch from a relatively limited selection, viewers will be able to call up what they want to watch from an almost unlimited source of programming.

Digital television is an enabling technology for both pay-per-view (PPV) and programming-on-demand. And while digital television can provide better video and audio quality than is currently available, it is positioned as a technology to serve the market, unlike the ill-fated D2-MAC, which offered an advanced technology with little obvious benefit to the consumer.

More Bandwidth, More Services

Analog television allocates each channel a fixed amount of the radio spectrum (bandwidth), which is unaffected by the type of program transmitted. However, because all current programming delivered via digital broadcasting must first be converted (encoded) into a digital format, it allows analog programmes to be encoded in a manner that is related to the program content. For example, a football match, which is made up of rapidly changing video images, may require (and therefore be allocated) more bandwidth than an interview, which features relatively static images; and a wide-screen motion picture may require more bandwidth than a television drama shot on video. Because bandwidth can be allocated on a dynamic (and almost per-program) basis, it allows the broadcast spectrum to be used efficiently at all times.

The benefit of this efficient use of bandwidth is that broadcasters have a choice of offering more individual (and unique) channels or transmitting the same program on multiple channels, with a different starting time on each (near video on demand).

Product Definition

This report deals with integrated receiver decoders (IRDs) which are compliant with the digital video broadcasting (DVB) system. The DVB system is supported by a Memorandum of Understanding signed by organizations including MSOs, content owners, equipment manufacturers, broadcasters, telcos and semiconductor vendors. It defines a number of standards including DVB delivered via satellite (DVB-S), cable (DVB-C) and terrestrial (DVB-T). The system specifies standards for data transmission, error correction and service information. In addition, it offers approved scrambling, modulation, channel coding and conditional access (CA) systems.

Market Opportunity

More than 8 million analog and digital satellite and cable IRDs were shipped in Europe in 1995, more than 60 percent of which were satellite IRDs. Although analog production peaked in 1995, shipments are forecast to predominate in Europe until 1998. One of the major aspects concerning shipments in Europe is the uncertainty about when major MSOs such as Canal Plus and BSkyB will introduce DVB transmissions. Both organizations have indicated that services are unlikely to start until late 1996 at the earliest. Delays in the introduction of digital services in Europe are more a result of commercial issues than because of the DVB technology. Issues include how to migrate existing analog subscribers to digital services, and how to attract new subscribers who have not already been tempted by existing analog services.

This has led to DVB shipments in Europe in 1995 estimated at 210,000 units, with forecast shipments in 1996 of 555,000 units. Markets in Asia/Pacific and the Middle East are consuming initial European production of DVB-compliant IRDs.

European Production

In a similar way to the introduction of GSM, the DVB Memorandum of Understanding has allowed the DVB system to gain widespread support from equipment manufacturers. For multinational broadcasters that have been involved with DVB in Europe, it offers a standard platform that can be adopted outside Europe. The overseas market, together with the emerging European market, is driving production.

Unit Production

Table 2-1 and Figure 2-1 show Dataquest's European production forecast for both cable and satellite DVB-compliant IRDs. The CAGR for total DVB IRD production in Europe from 1995 to 2000 is just over 100 percent. The overall growth in production is being generated initially by production of satellite IRDs, with production of cable IRDs increasing significantly during the forecast period.

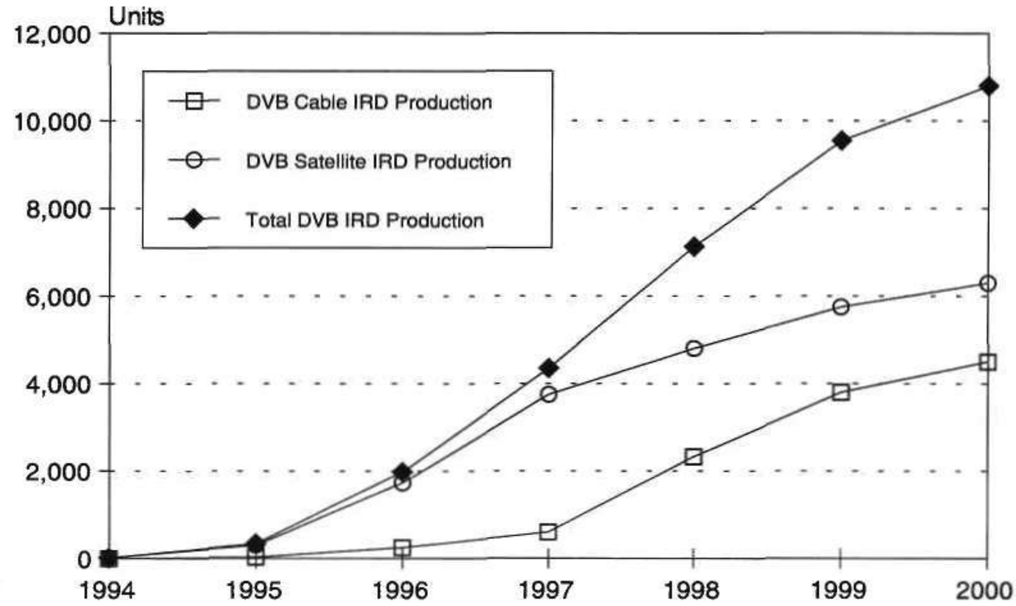
For readers who require more information about the European market for DVB-compliant IRDs, Dataquest has published a *Focus Report*, IRD Markets in Europe (SAMM-EU-FR-9601), containing more information. It includes a forecast for European shipments; details of interactive television and video-on-demand (VOD) trials; satellite transponder bookings; details of specific contracts awarded to European equipment manufacturers; a list of DVB-compliant chip sets; together with profiles of both European MSOs (including joint ventures and alliances) and companies manufacturing DVB-compliant IRDs in Europe.

Table 2-1
Digital IRD Production in Europe
(Thousands of Units)

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
DVB Cable IRD Production	2	30	250	600	2,330	3,800	4,500	NA
DVB Satellite IRD Production	15	305	1,730	3,750	4,800	5,750	6,300	83.2%
Total DVB IRD Production	17	335	1,980	4,350	7,130	9,550	10,800	100.3%

NA = not applicable
Source: Dataquest (May 1996 Estimates)

Figure 2-1
Digital IRD Production in Europe
(Thousands of Units)



Source: Dataquest (May 1996 Estimates)

Chapter 3

Digital IRD Technology

Overview

The purpose of a digital IRD is to receive a high-frequency radio signal (delivered via satellite, cable or other means), convert the transmitted signal into a digital bitstream, separate the audio, video and data components of the bitstream and convert the digital audio and video signals into an analog format that can be received by a conventional TV or VCR.

Digital Transmission

Each television channel for broadcast must first be encoded into a digital bitstream. This could vary from 2 Mbit/s to a maximum of 100 Mbit/s (typically 5 Mbit/s), depending upon program content. Once in digital format, multiple channels can be combined. Satellite transmission using a broadcast channel bandwidth of about 36 MHz can support a data rate of about 35 Mbit/s (depending on the specific coding methods used); while cable transmission using a channel bandwidth of 8 MHz can support digital bitstream rates from about 25 Mbit/s to 50 Mbit/s (again depending on coding methods).

The DVB system combines data (such as video and audio) for transmission into packets, each with a header identifying the packet uniquely. This series of packets is known as the transport stream (TS). However, not all of the transmission capacity is available for TS packets, some of it is used for error correction and other information. So for example, a transmission rate of 35 Mbit/s could support five channels, each coded at 6 Mbit/s, with 5 Mbit/s available for other purposes.

Digital Reception

Figure 3-1 shows a generic DVB-compliant IRD. The incoming RF signal from a cable feed, satellite low-noise block (LNB), or other source will be at a frequency of about 1 GHz. Transmission from satellite to receiver dish typically takes place between 10 and 14 GHz, and it is the function of the LNB to shift the frequency down to about 1 GHz. Depending on control signals, the tuner selects a specific frequency (containing a number of channels) to receive. This signal passes to a high-speed analog-to-digital converter (ADC), which samples the continuous analog signal. These samples are then passed to the demodulator.

Modulation and Demodulation

The purpose of modulation is to ensure that the digital bitstream is transmitted as efficiently as possible. Because of this, different modulation techniques are used for each transmission medium. These techniques include quadrature phase-shift keying (QPSK) modulation for satellite transmission, and quadrature amplitude modulation (QAM) for cable transmission. QPSK can operate at varying data rates, and for DVB these can range from 2 Mbit/s to 100 Mbit/s.

A signal coded using QAM uses a specific number of discrete levels. The number of levels used (16, 32, 64, 128 or 256) affects the data rate; for example, 16-QAM provides a maximum rate of 27.8 Mbit/s and 256-QAM provides a maximum rate of 55.6 Mbit/s. However, the trade-off is that while more levels provide higher data rates, it is more difficult to differentiate between the levels. This allows cable operators to choose a modulation method suitable for their particular transmission network. The DVB system encourages the use of 64-QAM (providing a maximum of 38.5 Mbit/s).

Error Correction

The output from the modulator is a continuous digital bitstream, which passes to the error-correction function. It is inevitable that data transmitted through any inherently lossy medium will suffer bit errors and packet loss, and therefore require some form of error correction. For signals transmitted via satellite, the first part of the error correction is Viterbi decoding. Data transmitted via cable are not subject to Viterbi coding. Viterbi is a predictive coding system that reduces errors at the bitstream level, allowing the use of lower power satellite transponders or smaller reception dishes. The coding prior to transmission adds an overhead of between 6 percent and 12 percent to the TS. And following Viterbi correction, the data pass to the Reed-Solomon (RS) error-correction function.

All DVB transmission methods use RS error correction. It operates on packets of data before transmission; adding additional bytes containing parity information and appending a sequence identity number (to help identify lost packets). The new data packets (which now include additional information) are interleaved, effectively forming rows in an array. The data from the array are then removed as columns (each column containing a piece of information from each row). This process helps to ensure that previously adjacent data now travel in separate packets, thereby reducing the severity of individual packet loss. The RS decoding can correct bit errors and replace lost packets. It adds no more than a 12 percent overhead to the TS (although using both Viterbi and RS is unlikely to add a 24 percent overhead!)

Transport Stream Demultiplexer

The error-correction function passes the TS to the demultiplexing function. The purpose of the demultiplexer is to separate the video, audio and data streams for the selected channel (from several available within the TS). The audio and video components are then passed to their respective decoding functions. It is at the TS demultiplexing stage that the CA function controls whether a program stream can be decoded.

Conditional Access

Conditional access is a process used to ensure that viewers are allowed to watch only the programming for which they have paid. It includes two separate elements, decryption and descrambling. Decryption is the process of transmitting a key which can then be used to descramble the encoded programming. The decryption process is based on key-cryptography technology. To gain access to specific programming, a viewer must insert an electronic key (for example, a smartcard issued by an MSO) into the IRD. This key allows the IRD to receive messages destined for that specific card. Assuming the MSO is satisfied that the viewer has the right to watch, a signal is transmitted to the descrambler authorizing it to make the programming available unscrambled.

The DVB system lays down standards for information passed to and from the CA function. However, IRD manufacturers and MSOs are free to implement their own proprietary CA algorithms. The DVB project offers a common scrambling system, a CA technology called Simulcrypt, together with a PCMCIA interface standard for the electronic key.

The current issues with CA are related to commercial rather than technology aspects. Control of the CA technology effectively means control of the program choices available to the viewer. MSOs have a variety of CA systems to choose from, including those licensed by Irdeto, News Datacom and Seca.

MPEG Decoding

Video images are encoded to the MPEG-2 standard prior to transmission. MPEG-2 is designed specifically for interlaced, that is video images, while the MPEG-1 standard is more efficient at coding images from non-interlaced (that is film) sources. The MPEG standards merely define a syntax to which images must be encoded. It is left to individual IC manufacturers to implement algorithms to perform the encoding and decoding. MPEG coding uses the principal of redundancy in images, looking for similarities between adjacent pixels in the same frame, and similarities between adjacent frames. Discarding redundant information reduces the amount of data necessary to reconstitute the image.

The MPEG-2 decoder uses information from I-frames, which are complete images, and P (predictive) and B (bi-directional) frames which both contain an element of redundancy. The digital signal from the MPEG decoding process contains enough information to fully represent the originally encoded image.

Audio

Packets of audio data are fed to an audio decoding function. The DVB project specifies the use of MPEG audio coding; and suggests that the MPEG Layer II (MUSICAM) system be used. The digital output from the decoder passes to a digital-to-analog converter (DAC), providing sound quality comparable to compact disc. The audio output can be fed to a SCART output.

Analog Video Encoding

The output from the MPEG-2 video decoder (either digitized RGB or digitized luminance/chrominance information) passes to an analog video encoder. This provides analog RGB video and analog composite video (in PAL or SECAM format), which can be fed to a SCART output. In addition the composite video, together with the audio, can be fed into an RF modulator for conventional output to a TV or VCR.

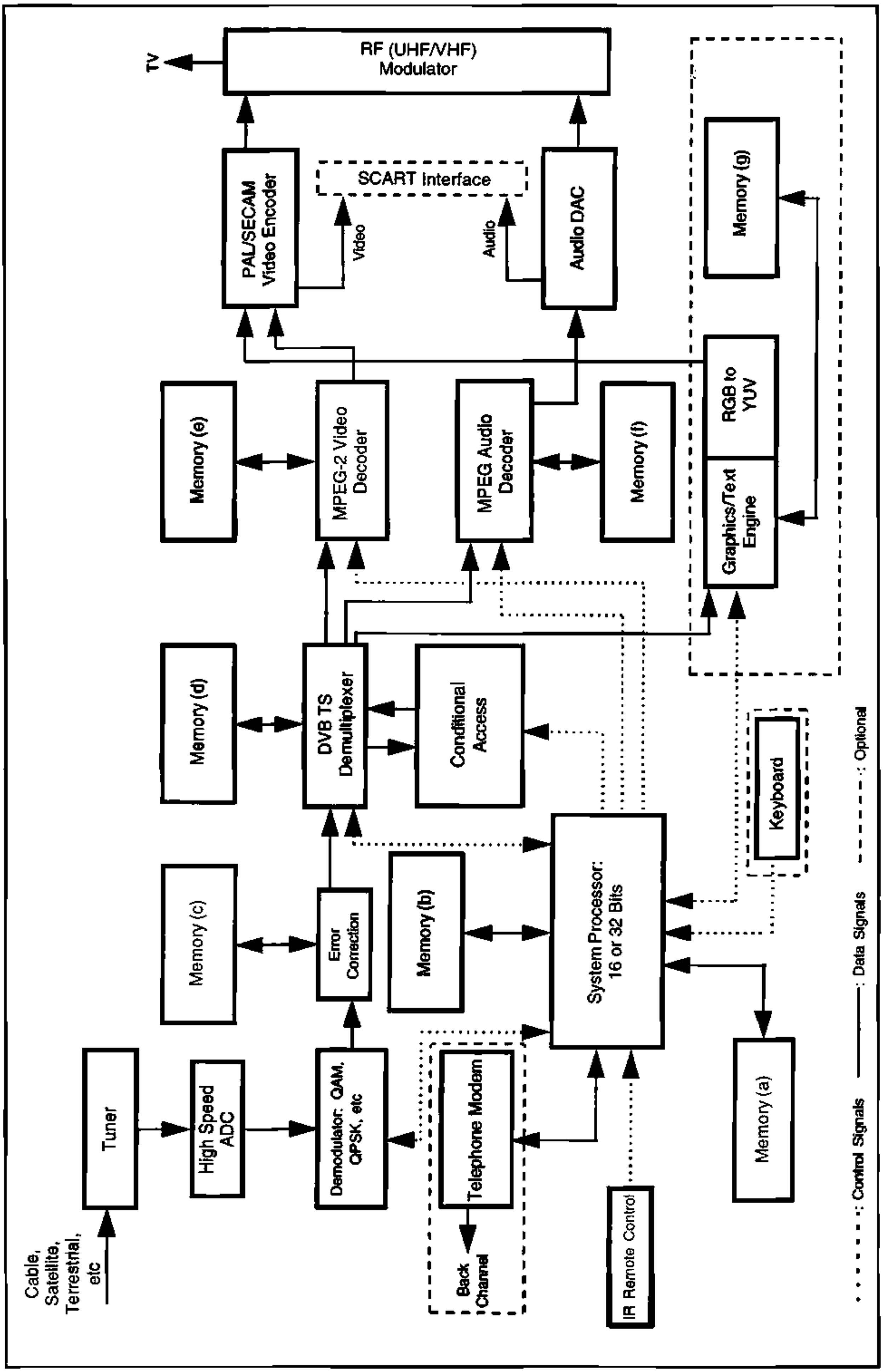
Additional Components

The IRD is controlled by a 16-bit or, more probably, a 32-bit microcontroller, a second (typically 8-bit) microcontroller may handle functions such as front panel indicators and switches. Additional functions (which are optional) include a graphics/text engine for sophisticated on-screen display (OSD) features; a keyboard for data entry; and a modem (or other device) to provide a back channel in order to make individual program or service requests.

Memory

The nature of digital IRDs means that they tend to require temporary storage for video and audio data while it is being processed (in addition to memory capacity for an operating system). Figure 3-1 includes a number of memory blocks, not all of which are used in every IRD design. Block A is likely to be made up of 2 to 4MB of Flash memory to store the IRD's operating system. Block B is made up of EEPROM for storing semi-permanent system settings, and DRAM for temporary storage. Block C is likely to be fast SRAM for the Viterbi decoding function, while block D may use DRAM for the TS demultiplex function. Block E is made up of at least 2MB of DRAM for MPEG-2 decoding, and some audio decoders may require memory, block F. Block G is associated with the optional OSD function, and can contain as much as 2MB of DRAM.

Figure 3-1
DVB-Compliant IRD



Source: Dataquest (May 1996)

Chapter 4

Major Manufacturers

Pace's Lead in 1995 Will Continue in 1996

Digital IRD production in 1995 was limited to 340,000 units, almost 80 percent of which were manufactured by Pace. The units were produced for export to countries in the Asia/Pacific region; to receive DVB broadcasts from various MSOs owned by News Corporation. Production by Nokia, Sagem and others in 1995 was used for small-scale trials by various (mainly European) broadcasters. Table 4-1 shows how the estimated 340,000 digital IRDs manufactured in 1995 were split by manufacturer.

Table 4-2 is a forecast for 1996 production, split by manufacturer. Pace leads with 48 percent of European production. Again, much of this is for export to the Asia/Pacific region, with additional European demand from Canal Plus and Nethold. Nokia will be producing digital IRDs in volume, helped by a large contract from Deutsche Telekom. Grundig, Philips and Sagem should each capture about 6 percent share, manufacturing mainly for the European market. Both tables include production for OEMs by contract electronics manufacturers (CEMs) such as D2D's work for Pace, and Panasonic's use of a South African subcontractor.

Table 4-1
Digital IRD Production by Manufacturer, 1995

Company	Unit Production	Production Share (%)	Cumulative Share (%)
Pace	270,000	79%	79%
Nokia	15,000	4%	83%
Sagem	11,500	3%	86%
Others	43,500	14%	100%
Total Production	**340,000**	**100%**	

Source: Dataquest (May 1996 Estimates)

Table 4-2
Forecast Digital IRD Production by Manufacturer, 1996

Company	Unit Production	Production Share (%)	Cumulative Share (%)
Pace	960,000	48%	48%
Nokia	195,000	10%	58%
Grundig	140,000	7%	65%
Philips	120,000	6%	71%
Sagem	125,000	6%	77%
Thomson	60,000	3%	80%
Others	380,000	20%	100%
Total Production	**1,980,000**	**100%**	

Source: Dataquest (May 1996 Estimates)

Other Manufacturers

Other companies manufacturing digital IRDs in Europe include Panasonic, Sony and Technistat. All of these OEMs are likely to capture production share from late 1996 onwards. Technistat already manufactures analog IRDs, but both Sony and Panasonic previously bought OEM units, and sold them under their respective brands. Mitsubishi, which manufactures analog IRDs, has announced that it will build digital units, but it has not yet announced the production site.

European Locations

Manufacturers of digital IRDs are companies already involved in consumer electronics, and in many cases already have sites manufacturing analog IRDs. Table 4-3 shows the European manufacturing and design locations for OEMs involved in DVB production.

However, many of the facilities used for production of digital units are not the same locations used for production of analog IRDs. Grundig, for example, moved production of analog units to the United Kingdom, but retains a manufacturing site in Germany for digital production. Nokia has added production capacity at its plant in Motala, Sweden, in addition to its plant in Salo; Thomson is using a plant in Strasbourg as well existing capacity at Angers; and Philips is manufacturing in Germany rather than at its analog plant in France.

Table 4-3
Digital IRD OEM Manufacturing and R&D Locations in Europe, Middle East & Africa

Company	City	Country	R&D	Production
Grundig	Furth	Germany	*	*
Nokia	Salo	Finland	*	*
Nokia	Motala	Sweden		*
Pace	Shipley	England	*	*
Panasonic	Cape Town	South Africa		*
Philips	Paris	France	*	
Philips	Krefeld	Germany		*
Philips	Hamburg	Germany		*
Pioneer	Erpe-Mère	Belgium		*
Pioneer	Bristol	England	*	
Sagem	Fougères	France		*
Sagem	Pointois	France	*	
Sony	Pencoed	Wales	*	*
Sony	Basingstoke	England	*	
Technistat	Dippach	Germany		*
Technistat	Schoneck	Germany		*
Thomson	Angers	France	*	*
Thomson	Strasbourg	France		*
Thomson	Villingen	Germany	*	

Source: Dataquest (May 1996)

Chapter 5

Teardown and Component-Spend Analysis of a Pace DGT 400 DVB-Compliant IRD

The digital IRD chosen for teardown is a Pace DGT 400, which could be considered a first-generation model. The PCB layout is similar to Pace's analog PRD800 Plus, with the power supply, RF modulator, smart card socket, infrared receiver, and front panel switches and indicators all located in similar positions. The LNB tuner is placed away from the RF modulator and power supply, which is a departure from the analog design and the conditional-access technology is fitted as a module that plugs onto the motherboard. The design does not feature a SCART connector, which is probably because it is destined for a non-European market.

There is, however, the opportunity to integrate functions which currently reside on several ICs and subsequent designs are likely to use recently announced chip sets, which would lead to a reduction in both material and manufacturing costs.

The teardown includes all electronic components in the IRD. It does not include the CA module, smartcard, low noise block (LNB) amplifier, or receiving dish although the production and shipment figures may be used to forecast production and shipments of these items.

Component Summary

- QPSK demodulation/error correction: LSI Logic
- 32-bit microcontroller: Motorola
- MPEG-2 video decoder: SGS-Thomson
- MPEG audio decoder: Texas Instruments
- Analog video encoder: Brooktree
- Smart card socket: Alcatel CIT
- Infrared receiver: Sony

Component Spend Analysis

Component-spend analysis uses the component pricing (from the BOM), and the market forecast for digital IRD production, to calculate the size of the market for each type of component. The BOM is in Appendix A. Table 5-1 shows Dataquest's forecast of digital IRD production in Europe from 1994 to 2000 and a forecast of the ex-factory average selling price (ASP). The forecasts for both ex-factory ASP and production, can be combined to indicate the value of digital IRD production in Europe.

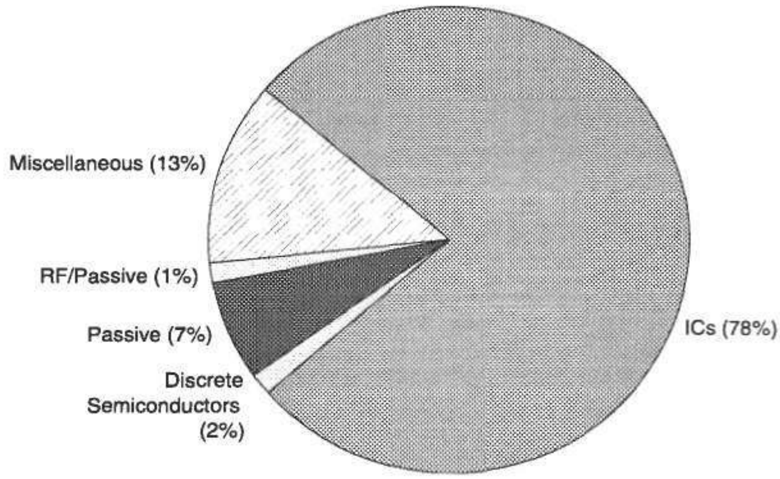
Figure 5-1 shows the cost distribution between ICs, discrete semiconductors, passive components, RF/passive components, and miscellaneous components (based on component volumes of 100,000).

Table 5-1
Digital IRD Production in Europe, Factory ASP and Factory Revenue History & Forecast

	1994	1995	1996	1997	1998	1999	2000	CAGR 1995-2000
Total DVB IRD Production (K)	17	335	1,980	4,350	7,130	9,550	10,800	100%
Factory ASP ($)	$838	$746	$594	$472	$392	$340	$290	-17%
Factory Revenue ($M)	$14	$250	$1,176	$2,051	$2,794	$3,248	$3,128	66%

Source: Dataquest (May 1996 Estimates)

Figure 5-1
Component Cost Distribution-Pace DGT 400 IRD
(Based on Component Volumes of 100,000 Units)



Source: Dataquest (May 1996 Estimates)

Component Sector Analysis

The bill of materials is divided into component sectors. For the digital IRD, these sectors are:

- ICs, Table 5-2
- Discrete Semiconductors, Table 5-3
- Passives, Table 5-4
- RF/Passive, Table 5-5
- Miscellaneous, Table 5-6

For each component sector the following information is listed:

- Device reference, device type, quantity and manufacturer (where known)
- Average device cost for 1996 and 2000 (and percent cost change 1996 to 1997)
- Total cost of the parts in a digital IRD (device cost × quantity) for 1996 and 1997
- The total volume of parts required by the market, for 1996 and 1997
- The total value of the market for a specific part (and the component sector), for 1996 and 1997

Integrated Circuits (ICs)

The IC spend analysis is in Table 5-2. The ICs make up 77 percent of the component cost of the IRD; and it is the functionality within these devices which offers considerable scope for integration and significant cost reduction. High-value items include the demodulator and error-correction devices, the transport demultiplexer and the two MPEG decoders, together with their related audio and video DACs. Semiconductor vendors have already announced second-generation chipsets integrating several of these devices. Typically, a combined demodulator and error correction device, a transport demultiplexer incorporating a microcontroller and combined audio and video MPEG decoding with analog outputs.

Discrete Semiconductors

Table 5-3 shows the discrete semiconductor spend analysis. The discrete devices include a number of transistors and diodes, including LEDs used for the front panel indicators.

Passive Components

Table 5-4 shows the passive component spend analysis.

RF/Passive

Table 5-5 shows the RF/passive component spend analysis.

Miscellaneous Components

Table 5-6 shows the miscellaneous spend analysis. The LNB tuner in a digital IRD is more complex, and significantly more expensive, than the equivalent analog device.

Table 5-2
Pace DGT 400 IRD—IC Spend Analysis

Device Reference	Device Type	Manufacturer	Quantity	Unit Cost ($) 1996 (Q2)	Unit Cost ($) 1997 (Q2)	Total Cost ($) 1996 (Q2)	Total Cost ($) 1997 (Q2)	Cost Change 1997/1996	Market Volume (M) 1996	Market Volume (M) 1997	Market Value ($M) 1996	Market Value ($M) 1997
T7812CT	Voltage Regulator, 12V	Motorola	1	0.481	0.467	0.481	0.467	-3%	2.0	4.4	1.0	2.1
LM78M05CT	Voltage Regulator, 5V	National Semiconductor	2	0.298	0.289	0.596	0.578	-3%	4.0	8.8	1.2	2.5
LM78L05	Voltage Regulator, 5V	National Semiconductor	1	0.298	0.289	0.298	0.289	-3%	2.0	4.4	0.6	1.3
ZR431	Shunt Voltage Regulator	Zetex	1	0.294	0.285	0.294	0.285	-3%	2.0	4.4	0.6	1.3
TOP202YA1	Switching Power Supply Controller		1	0.775	0.752	0.775	0.752	-3%	2.0	4.4	1.6	3.3
MC68306FC16	Microcontroller, 32 bit, 16 MHz	Motorola	1	6.806	6.466	6.806	6.466	-5%	2.0	4.4	13.6	28.5
PD78P054GC	Microcontroller, 8/16 bit	NEC	1	6.243	6.056	6.243	6.056	-3%	2.0	4.4	12.5	26.6
TDA8722T	Antenna Signal Processor	Philips	1	1.454	1.381	1.454	1.381	-5%	2.0	4.4	2.9	6.1
CG31104	Asic, Transport Demultiplexer	NTL/Fujitsu	1	35.017	22.761	35.017	22.761	-35%	2.0	4.4	70.0	100.1
AV9110-02	Clock Generator, Programmable	ICS	3	2.500	2.325	7.500	6.975	-7%	6.0	13.2	15.0	30.7
LS64706MC-60	Demodulator, QPSK	LSI Logic	1	22.320	15.624	22.320	15.624	-30%	2.0	4.4	44.6	68.7
LS64709MC-60	DBS/FEC	LSI Logic	1	17.780	12.446	17.780	12.446	-30%	2.0	4.4	35.6	54.8
814260-70	DRAM, 256K × 16, 70 ns	Fujitsu	5	10.167	6.609	50.835	33.045	-35%	10.0	22.0	101.7	145.4
424260-70	DRAM, 256K × 16, 70 ns	NEC	1	14.500	9.425	14.500	9.425	-35%	2.0	4.4	29.0	41.5
81C4256A-70	DRAM, 256K × 4, 70 ns	Fujitsu	1	3.900	2.535	3.900	2.535	-35%	2.0	4.4	7.8	11.2
IS61C64AH-20J	SRAM, 8K × 8, 20 ns	ISSI	1	2.150	2.150	2.150	2.150	0%	2.0	4.4	4.3	9.5
AM29F400B-120SC	Flash, 4Mb	AMD	1	13.000	11.700	13.000	11.700	-10%	2.0	4.4	26.0	51.5
24C64W	Eeprom, 64Kb, Serial	Atmel	1	2.050	2.050	2.050	2.050	0%	2.0	4.4	4.1	9.0
HC04 46A	Hex Inverter	Texas Instruments	2	0.173	0.168	0.346	0.336	-3%	4.0	8.8	0.7	1.5
MC74F245	Octal Bus Tranceiver, Tri-state	Motorola	3	0.279	0.271	0.837	0.813	-3%	6.0	13.2	1.7	3.6
MAX202C	RS232 Line Driver	Maxim	1	0.245	0.238	0.245	0.238	-3%	2.0	4.4	0.5	1.0

(continued)

Table 5-2 (Continued)
Pace DGT 400 IRD—IC Spend Analysis

				Unit Cost ($)		Total Cost ($)		Cost Change	Market Volume (M)		Market Value ($M)	
Device Reference	Device Type	Manufacturer	Quantity	1996 (Q2)	1997 (Q2)	1996 (Q2)	1997 (Q2)	1997/ 1996	1996	1997	1996	1997
TDA8725T	I2C Bus Controller	Philips	1	0.712	0.676	0.712	0.676	-5%	2.0	4.4	1.4	3.0
PCF8584T	I2C Bus Programmable Modulator	Philips	1	3.666	3.483	3.666	3.483	-5%	2.0	4.4	7.3	15.3
GAL22V10B	Programmable Logic	Lattice	1	1.522	1.476	1.522	1.476	-3%	2.0	4.4	3.0	6.5
LM358M	Op-amp, Dual	National Semiconductor	3	0.230	0.223	0.690	0.669	-3%	6.0	13.2	1.4	2.9
TL072C	Op-amp, Dual, FET	SGS-Thomson	3	0.221	0.214	0.663	0.642	-3%	6.0	13.2	1.3	2.8
H3140	Op-amp, Mosfet	Harris	3	0.327	0.317	0.981	0.951	-3%	6.0	13.2	2.0	4.2
CNY17-2G	Opto-isolator	Isocom	1	0.258	0.250	0.258	0.250	-3%	2.0	4.4	0.5	1.1
BT856KPJ	Video Encoder	Brooktree	1	6.450	5.160	6.450	5.160	-20%	2.0	4.4	12.9	22.7
TMXE320	MPEG-2 Audio Dsp	Texas Instruments	1	15.600	10.920	15.600	10.920	-30%	2.0	4.4	31.2	48.0
STI3500ACV	MPEG-2 Video	SGS-Thomson	1	30.000	21.000	30.000	21.000	-30%	2.0	4.4	60.0	92.4
AK4318-VS	DAC, Audio, 18 bit, Dual	Asahi Kasei	1	2.326	2.047	2.326	2.047	-12%	2.0	4.4	4.7	9.0
Total						$250.295	$183.646				500.6	808.0

Source: Dataquest (May 1996 Estimates)

Table 5-3
Pace DGT 400 IRD—Discrete Semiconductor Spend Analysis

Device Reference	Device Type	Manufacturer	Quantity	Unit Cost ($) 1996 (Q2)	Unit Cost ($) 1997 (Q2)	Total Cost ($) 1996 (Q2)	Total Cost ($) 1997 (Q2)	Cost Change 1997/1996	Market Volume (M) 1996	Market Volume (M) 1997	Market Value ($M) 1996	Market Value ($M) 1997
Transistor	Transistor		3	0.047	0.046	0.141	0.138	-2%	6.0	13.2	0.3	0.6
Transistor	Transistor		14	0.047	0.046	0.658	0.644	-2%	28.0	61.6	1.3	2.8
FXT7F9	Transistor		1	0.181	0.177	0.181	0.177	-2%	2.0	4.4	0.4	0.8
BC557	Transistor	Philips	3	0.024	0.024	0.072	0.072	-2%	6.0	13.2	0.1	0.3
TIP31A	Power Transistor, NPN, 60V	SGS-Thomson	2	0.119	0.117	0.238	0.234	-2%	4.0	8.8	0.5	1.0
1N4742	Diode		6	0.068	0.067	0.408	0.402	-2%	12.0	26.4	0.8	1.8
4V7	Diode		4	0.035	0.034	0.140	0.136	-2%	8.0	17.6	0.3	0.6
BZX55C	Diode		1	0.146	0.143	0.146	0.143	-2%	2.0	4.4	0.3	0.6
Diode	Diode		1	0.120	0.118	0.120	0.118	-2%	2.0	4.4	0.2	0.5
Diode	Diode		1	0.089	0.087	0.089	0.087	-2%	2.0	4.4	0.2	0.4
Diode	Diode		2	0.027	0.026	0.054	0.052	-2%	4.0	8.8	0.1	0.2
MR851	Diode		1	0.100	0.098	0.100	0.098	-2%	2.0	4.4	0.2	0.4
STP57	Diode	SGS-Thomson	1	0.080	0.078	0.080	0.078	-2%	2.0	4.4	0.2	0.3
YV37	Diode		2	0.143	0.140	0.286	0.280	-2%	4.0	8.8	0.6	1.2
UF5402	Diode, Fast Rectifier		2	0.316	0.307	0.632	0.614	-3%	4.0	8.8	1.3	2.7
1N53511	Diode, High Power Zener, 5W	Motorola	2	0.294	0.285	0.588	0.570	-3%	4.0	8.8	1.2	2.5
LED	Display, 7-segment × 3		1	0.863	0.837	0.863	0.837	-3%	2.0	4.4	1.7	3.7
LED	Green, 5 mm		3	0.036	0.035	0.108	0.105	-3%	6.0	13.2	0.2	0.5
Total						$4.904	$4.785				9.8	21.1

Source: Dataquest (May 1996 Estimates)

Table 5-4
Pace DGT 400 IRD—Passive Component Spend Analysis

Device Reference	Device Type	Manufacturer	Quantity	Unit Cost ($) 1996 (Q2)	Unit Cost ($) 1997 (Q2)	Total Cost ($) 1996 (Q2)	Total Cost ($) 1997 (Q2)	Cost Change 1997/1996	Market Volume (M) 1996	Market Volume (M) 1997	Market Value ($M) 1996	Market Value ($M) 1997
Capacitor	1000uF, 25V, Radial	LCC	1	0.239	0.234	0.239	0.234	-2%	2.0	4.4	0.5	1.0
Capacitor	1000uF, 50V, Radial	Koshin	1	0.654	0.641	0.654	0.641	-2%	2.0	4.4	1.3	2.8
Capacitor	100uF, 25V, Radial	LCC	7	0.039	0.038	0.273	0.266	-2%	14.0	30.8	0.5	1.2
Capacitor	100uF, 63V, Radial	Dubilier	1	0.188	0.184	0.188	0.184	-2%	2.0	4.4	0.4	0.8
Capacitor	10uF, 50V, Radial	LCC	20	0.062	0.061	1.240	1.220	-2%	40.0	88.0	2.5	5.4
Capacitor	2200uF, 35V, Radial	Dubilier	2	0.060	0.059	0.120	0.118	-2%	4.0	8.8	0.2	0.5
Capacitor	220uF, 25V, Radial	Koshin	1	0.130	0.127	0.130	0.127	-2%	2.0	4.4	0.3	0.6
Capacitor	220uF, 50V, Radial	LCC	2	0.228	0.223	0.456	0.446	-2%	4.0	8.8	0.9	2.0
Capacitor	470uF, 35V, Radial	Dubilier	3	0.323	0.317	0.969	0.951	-2%	6.0	13.2	1.9	4.2
Capacitor	470uF, 50V, Radial	LCC	1	0.330	0.323	0.330	0.323	-2%	2.0	4.4	0.7	1.4
Capacitor	47uF, 400V, Radial	LCC	1	1.133	1.110	1.133	1.110	-2%	2.0	4.4	2.3	4.9
CSA16:00MX	Resonator	CSA	1	0.248	0.241	0.248	0.241	-3%	2.0	4.4	0.5	1.1
VE17 2750	Capacitor	LCC	1	0.041	0.040	0.041	0.040	-2%	2.0	4.4	0.1	0.2
104M275VAC	Capacitor, Boxed Polyester	LCC	1	0.074	0.073	0.074	0.073	-2%	2.0	4.4	0.1	0.3
47NK63	Capacitor	Siemens-Matsushita	2	0.131	0.128	0.262	0.256	-2%	4.0	8.8	0.5	1.1
KD102M	Capacitor		1	0.100	0.098	0.100	0.098	-2%	2.0	4.4	0.2	0.4
681K2KV	Capacitor		2	0.081	0.079	0.162	0.158	-2%	4.0	8.8	0.3	0.7
Capacitor	MLCC		194	0.035	0.034	6.790	6.596	-2%	388.0	853.6	13.6	29.0
D105K 6ZS	Capacitor		6	0.213	0.209	1.278	1.254	-2%	12.0	26.4	2.6	5.5
Resistor	Carbon Film, 5%		11	0.005	0.005	0.055	0.055	-2%	22.0	48.4	0.1	0.2
Resistor	Axial		12	0.005	0.005	0.060	0.060	-2%	24.0	52.8	0.1	0.3
Resistor	Resistor		303	0.005	0.005	1.515	1.515	-2%	606.0	1,333.2	3.0	6.7

(continued)

Table 5-4
Pace DGT 400 IRD—Passive Component Spend Analysis

Device Reference	Device Type	Manufacturer	Quantity	Unit Cost ($) 1996 (Q2)	Unit Cost ($) 1997 (Q2)	Total Cost ($) 1996 (Q2)	Total Cost ($) 1997 (Q2)	Cost Change 1997/1996	Market Volume (M) 1996	Market Volume (M) 1997	Market Value ($M) 1996	Market Value ($M) 1997
Inductor	Air-wound Coil		1	0.015	0.015	0.015	0.015	-3%	2.0	4.4	0.0	0.1
Inductor	Inductor, Radial		2	0.250	0.243	0.500	0.486	-3%	4.0	8.8	1.0	2.1
Inductor	Variable		1	0.224	0.215	0.224	0.215	-4%	2.0	4.4	0.4	0.9
Inductor	Wound, Encapsulated		1	0.336	0.326	0.336	0.326	-3%	2.0	4.4	0.7	1.4
Inductor	Wound-Toroid	Taiyo Yuden	1	0.175	0.170	0.175	0.170	-3%	2.0	4.4	0.4	0.7
Inductor	Balun		5	0.058	0.056	0.290	0.280	-3%	10.0	22.0	0.6	1.2
Fuse	20 × 5 mm, Quickblow		1	0.048	0.047	0.048	0.047	-2%	2.0	4.4	0.1	0.2
Connector	Ac Input, Telefunken Style		1	0.534	0.523	0.534	0.523	-2%	2.0	4.4	1.1	2.3
Connector	Board-to-board Female 10, 11, 12, 13 Way		4	0.360	0.346	1.440	1.384	-4%	8.0	17.6	2.9	6.1
Connector	DS-15, Female		1	0.212	0.206	0.212	0.206	-3%	2.0	4.4	0.4	0.9
Connector	DS-9, Female		1	0.118	0.114	0.118	0.114	-3%	2.0	4.4	0.2	0.5
Connector	Header, 2 × 8, 0.2.5 mm Pitch		1	0.142	0.139	0.142	0.139	-2%	2.0	4.4	0.3	0.6
Connector	Quad-phono, Female		1	0.485	0.475	0.485	0.475	-2%	2.0	4.4	1.0	2.1
Connector	Smart-card Connector	Alcatel-Cit/ Framatome	1	0.939	0.901	0.939	0.901	-4%	2.0	4.4	1.9	4.0
Switch	Push-to-make, SPST	OMRON	4	0.061	0.060	0.244	0.240	-2%	8.0	17.6	0.5	1.1
Total						$22.019	$21.487				44.0	94.5

Source: Dataquest (May 1996 Estimates)

Table 5-5
Pace DGT 400 IRD—RF/Passive Component Spend Analysis

Device Reference	Device Type	Manufacturer	Quantity	Unit Cost ($) 1996 (Q2)	Unit Cost ($) 1997 (Q2)	Total Cost ($) 1996 (Q2)	Total Cost ($) 1997 (Q2)	Cost Change 1997/ 1996	Market Volume (M) 1996	Market Volume (M) 1997	Market Value ($M) 1996	Market Value ($M) 1997
IQXO-22C 55.0	Crystal	BHK	1	0.780	0.757	0.780	0.757	-3%	2.0	4.4	1.6	3.3
KD4.9152	Crystal	IQD	1	0.485	0.470	0.485	0.470	-3%	2.0	4.4	1.0	2.1
K3.6864	Crystal	IQD	1	0.481	0.467	0.481	0.467	-3%	2.0	4.4	1.0	2.1
J17.28	Crystal	IQD	2	0.364	0.353	0.728	0.706	-3%	4.0	8.8	1.5	3.1
K10.000	Crystal	IQD	3	0.380	0.369	1.140	1.107	-3%	6.0	13.2	2.3	4.9
J-25.0000	Crystal	IQD	1	0.349	0.339	0.349	0.339	-3%	2.0	4.4	0.7	1.5
J4000.00	Crystal	IQD	1	0.465	0.451	0.465	0.451	-3%	2.0	4.4	0.9	2.0
Total						$4.428	$4.297				8.9	18.9

Source: Dataquest (May 1996 Estimates)

Table 5-6
Pace DGT 400 IRD—Miscellaneous Component Spend Analysis

Device Reference	Device Type	Manufacturer	Quantity	Unit Cost ($) 1996 (Q2)	Unit Cost ($) 1997 (Q2)	Total Cost ($) 1996 (Q2)	Total Cost ($) 1997 (Q2)	Cost Change 1997/ 1996	Market Volume (M) 1996	Market Volume (M) 1997	Market Value ($M) 1996	Market Value ($M) 1997
SD926B	LNB Tuner		1	18.240	16.416	18.240	16.416	-10%	2.0	4.4	36.5	72.2
Heatsink	Heatsink		3	0.162	0.159	0.486	0.477	-2%	6.0	13.2	1.0	2.1
Heatsink	Heatsink		1	0.150	0.147	0.150	0.147	-2%	2.0	4.4	0.3	0.6
SBX-1620-E2	Infra-red Receiver	Sony	1	1.057	1.004	1.057	1.004	-5%	2.0	4.4	2.1	4.4
463VOR6	Transformer	TDK	1	0.400	0.388	0.400	0.388	-3%	2.0	4.4	0.8	1.7
Transformer	Transformer		1	1.978	1.919	1.978	1.919	-3%	2.0	4.4	4.0	8.4
Metal-housing/connectors	TV-RF I/O		1	0.230	0.225	0.230	0.225	-2%	2.0	4.4	0.5	1.0
Fuse-end Holder			2	0.003	0.003	0.006	0.006	-2%	4.0	8.8	0.0	0.0
PCB	4 Layer, 185mm × 310mm		1	18.56	18.003	18.560	18.003	-3%	2.0	4.4	37.1	79.2
Total						$41.107	$38.585				$82.214	$169.774

Source: Dataquest (May 1996 Estimates)

High-Volume Pricing

The bill-of-materials pricing is based on component volumes of 100,000. However, major producers will buy in greater volume; in many cases direct from the component manufacturer. Besides avoiding distribution, an equipment manufacturer can source many part types from a single vendor, and negotiate further discounts.

Table 5-7 shows 1996 component pricing, based on quantities of 100,000 and 1 million units.

Table 5-7
1996 High-Volume Component Pricing for Digital IRDs

Device Reference	Device Type	Manufacturer	Quantity	1996 (Q2) Total Cost ($) Vol. = 100,000	Vol. = 1 Million
ICS					
T7812CT	Voltage Regulator, 12V	Motorola	1	0.481	0.476
LM78M05CT	Voltage Regulator, 5V	National Semiconductor	2	0.596	0.589
LM78L05	Voltage Regulator, 5V	National Semiconductor	1	0.298	0.295
ZR431	Shunt Voltage Regulator	Zetex	1	0.294	0.291
TOP202YA1	Switching Power Supply Controller		1	0.775	0.766
MC68306FC16	Microcontroller, 32 Bit, 16 MHz	Motorola	1	6.806	6.678
PD78P054GC	Microcontroller, 8/16 Bit	NEC	1	6.243	6.172
TDA8722T	Antenna Signal Processor	Philips	1	1.454	1.427
CG31104	Asic, Transport Demultiplexer	NTL/Fujitsu	1	35.017	30.398
AV9110-02	Clock Generater, Programmable	ICS	3	7.500	7.302
LS64706MC-60	Demodulator, QPSK	LSI Logic	1	22.320	19.796
LS64709MC-60	DBS/FEC	LSI Logic	1	17.780	15.770
814260-70	Dram, 256K × 16, 70 ns	Fujitsu	5	50.835	44.130
424260-70	Dram, 256K × 16, 70 ns	NEC	1	14.500	12.587
81C4256A-70	Dram, 256K × 4, 70 ns	Fujitsu	1	3.900	3.386
IS61C64AH-20J	Sram, 8K × 8, 20 ns	ISSI	1	2.150	2.150
AM29F400B-120SC	Flash, 4Mb	AMD	1	13.000	12.510
24C64W	Eeprom, 64Kb, Serial	Atmel	1	2.050	2.050
HC04 46A	Hex Inverter	Texas Instruments	2	0.346	0.342
MC74F245	Octal Bus Tranceiver, Tri-state	Motorola	3	0.837	0.828
MAX202C	RS232 Line Driver	Maxim	1	0.245	0.242
TDA8725T	I2C Bus Controller	Philips	1	0.712	0.699
PCF8584T	I2C Bus Programmable Modulator	Philips	1	3.666	3.597
GAL22V10B	Programmable Logic	Lattice	1	1.522	1.505
LM358M	Op-amp, Dual	National Semiconductor	3	0.690	0.682
TL072C	Op-amp, Dual, FET	SGS-Thomson	3	0.663	0.656
H3140	Op-amp, MOSFET	Harris	3	0.981	0.970
CNY17-2G	Opto-isolator	Isocom	1	0.258	0.255
BT856KPJ	Video Encoder	Brooktree	1	6.450	5.964
TMXE320	MPEG-2 Audio Dsp	Texas Instruments	1	15.600	13.836
STI3500ACV	MPEG-2 Video	SGS-Thomson	1	30.000	26.608
AK4318-VS	DAC, Audio, 18 bit, Dual	Asahi Kasei	1	2.326	2.221
			Subtotal	$250.295	$225.176

(continued)

Table 5-7 (Continued)
1996 High-Volume Component Pricing for Digital IRDs

Device Reference	Device Type	Manufacturer	Quantity	1996 (Q2) Total Cost ($) Vol. = 100,000	Vol. = 1 Million
Discrete Semiconductors					
Transistor	Transistor		3	0.141	0.223
Transistor	Transistor		14	0.658	0.067
FXT7F9	Transistor		1	0.181	0.169
BC557	Transistor	Philips	3	0.072	0.132
TIP31A	Power Transistor, NPN, 60V	SGS-Thomson	2	0.238	0.615
1N4742	Diode		6	0.408	0.000
4V7	Diode		4	0.140	0.075
BZX55C	Diode		1	0.146	0.382
Diode	Diode		1	0.120	0.137
Diode	Diode		1	0.089	0.131
Diode	Diode		2	0.054	0.000
MR851	Diode		1	0.100	0.268
STP57	Diode	SGS-Thomson	1	0.080	0.000
YV37	Diode		2	0.286	0.051
UF5402	Diode, Fast Rectifier		2	0.632	0.571
1N53511	Diode, High Power Zener, 5W	Motorola	2	0.588	0.531
LED	Display, 7-segment × 3		1	0.863	0.779
LED	Green, 5mm		3	0.108	0.098
			Subtotal	**$4.904**	**$4.227**
Passive					
Capacitor	1000uF, 25V, Radial	LCC	1	0.239	0.214
Capacitor	1000uF, 50V, Radial	Koshin	1	0.654	0.586
Capacitor	100uF, 25V, Radial	LCC	7	0.273	0.245
Capacitor	100uF, 63V, Radial	Dubilier	1	0.188	0.169
Capacitor	10uF, 50V, Radial	LCC	20	1.240	1.112
Capacitor	2200uF, 35V, Radial	Dubilier	2	0.120	0.108
Capacitor	220uF, 25V, Radial	Koshin	1	0.130	0.117
Capacitor	220uF, 50V, Radial	LCC	2	0.456	0.409
Capacitor	470uF, 35v, Radial	Dubilier	3	0.969	0.869
Capacitor	470uF, 50v, Radial	Lcc	1	0.330	0.296
Capacitor	47uF, 400V, Radial	LCC	1	1.133	1.016
CSA16:00MX	Resonator	CSA	1	0.248	0.209
VE17 2750	Capacitor	LCC	1	0.041	0.037
104M275VAC	Capacitor, Boxed Polyester	LCC	1	0.074	0.066
47NK63	Capacitor	Siemens-Matsushita	2	0.262	0.235
KD102M	Capacitor		1	0.100	0.090
681K2KV	Capacitor		2	0.162	0.145
Capacitor	MLCC		194	6.790	6.087
D105K 6ZS	Capacitor		6	1.278	1.146
Resistor	Carbon Film, 5%		11	0.055	0.049
Resistor	Axial		12	0.060	0.054
Resistor	Resistor		303	1.515	1.358

(continued)

Table 5-7 (Continued)
1996 High-Volume Component Pricing for Digital IRDs

Device Reference	Device Type	Manufacturer	Quantity	1996 (Q2) Total Cost ($) Vol. = 100,000	Vol. = 1 Million
Inductor	Air-wound Coil		1	0.015	0.013
Inductor	Inductor, Radial		2	0.500	0.422
Inductor	Variable		1	0.224	0.178
Inductor	Wound, Encapsulated		1	0.336	0.284
Inductor	Wound-toroid	Taiyo Yuden	1	0.175	0.148
Inductor	Balun		5	0.290	0.245
Fuse	20 X 5mm, Quickblow		1	0.048	0.043
Connector	AC Input, Telefunken Style		1	0.534	0.479
Connector	Board-to-board Female 10, 11, 12, 13 Way		4	1.440	1.142
Connector	DS-15, Female		1	0.212	0.179
Connector	DS-9, Female		1	0.118	0.100
Connector	Header, 2 X 8, 0.2.5 mm Pitch		1	0.142	0.127
Connector	Quad-phono, Female		1	0.485	0.435
Connector	Smart-card Connector	Alcatel-Cit/Framatome	1	0.939	0.744
Switch	Push-to-make, SPST	Omron	4	0.244	0.538
			Subtotal	**$22.019**	**$19.690**
RF/Passive					
IQXO-22C 55.0	Crystal	BHK	1	0.780	0.69
KD4.9152	Crystal	IQD	1	0.485	0.427
K3.6864	Crystal	IQD	1	0.481	0.423
J17.28	Crystal	IQD	2	0.728	0.641
K10.000	Crystal	IQD	3	1.140	1.003
J-25.0000	Crystal	IQD	1	0.349	0.307
J4000.00	Crystal	IQD	1	0.465	0.409
			Subtotal	**$4.428**	**$3.897**
Miscellaneous					
SD926B	LNB Tuner		1	18.240	14.614
Heatsink	Heatsink		3	0.486	0.467
Heatsink	Heatsink		1	0.150	0.144
SBX-1620-E2	Infra-red Receiver	Sony	1	1.057	0.952
463VOR6	Transformer	TDK	1	0.400	0.376
Transformer	Transformer		1	1.978	1.860
Metal-housing/connectors	TV-RF I/O		1	0.230	0.221
Fuse-end Holder			2	0.006	0.006
PCB	4 Layer, 185 mm X 310 mm		1	18.56	17.453
			Subtotal	**$41.107**	**$36.092**
			Total	**$322.753**	**$289.082**

Source: Dataquest (May 1996 Estimates)

Market Value in 2000

The high cost of digital IRDs is largely because of the value of ICs within the systems, and the relatively low production volumes at present. Many semiconductor vendors have already announced more integrated chipsets for digital IRDs, and these are likely to lead to further integration during the next few years. The integration of semiconductors, together with the possible use of a unified memory architecture offers the opportunity for significant cost reductions. In addition, as more MSOs roll out digital television services, the higher production volumes will also help to force down the ex-factory selling price.

Table 5-8
2000 High Volume Component Pricing for Digital IRDs

	Digital IRD Content ($)		No. of Digital IRDs (M)		Component Market Value ($M)	
Component Type	1996	2000	1996	2000	1996	2000
ICs	225.176	135.106	2.0	10.8	450.4	1,459.1
Discrete-Semi	4.227	3.889	2.0	10.8	8.5	42.0
Passives	19.690	16.540	2.0	10.8	39.4	178.6
RF/Passive	3.897	2.338	2.0	10.8	7.8	25.3
Miscellaneous	36.092	21.655	2.0	10.8	72.2	233.9
Total	$289.082	$179.527			578.2	1,938.9

Source: Dataquest (May 1996 Estimates)

Appendix A

Bill of Materials

Table A-1
Bill of Materials

Device Reference	Device Type	Manufacturer	Quantity	1996 (Q1) Unit Cost ($)	Package	1996 (Q1) Total Cost ($)
ICs						
T7812CT	Voltage Regulator, 12V	Motorola	1	0.481	TO-220	0.481
LM78M05CT	Voltage Regulator, 5V	National Semiconductor	2	0.298	TO-220	0.596
LM78L05	Voltage Regulator, 5V	National Semiconductor	1	0.298	TO-220	0.298
ZR431	Shunt Voltage Regulator	Zetex	1	0.294	TO-92	0.294
TOP202YA1	Switching Power Supply Controller		1	0.775	TO-221	0.775
MC68306FC16	Microcontroller, 32 bit, 16 MHz	Motorola	1	6.806	PQFP-132	6.806
PD78P054GC	Microcontroller, 8/16 bit	NEC	1	6.243	PQFP-80	6.243
TDA8722T	Antenna Signal Processor	Philips	1	1.454	SOP-20	1.454
CG31104	ASIC, Transport Demultiplexer	NTL/Fujitsu	1	35.017	PQFP-160	35.017
AV9110-02	Clock Generater, Programmable	ICS	3	2.500	SOP-14	7.500
LS64706MC-60	Demodulator, QPSK	LSI Logic	1	22.320	CQPF-100	22.320
LS64709MC-60	DBS/FEC	LSI Logic	1	17.780	CQPF-101	17.780
814260-70	DRAM, 256K × 16, 70 nS	Fujitsu	5	10.167	SOJ-40	50.835
424260-70	DRAM, 256K × 16, 70 nS	NEC	1	14.500	SOJ-40	14.500
81C4256A-70	DRAM, 256K × 4, 70 nS	Fujitsu	1	3.900	DIL-20	3.900
IS61C64AH-20J	SRAM, 8K × 8, 20 nS	ISSI	1	2.150	DIL-28	2.150
AM29F400B-120SC	Flash, 4MB	AMD	1	13.000	SOP-44	13.000
24C64W	EEPROM, 64KB, Serial	Atmel	1	2.050	SOP-8	2.050
HC04 46A	HEX Inverter	Texas Instruments	2	0.173	SOP-14	0.346
MC74F245	Octal Bus Tranceiver, Tri-state	Motorola	3	0.279	SOP-20	0.837
MAX202C	RS232 Line Driver	MAXIM	1	0.245	SOP-16	0.245
TDA8725T	I2C Bus Controller	Philips	1	0.712	SOP-16	0.712
PCF8584T	I2C Bus Programmable Modulator	Philips	1	3.666	SOP-20	3.666
GAL22V10B	Programmable Logic	Lattice	1	1.522	PLCC-28	1.522
LM358M	OP-AMP, Dual	National Semiconductor	3	0.230	SOP-8	0.690
TL072C	OP-AMP, Dual, FET	SGS-Thomson	3	0.221	SOP-8	0.663
H3140	OP-AMP, MOSFET	Harris	3	0.327	SOP-8	0.981
CNY17-2G	Opto-isolator	ISOCOM	1	0.258	DIL-6	0.258
Bt856KPJ	Video Encoder	Brooktree	1	6.450	PLCC-68	6.450
TMXE320	MPEG-2 Audio DSP	Texas Instruments	1	15.600	PQFP-120	15.600
STi3500ACV	MPEG-2 Video	SGS-Thomson	1	30.000	PQFP-144	30.000
AK4318-VS	DAC, Audio, 18 bit, Dual	Asahi Kasei	1	2.326	SOP-28	2.326
GPS869C	ADC Dual, 6-bit	GPS	1	3.533	PLCC-44	3.533

(continued)

Table A-1 (Continued)
Bill of Materials

Device Reference	Device Type	Manufacturer	Quantity	1996 (Q1) Unit Cost ($)	Package	1996 (Q1) Total Cost ($)
Discrete Semiconductors						
Transistor	Transistor		3	0.047	SOT23	0.141
Transistor	Transistor		14	0.047	UMT	0.658
FXT7F9	Transistor		1	0.181	TO-92	0.181
BC557	Transistor	PHILIPS	3	0.024	TO-92	0.072
TIP31A	Power Transistor, NPN, 60V	SGS-Thomson	2	0.119	TO-220	0.238
1N4742	Diode		6	0.068	PIH	0.408
4V7	Diode		4	0.035	PIH	0.140
BZX55C	Diode		1	0.146	DO-35	0.146
Diode	Diode		1	0.120	TO-126	0.120
Diode	Diode		1	0.089	PIH	0.089
Diode	Diode		2	0.027	UMT	0.054
MR851	Diode		1	0.100	PIH	0.100
STP57	Diode	SGS-Thomson	1	0.080	TO-220	0.080
YV37	Diode		2	0.143	PIH	0.286
UF5402	Diode, Fast Rectifier		2	0.316	PIH	0.632
1N53511	Diode, High Power Zener, 5W	Motorola	2	0.294	PIH	0.588
LED	Display, 7-Segment X 3		1	0.863	PIH	0.863
LED	Green, 5mm		3	0.036	PIH	0.108
Passive Components						
Capacitor	1000uF, 25V, Radial	LCC	1	0.239	PIH	0.239
Capacitor	1000uF, 50V, Radial	Koshin	1	0.654	PIH	0.654
Capacitor	100uF, 25V, Radial	LCC	7	0.039	PIH	0.273
Capacitor	100uF, 63V, Radial	Dubilier	1	0.188	PIH	0.188
Capacitor	10uF, 50V, Radial	LCC	20	0.062	PIH	1.240
Capacitor	2200uF, 35V, Radial	Dubilier	2	0.060	PIH	0.120
Capacitor	220uF, 25V, Radial	Koshin	1	0.130	PIH	0.130
Capacitor	220uF, 50V, Radial	LCC	2	0.228	PIH	0.456
Capacitor	470uF, 35V, Radial	Dubilier	3	0.323	PIH	0.969
Capacitor	470uF, 50V, Radial	LCC	1	0.330	PIH	0.330
Capacitor	47uF, 400V, Radial	LCC	1	1.133	PIH	1.133
CSA16:00MX	Resonator	CSA	1	0.248	PIH	0.248
VE17 2750	Capacitor	LCC	1	0.041	PIH	0.041
104M275VAC	Capacitor, Boxed Polyester	LCC	1	0.074	PIH	0.074
47nK63	Capacitor	Siemens-Matsushita	2	0.131	PIH	0.262
KD102M	Capacitor		1	0.100	PIH	0.100
681K2KV	Capacitor		2	0.081	PIH	0.162
Capacitor	MLCC		194	0.035	0603	6.790
D105K 6ZS	Capacitor		6	0.213	PIH	1.278
Resistor	Carbon Film, 5%		11	0.005	PIH	0.055
Resistor	Axial		12	0.005	PIH	0.060
Resistor	Resistor		303	0.005	0805	1.515

(continued)

Table A-1 (Continued)
Bill of Materials

Device Reference	Device Type	Manufacturer	Quantity	1996 (Q1) Unit Cost ($)	Package	1996 (Q1) Total Cost ($)
Inductor	Air-wound Coil		1	0.015	PIH	0.015
Inductor	Inductor, Radial		2	0.250	PIH	0.500
Inductor	Variable		1	0.224	PIH	0.224
Inductor	Wound, Encapsulated		1	0.336	SMT	0.336
Inductor	Wound-toroid	Taiyo Yuden	1	0.175	PIH	0.175
Inductor	Balun		5	0.058	PIH	0.290
FUSE	20 × 5MM, Quickblow		1	0.048	N/A	0.048
Connector	AC Input, Telefunken Style		1	0.534	PIH	0.534
Connector	Board-to-Board Female 10, 11, 12, 13 WAY		4	0.360	PIH	1.440
Connector	DS-15, Female		1	0.212	PIH	0.212
Connector	DS-9, Female		1	0.118	PIH	0.118
Connector	Header, 2 × 8, 0.2.5 mm Pitch		1	0.142	PIH	0.142
Connector	Quad-phono, Female		1	0.485	PIH	0.485
Connector	Smart-card Connector	Alcatel-CIT/Framatome	1	0.939	PIH	0.939
Switch	Push-to-make, SPST	OMRON	4	0.061	PIH	0.244
RF/Passive Components						
IQXO-22C 55.0	Crystal	BHK	1	0.780	PIH	0.780
KD4.9152	Crystal	IQD	1	0.485	PIH	0.485
K3.6864	Crystal	IQD	1	0.481	PIH	0.481
J17.28	Crystal	IQD	2	0.364	PIH	0.728
K10.000	Crystal	IQD	3	0.380	PIH	1.140
J-25.0000	Crystal	IQD	1	0.349	PIH	0.349
J4000.00	Crystal	IQD	1	0.465	PIH	0.465
Miscellaneous Components						
SD926B	LNB Tuner		1	18.240	PIH	18.240
Heatsink	Heatsink		3	0.162	N/A	0.486
Heatsink	Heatsink		1	0.150	N/A	0.150
SBX-1620-E2	Infrared Receiver	SONY	1	1.057	PIH-3	1.057
463VOR6	Transformer	TDK	1	0.400	PIH	0.400
Transformer	Transformer		1	1.978	PIH	1.978
Metal-housing/ connectors	TV-RF I/O		1	0.230	PIH	0.230
Fuse-end Holder			2	0.003	PIH	0.006
PCB	4 Layer, 185 mm × 310 mm		1	18.560	N/A	18.560
					Total	$326.286

N/A = not available
Source: Dataquest (May 1996 Estimates)

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