ELECTRONICS EQUIPMENT PRODUCTION MONITOR
EUROPE 1995

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Dataquest

a company of
The Dun&Bradstreet Corporation

31 May, 1995

Internal Distribution

ELECTRONIC EQUIPMENT PRODUCTION MONITOR
Quarterly Industry Review, SAPM-EU-QR-9501

Here is the first edition of this new program from the European Semiconductors Group. The binder will follow shortly if applicable.

Dataquest Europe Limited, Holmers Farm Way, High Wycombe, Buckinghamshire, HP12 4XH United Kingdom.
Tel: +44 (0) 1494 422 722 Fax: +44 (0) 1494 422 742

Registered Office: Holmers Farm Way, High Wycombe, Bucks, HP12 4XH. Registered in England No. 1558748

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The Dun&Bradstreet Corporation

Digital Cellular Handsets: Implications for Component Consumption Within the European Market

Component Sector Analysis—Market Values

Market values in this section commencing for the tables commencing on page 11 in the above report (SAPM-EU-FR-9501), were ommitted. They are given below.

Table 4-2 IC		**Table 4-3 Discrete**		**Table 4-4 Passive**		**Table 4-5 RF/Passive**		**Table 4-6 Miscellaneous**	
Market Value ($M)		**Market Value ($M)**		**Market Value ($M)**		**Market Value ($M)**		**Market Value ($M)**	
1995	**1996**	**1995**	**1996**	**1995**	**1996**	**1995**	**1996**	**1995**	**1996**
75.7	100.5	100.1	135.9	12.8	18.6	36.8	51.6	11.4	16.0
28.0	37.2	7.4	10.7	3.7	5.4	105.1	147.4	102.6	145.4
70.0	93.0	0.8	1.1	9.0	13.1	48.2	65.4	7.5	10.0
70.0	93.0	3.8	5.5	9.0	13.1	58.5	82.1	10.5	14.8
59.3	78.8	0.5	0.7	43.7	63.2	29.3	41.0	8.5	12.0
42.0	58.9	42.0	60.8	15.2	22.0	25.0	35.0	9.0	12.8
12.4	17.3	**154.5**	**214.7**	**93.5**	**135.3**	135.1	159.6	**149.5**	**211.0**
51.4	66.8					**438.0**	**582.2**		
115.1	149.5								
142.4	178.6								
171.3	222.5								
77.6	103.0								
86.7	115.1								
201.5	252.8								
167.7	260.0								
10.0	14.0								
13.1	17.8								
60.1	79.8								
1,454.1	**1,938.1**								

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Market Analysis

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Market
Analysis

Electronic Equipment Production Monitor

Quarterly Industry Review

Market Trends in European Electronic Equipment Production:
This Quarterly Industry Review looks at production of electronic equipment in Europe during the third-quarter of 1995 (July to September).

Contract Electronics Manufacturing Report

This review contains a major report, based on a survey of European contract manufacturers, assessing the size of the market, identifying the leading contract manufacturers and their services, along with trends in the market.

Introduction

Contract electronics manufacturers (CEMs) are an accepted, and growing, part of the electronic equipment production industry in 1995, due to the continuing growth in unit production of electronic equipment, and the trend of OEMs to outsource their manufacturing activities. This report, based on a survey carried out in Europe, covers:

- Reasons why original equipment manufacturers (OEMs) use CEMs
- The size of the European market for CEM services
- The leading CEMs in Europe
- Services offered by CEMs and a CEM cost model
- CEM procurement trends

The transition from OEMs carrying out their own equipment manufacture to outsourcing it to CEMs is governed by the now familiar make-or-buy decision. With current management doctrine emphasizing "do what you do best, and outsource the rest," there is more pressure than ever for OEMs to discontinue their in-house manufacturing, and pass it to CEMs.

Dataquest

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The value of manufactured equipment continues to fall in proportion to the value of the intellectual property in the product and the cost of the channel. Because of this, more and more OEMs will seek to minimize the cost of equipment production, and add value at other stages of the design-through-supply chain.

In the past, many items of electronic equipment had a three- or four-year lifetime and were redesigned almost from scratch at the end of their life. Now, in order for OEMs to stay ahead of the competition, they are constantly developing and enhancing existing products, and focusing on the marketing of these sometimes minor improvements. This means that the manufacturing process has changed from producing a stable product for long periods of time, to implementing frequent engineering changes on shorter production runs of subtly different products. It is the management of this flexibility, which CEMs offer, that allows OEMs to concentrate on design and marketing.

Methodology

This report is based on a survey of European CEMs. A list of the CEMs that responded to our survey is contained in Table 1. Where necessary, survey data have been supplemented by information from other Dataquest publications and surveys, as well as information from the public domain and industry sources.

Definitions

Dataquest defines a contract electronics manufacturer as a company or division of a company that provides electronics manufacturing, design or other services to the market. CEM work predominantly (but not exclusively) includes printed circuit board assembly (PCA), system assembly, and component procurement.

Product Sectors

This section defines the product sectors used in this report. Dataquest's objective is to provide relevant data about the electronic equipment manufacturing industry, and component applications markets. For forecasting purposes, Dataquest segments the electronics industry into six broad product sectors, these six sectors are defined by the narrower product sectors they represent:

- **Electronic Data Processing**
  - Computers
  - Data storage
  - Input/output devices
  - Dedicated systems
- **Communications**
  - Premise telecoms
  - Public telecoms
  - Mobile/radio communications equipment
  - Other communications
  - Broadcast and studio equipment
- **Industrial**
  - Security and energy management systems
  - Manufacturing and instrumentation systems
  - Robot systems

Table 1
Respondents to CEM Survey

Company	Location	Country
AB Electronic Assemblies	Newport	UK
AB Mikroelektronik GmbH	Salzburg	Austria
ACW Technology	Petersfield	UK
Avex Electronics Ltd	East Kilbride	UK
Brother Industries (IRL) Ltd	Drogheda	Ireland
Celab Ltd	Bordon	UK
Chase Advanced Technology Ltd	Bradford	UK
DDL Electronics Ltd	Craigavon	UK
Design to Distribution Ltd	Stoke-on-Trent	UK
Dovatron Ireland	Cork	Ireland
EDMS Ltd	Maldon	UK
Evic Electronics	Echt	Netherlands
GEC Alsthom Electronic Service	Stafford	UK
GSPK Electronics Ltd	Knaresborough	UK
Genrad Manufacturing	Stockport	UK
Hosiden Besson Limited	Hove	UK
Hughes Microelectronics Europe	Glenrothes	UK
Jabil Circuit	Livingston	UK
Karavale Enterprises Ltd	Welwyn Garden City	UK
Kemitron Manufacturing	Deeside	UK
Kyrel Oy	Kyroskoski	Finland
Lucas Electronics	Birmingham	UK
Manufacturers Services Ltd	Athlone	Ireland
Mion Electronics	Wombwell	UK
Quantum Electronics Manufacturing	Pontsewett	UK
SPA Superior Print Assembly BV	Almelo	Netherlands
Securicor Electronics Ltd	Bath	UK
Solectron	Fife	UK
Solectron France S.A	Cestas Cedex	France
Surtech Interconnection	Basingstoke	UK
Welwyn Systems Ltd	Blyth	UK

Source: Dataquest (October 1995)

- Medical equipment
- Other industrial equipment

- **Consumer**
  - Audio
  - Video
  - Personal electronics
  - Appliances
- **Military and Civil Aerospace**
  - Transportation

Component Sectors

- **Semiconductor components**: Includes memory, microprocessors, microcontrollers, microperipherals, logic, ASICs, analog semiconductors, discrete semiconductors (diodes, transistors, and so on), optoelectronic semiconductor components (LEDs, opto-isolators, and so on), LCD display devices
- **Other components**: Includes batteries, cables, capacitors, connectors, crystals, fans, filters, fuses/protection, inductors, keypads/keyboards, microphones, oscillators, PCBs, resistors, sockets, speakers/sounders, switches, transformers, others

History

In the United States, CEMs grew up around the defense and space industries from the 1960s onwards. During the 1970s, CEMs started to diversify (to try to counter cyclical defense spending), by taking on one-off "jobs" for commercial OEMs. This "job-shop" mentality continued into the 1980s, but was being tempered by the rapid growth of the major CEM players, and the long-term strategies they were developing.

In Europe, the situation differed because the defense spending was placed with well-established, national companies which had their own manufacturing capabilities. There were few start-up companies requiring significant manufacturing capacity, and no European equivalent with NASA's budget.

During the 1980s, the proliferation of OEMs of electronic equipment in Scotland and Ireland (located in these regions for financial and other reasons) spawned a secondary industry of contract manufacturers. Many of these companies (and others located in the United Kingdom and in continental Europe) continued to serve a few major customers which were located nearby.

When the big US-based CEMs started to follow their major PC OEM customers, and invested in European plants (either by taking over existing facilities or by opening "greenfield" sites), the European CEM industry discovered that it was part of a global switch to outsourced manufacturing.

As the industry has matured in the 1990s, a few US-headquartered companies dominate the market worldwide. Europe-headquartered CEMs, with a few exceptions, tend to be smaller players focused on local customers and markets.

Why OEMs Choose to Outsource

Advantages of Using a CEM

The reasons most often cited for using a CEM are as follows (in order of importance):

- Lower total cost of materials. This includes materials management, vendor assessment and approval, just-in-time (JIT) delivery and quality control
- High level of service
- Manufacturing expertise
- Additional manufacturing capacity
- Ease of doing business

Disadvantages of Using a CEM

Paradoxically, many of the reasons for using a CEM are also given as reasons not to use one. These include:

- The cost of doing business with a CEM
- Loss of control over equipment production
- Production-cycle times too long, or inflexible

Reasons for Using a CEM

Essentially, the CEM removes the "hassle" in manufacturing electronic equipment—a complex task requiring a high level of experience and expertise. The advantage of additional manufacturing capacity has two benefits: firstly, it offers a degree of flexibility when demand rises in the short to medium term; and it also removes the need for costly capital investment.

Surface mount (SMT) assembly equipment is costly to capitalize and may have to be upgraded (or replaced) at regular intervals in order to maintain production capability. It can also be expensive to run, due to direct labor costs and the cost of equipment support.

CEMs can offer genuine cost savings to the OEM. They ensure that the use of manufacturing capacity is well planned, which ensures that capital equipment is fully utilized. And their large-scale component procurement offers scope for reduced material costs.

Market Size and Forecast

Reasons for Market Growth

European, and global, CEM growth (and the demand for CEM services) has been strengthened by two main factors:

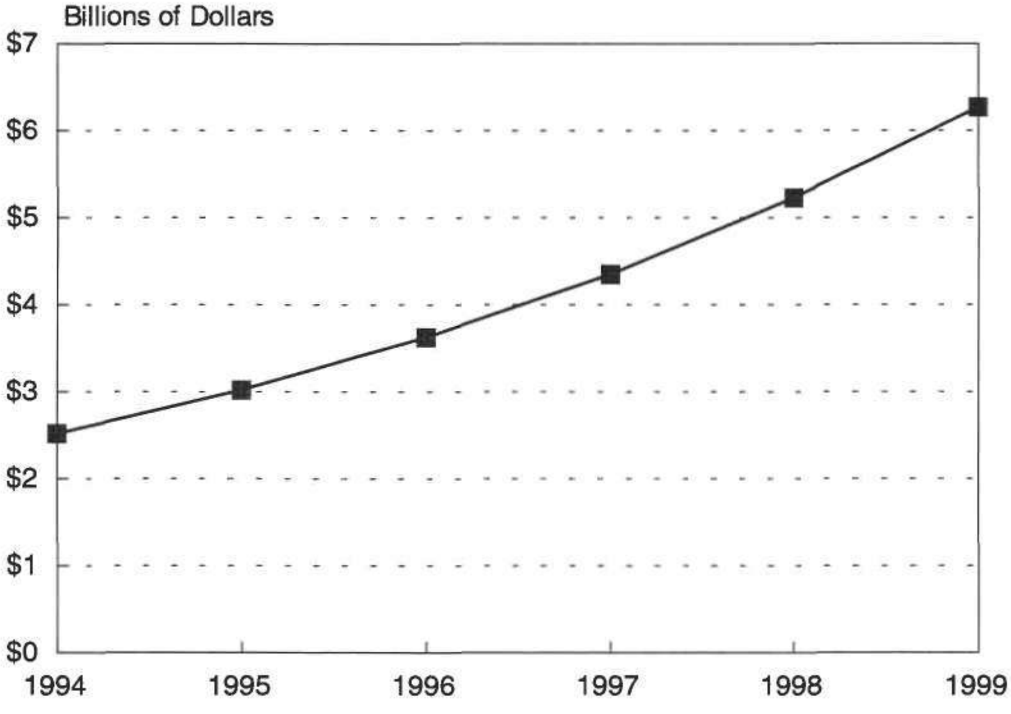
- The continuing growth in unit production of electronic equipment, due to the increasing demand for existing and emerging products. In Europe, equipment production revenue is forecast to grow with a compound annual growth rate (CAGR) of 6 percent.
- The continuing trend of OEMs to outsource their manufacturing activities.

In 1994, the total value of electronic equipment production in Europe was $156 billion (measured by factory sales revenue). European OEMs outsourced manufacturing services worth about 1.6 percent of total production; this is forecast to rise to 4.0 percent by 1999.

Factory sales revenue for European CEMs was $2.52 billion in 1994, and this is forecast to rise to $6.27 billion in 1999. Figure 1 shows the revenue generated by European CEMs from manufacturing services.

Table 2 shows factory sales revenue for manufacturing services, generated by European CEMs. CEM factory sales revenue is forecast to grow with a CAGR of 20 percent from 1994 to 1999.

Figure 1
European CEM Services
Factory Sales Revenue, History and Forecast



Source: Dataquest (October 1995 Estimates), Technology Forecasters

Table 2
European CEM Services
Factory Sales Revenues, History and Forecast
(Billions of Dollars)

Year	Revenue ($B)
1994	2.52
1995	3.02
1996	3.63
1997	4.35
1998	5.23
1999	6.27
CAGR 1994-1999	20%

Source: Dataquest (October 1995 Estimates), Technology Forecasters

European Market Share

The European market for CEM services is served by a variety of companies. These range from several companies with a turnover in excess of $200 million, to a myriad of smaller companies, many of which serve niche markets. In this report we have only included companies whose primary business is the provision of CEM services. For companies which have worldwide production sites, we have only included revenue generated from European production. Table 3 shows Europe's top 15 CEMs ranked by 1994 factory sales revenue.

Many of the large CEMs in the United Kingdom, Ireland and France are in fact plants owned by US-based CEMs. The United Kingdom and Ireland, in particular, have experienced rationalization in the CEM sector. This has included Flextronics International's purchase of Assembly and Automation, TT Group's acquisition of Race (to complement AB Electronics and Welwyn Systems), and Keltek's recent purchase of EDMS.

This has taken place alongside acquisitions by CEMs of OEM manufacturing plants, including SCI and Solectron taking over Hewlett-Packard plants in France, and the recent purchase by Ogden (a US-based CEM) of Logitech's plant in Ireland.

This has led to fewer players, with larger revenues and multiple production facilities. However, in much of continental Europe the picture is very different. Outsourcing has not occurred to the same extent as it has in the United Kingdom and Ireland, and it may be some years before there are sizeable CEMs in many European countries.

Production Share by Application Sector

Figure 2 shows how 1994 factory sales revenue is split by application sector. Just under 50 percent of revenue is from the EDP sector. Most of this revenue is derived from manufacturing PCs. The PC is a high-volume commodity product, and is an ideal candidate for outsourcing to CEMs.

Another 30 percent of revenue is derived from communications products. This reflects the explosive growth in communications equipment production, which may have exceeded OEMs' in-house manufacturing capacity.

Many CEMs report revenue growth in the sectors which currently dominate their business. Although some are trying to reduce their dependence on particular product sectors, they are attempting to achieve this by increasing alternative business, rather than reduce their existing business.

CEMs with a diverse customer base are seeing a decline in industrial and military/aerospace work. However, more focused CEMs that currently derive a significant amount of revenue from these areas are reporting growth in these sectors.

CEM Services

Scope of CEM Services

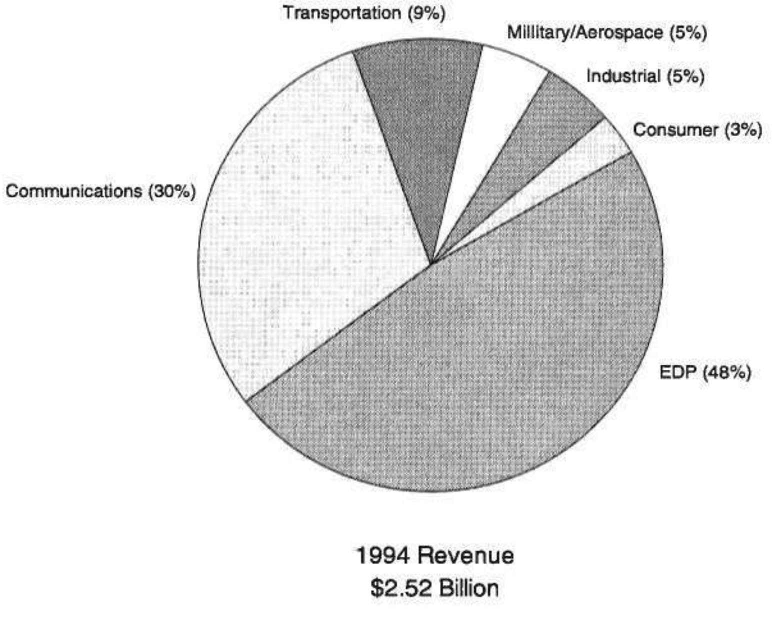
In the past, CEMs provided a PCA service to their OEM customers. In many cases this business was then augmented by system assembly. However, in addition to manufacturing, design and logistics services, most CEMs will now purchase components for their customers, in order to offer a "turnkey" service.

Table 3
Top 15 European CEMs
Ranked by 1994 Factory Sales Revenue

Rank	Company	Country
1	Solectron Corporation (Europe)	France/UK
2	SCI Systems (Europe)	France/Ireland/UK
3	Kyrel Oy	Finland
4	Design to Distribution	UK
5	Jabil Circuit (Europe)	UK
6	Avex Electronics (Europe)	UK
7	AB Electronic Assemblies	UK
8	Welwyn Systems	UK
9	Race Electronics	UK
10	Hughes Microelectronics Europa	UK/Spain
11	Dovatron (Europe)	Ireland
12	Assembly & Automation	UK
13	Keltek Electronics	UK
14	EDMS	UK
15	SM2E Electronique	France

Source: Dataquest (October 1995 Estimates)

Figure 2
European CEM Services by Application Sector
Ranked by 1994 Factory Sales Revenue



Source: Dataquest (October 1995 Estimates)

When contract manufacturing was in its infancy, OEMs would supply components free of charge (free issue), or charge them at cost to the CEM (consignment). This was done for several reasons: because the OEM had greater buying power than the CEM, and could obtain the components at lower cost; or because the component manufacturer would only supply to the OEM due to component warranty issues; or because there was a restricted supply of particular components. In many cases, though, CEMs now have greater purchasing power than their OEM customers, and component warranty has ceased to be a major issue.

By offering additional (and complementary) services, CEMs can increase their revenue and profitability. In turn, OEMs can benefit by outsourcing more of their production activities.

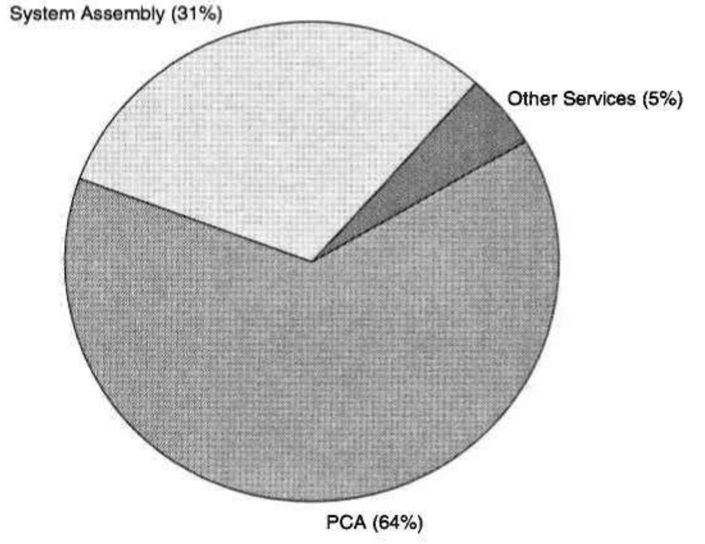
European CEMs still derive most of their revenue from PCA services. Figure 3 shows the split between PCA, system assembly and "other services." These other services include design for manufacture, product distribution, electromagnetic compatibility (EMC) testing, and full product design.

European CEMs report significant growth in both PCA and system assembly work, and a smaller increase in other work. Much of the growth over the last few years has been in PCB assembly capacity. As CEMs win PCA business to fill the new capacity, they then attempt to increase revenue by bidding for additional system assembly work.

CEM Cost Model

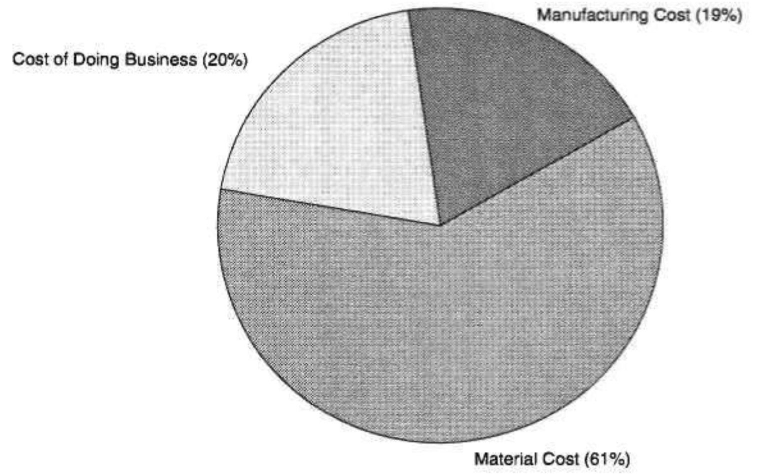
As various items of electronic equipment cease to be differentiated by proprietary intellectual property, and become commodity products which are predominantly sold on a cost per function basis, it is essential that the manufactured goods are as cost-effective as possible.

Figure 3
European CEM Services
Ranked by 1994 Factory Sales Revenue



Source: Dataquest (October 1995 Estimates)

Figure 4
CEM Cost Model



Source: Dataquest (October 1995 Estimates)

One of the major benefits of using a CEM is the lower cost of manufactured equipment. The CEM should be able to manufacture equipment more cost-effectively than an OEM, which is likely to have higher manufacturing costs for historic, or other, reasons. However, a significant part of the total cost of CEM-produced equipment is the "cost of doing business." This includes receiving, inventory and shipping costs, as well as the cost of managing the CEM.

The cost of doing business must be offset by cost savings due to material procurement and management, and lower direct manufacturing costs. Figure 4 shows the cost model for a typical CEM. The percentage split will vary among CEMs, depending on their product mix, the value of the material content, and how good their partnership is with their OEM customers.

Procurement Trends

A global procurement service means that CEMs can buy parts at favorable prices, as well as ensuring that their component supply is not interrupted. A global presence also helps CEMs understand local markets, both from a purchasing stance, and from the point of view of their customers.

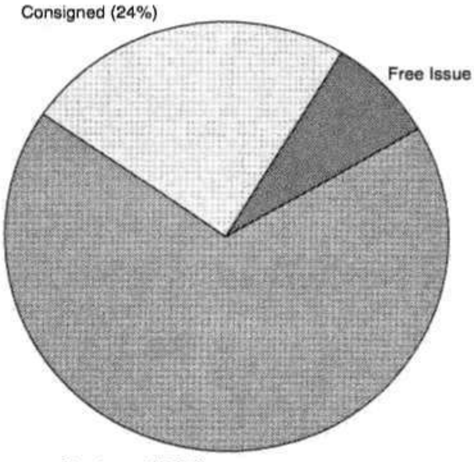
Value of Purchased Components

In 1994, the total value of semiconductors purchased was $896 million; this was 4.3 percent of the total European semiconductor market of $20.8 billion. The value of other components was $340 million (see earlier definitions). The ratio of semiconductors to other components varies between CEMs, depending on production levels of semiconductor-hungry applications such as PCs.

Component Sourcing

Most components are now purchased by the CEM on behalf of their OEM customers. In 1994, 68 percent (by value) of components were purchased,

Figure 5
1994 CEM Component Procurement (by Value)



Source: Dataquest (October 1995 Estimates)

24 percent were consigned (charged at cost by the OEM), and 8 percent were supplied at no charge (by the OEM). Figure 5 shows 1994 component procurement, by value.

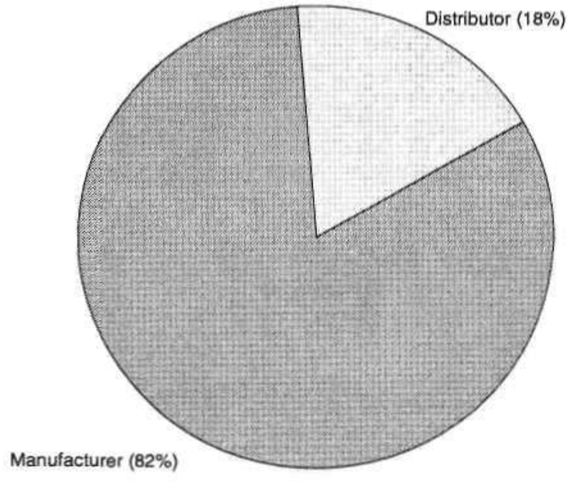
Over 90 percent of those who responded to our survey reported growth in purchased value, and 33 percent reported growth in the value of free-issue parts. About 15 percent reported growth in the value of consigned parts. These trends were not related to the size (measured by factory sales) of a CEM.

Component Suppliers

The majority of components (by value) are purchased from component manufacturers, rather than component distributors. However, this is related to the size of the CEM (measured by factory sales). Generally, CEMs with sales of more than $50 million will purchase at least 70 percent (by value) from component manufacturers. CEMs with sales less than $50 million, generally purchase the majority of their components from distributors. Figure 6 shows CEM component suppliers, by value.

Just over 70 percent of those who responded to our survey reported growth in component supplier value, and 58 percent reported growth in the value of distributor supplied parts. These trends were not related to the size (measured by factory sales) of a CEM.

Figure 6
CEM Component Supplier (by 1994 Value)



Source: Dataquest (October 1995 Estimates)

Dataquest Perspective

In addition to the overall growth in equipment production, these are the reasons why the CEM industry is growing:

- OEMs outsourcing part of their production (for capacity reasons, or for other reasons), in order to reduce the total cost of manufacturing electronic equipment
- OEMs using CEMs to manufacture equipment until it becomes cost-effective to invest in their own manufacturing capabilities
- OEMs choosing not to manufacture, either because they cannot justify manufacturing capacity, or do not see manufacturing as a strategic part of their business

While some of the newer single-product companies (such as the dedicated PC manufacturers) will build up in-house manufacturing capacity, many companies will continue to outsource. Many smaller companies will initially use CEMs, and as they grow will decide whether to add in-house capacity.

There is a continuing trend towards a handful of large, global CEM players—CEMs with a turnover of several billion dollars, worldwide production facilities and significant purchasing power. Only CEMs of this size, which can invest in sophisticated production technology and force down material costs, will be able to provide OEMs with the low-cost, high-volume products they demand.

There will be continued restructuring in the United Kingdom, Ireland and continental Europe, as larger players emerge. However, smaller players will continue to provide manufacturing services to various niches within the market, predominantly for low-volume, higher-value equipment.

OEM News

AT&T Network Systems

AT&T Network Systems is acquiring parts of Philips Communications Systems dealing with wide area networking technologies. Philips' desire to concentrate on the personal communications market has led to the disposal of businesses including Philips Kommunications Industrie, based in Germany, and manufacturing facilities in Rouen, France, producing transmission equipment, and Nürnberg, Germany which manufactures digital cellular base stations.

As with many of the announcements reported in this review, this benefits both parties in different ways. Philips continues to divest itself of peripheral businesses that it does not consider essential for future growth. This can generate cash, reduce debt, or eliminate costly investment. Philips had reached a point where it needed to make significant investment in the network systems business, and it chose to concentrate on personal technologies such as cellular and cordless telephones, faxes and smart cards.

AT&T strengthens its product portfolio, and also has a chance to gain market share in Europe, to help reduce its dependence on the US market. Although AT&T Network Systems has some European production capacity, gaining the two Philips plants should provide it with more than enough capacity to manufacture for the deregulating European telecoms market.

Canon

Canon has announced a $15.5 million investment to expand its manufacturing plant at Glenrothes, Scotland. The investment relates to Canon's plans to produce bubble jet printers from 1996 onwards, for sale in European markets. Output is forecast to reach 50,000 units per month by the end of 1996, with capacity for 100,000 per month in 1997.

The Glenrothes expansion was initially to provide assembly capacity for copiers. However, the decline in the copier market and increased competition in the ink jet printer market have forced Canon's hand. The company is losing market share in the European ink jet market, and local manufacture means it can deliver products faster to customers, with reduced freight costs.

Exabyte

After only a year, Exabyte is expanding its manufacturing and service site at Falkirk, Scotland. The facility also provides warehousing, and is a hub in Exabyte's European distribution network.

Exabyte's focus on tape storage devices has led to a significant customer base of European companies, as well as US-based companies which ship Exabyte products into Europe. Because customers frequently change their volume and technology requirements (and request customized configurations), Exabyte must be located as close as possible to the customers in order to reduce obsolescence in the supply chain.

Filtronic Comtek

Filtronic Comtek, which manufactures cellular base stations and is based in Shipley, England, has invested in a new manufacturing plant in Shipley, due to be completed in February 1996. It is also investing in its existing facility at

Stewarton, Scotland, which manufactures radio frequency components for base stations, and will also have design capability from now on.

Filtronic is using growth from cellular communications to invest in future manufacturing and design capability. As well as increasing its manufacturing capacity, it has plans to design and manufacture more of the components and subassemblies it uses. Long-term growth is coming from its support for GSM, PCN and PCS standards, as well as developing wireless local loop solutions with several other manufacturers.

Graseby Microsystems

Graseby Microsystems has agreed to acquire GEC Plessey's hybrids business (based in Lincoln, England), and will relocate equipment as well as a number of staff to its hybrid facility in Newmarket, England.

Graseby has been profitable in the hybrids business, but has found it necessary to increase market share and gain intellectual property via acquisition. GEC Plessey and Graseby have been collaborating in the manufacture of hybrids for some time, prior to GEC Plessey's divestiture of its hybrids business as part of a rationalization of the markets it operates in.

IBM

As well as selling a plant in Spain to contract manufacturer MSL (see other story), IBM has announced that it is selling its German STP subsidiary to Mayer & Cie. STP, based in Sindelfingen, manufactures bare PCBs for IBM and other companies. Mayer & Cie performs PCB surface-mount assembly, and manufactures for both IBM and other companies.

This deal should benefit both parties. IBM divests itself of yet another costly manufacturing site, but presumably with the proviso that Mayer & Cie will continue to supply high-technology PCBs. Meanwhile, Mayer & Cie vertically integrates its assembly business with one of its key suppliers (of high-technology interconnect), and gains some high-value business from IBM.

Järfälla

After announcing its intentions, back in March, to invest $11 million in Järfälla ICC (a Swedish printer company, formerly owned by IBM), Amstrad has pulled out of the deal. Instead, the plant is going to the Dallas, Texas–based company Nu-Kote Holding Inc. Nu-Kote plans to develop products in collaboration with OEMs, in most cases by licensing the piezo-electric print head technology. There is a possibility that Amstrad may opt for a licensing arrangement.

It took Canon and Hewlett-Packard almost 10 years to translate patented printer technology into a marketable product, and then several years before those products took off in the marketplace.

Amstrad was looking for a printer company which it could buy, in order to offer bundled deals with its new line of direct-sale PCs. Unfortunately, Järfälla was not that company. The print head technology offers long life, without sacrificing print quality. However, as a competitor to the market leaders, in terms of price and performance, it is likely to be several years away. In the meantime, the technology requires significant funding for technical development, which Amstrad is not prepared to pay for.

Nokia

Nokia Monitors has acquired the assets of a monitor production facility in Hungary. The plant was purchased from Hantarex SpA, an Italian company. The new company, Nokia Monitor Magyarorszag, is due to start manufacturing during the first quarter of 1996, with an initial capacity of 500,000 units annually. Nokia's existing monitor plant is in Salo, Finland.

The worldwide shortage of cathode ray tubes (CRTs) and monitors is encouraging many integrated electronics companies to invest in manufacturing capacity. The Hungarian plant will manufacture 38 cm monitors, predominantly for the worldwide PC market, although some will be used by Nokia's revitalized consumer electronics division.

Philips

Philips Display Components (PDC), part of Philips Electronics, is investing $48 million in a Russian CRT manufacturer. Philips has purchased a controlling interest, and is keen to involve the European Bank for Reconstruction and Development (EBRD) in the investment.

The company, Velt, based in Voronezh, has been manufacturing Philips' 51 cm CRTs under license since 1971. The plant currently produces 1.8 million CRTs annually; the intention is to increase this to more than 3 million within the next four years. In addition, the plant will immediately begin manufacturing glass parts for CRTs, to be assembled at other Philips plants in Europe.

Philips has also invested $25 million for an 85 percent stake in a plant at Kwidzyn in Poland, which will manufacture color televisions and tuner subassemblies. The initial production capacity will be 500,000 color TVs, and 5 million tuner subassemblies annually. The partnership is with Fabryka Telewizorow Brabork, a company which has distributed Philips products in Poland for the past seven years.

The monitor market is booming in line with PC shipments, and as monitor screen sizes increase, CRTs may be diverted from TV production. These are two factors leading to the recent acquisitions and investment in production capacity. The announcements by Philips are interesting for two reasons.

Firstly, by locating the CRT production in Russia, Philips gains all the main ingredients for cost-effective CRT production—cheap energy, cheap labor, and a plentiful supply of water. Philips claims that it can make CRTs in Russia for two-thirds of the cost of manufacturing in Western Europe. The Russian glass parts are destined for plants in Spain and Austria, and the new Polish plant may benefit from the cost-reduced CRTs manufactured in Russia.

By taking control of the Polish and Russian plants, Philips not only gains additional production capacity, but also increases its global reach. The new plants will help to serve the Central and Eastern European and Russian markets, joining plants in Western Europe, the Americas, and Asia/Pacific.

Samsung

Samsung has recently started production of microwave ovens and PC monitors at a new factory on Teesside, England. The large plant is the first stage of Samsung's plans for a major European manufacturing site, with future products including PCs and fax machines. The company also plans to set up a research and development facility in the south of England.

This scale of investment by one of the big Korean multinational companies shows how serious these companies are about manufacturing and selling in Europe. It remains to be seen whether research and development means design for manufacture and adapting products for local markets, or basic product design for local manufacture.

Contract Manufacturing News

D2D

D2D has announced contracts worth $200 million to manufacture digital satellite boxes for Pace, and networking systems for Madge. It has also announced a third contract, of unspecified value, to build Acorn's new A7000 computer.

The contract with Pace Micro Technology is valued at $110 million, for 400,000 units. The boxes are for digital broadcasting using MPEG-2 compression, and are destined for broadcasters (including Star-TV) in the Far East and Australia. When production has ramped up, D2D will manufacture 7,000 units per week, in a turnkey contract where it will procure components, assemble PCBs, and perform system assembly. All work will be carried out at D2D's plant at Kidsgrove, England, a plant which has not traditionally performed system assembly.

The contract with Madge is worth $90 million over two years, and covers networking products, including Token-Ring switches, hubs, bridges and routers. D2D will be Madge's sole CEM partner for European production, and will assemble PCBs at Kidsgrove, prior to system assembly at Ashton-Under-Lyne, England.

Until now D2D, the ICL/Fujitsu subsidiary, has primarily been a manufacturer of data processing equipment. These contracts offer it opportunities to diversify, as well as risks associated with any diversification.

Firstly, there is the Pace contract, which involves producing a high-volume product at a low, ex-factory price of about $275. Consumer products, even recently introduced units, featuring new technology are intrinsically low-margin. This unit is no exception, and because of this, D2D is offering a full "turnkey" service. By taking advantage of ICL's and Fujitsu's purchasing volumes, D2D can spread its gross margin across materials procurement, as well as PCB and system assembly.

Instead of shipping boards to its Ashton plant, D2D will build the Pace boxes at the end of the PCB assembly lines at Kidsgrove, a sensible plan for a low-margin, high-volume product. D2D will have to keep a tight control over materials on this contract, and ensure that production does not fall behind schedule.

The work for Pace appears more tactical than strategic, as the tight margins are unlikely to be paying for investment, and so it is more likely to be using current capacity, rather than promoting growth.

The Madge contract is of more strategic importance to D2D, signalling a move into networking products. Worth less overall ($90 million over two years) than the Pace deal, it is likely to be more profitable. D2D will be using its Ashton site for system assembly; this is a plant geared towards high-mix, lower-volume system production, and is also in discussions about an end-to-end service, which includes shipping to distributors.

The work for Madge is the sort of work most CEMs would jump at. It offers the chance to produce equipment for a growth market, with the opportunity to sell additional services such as distribution, and design for manufacture consultancy. One of the facts that could sour the relationship is Madge's own production facility in Ireland. As the new plant increases production, it could threaten any long-term relationship with D2D.

The Acorn contract has as much to do with Acorn's attempt to restructure its business (and reduce manufacturing costs) as D2D's attempts to widen its customer base. Acorn generally sells into different markets from those of PC OEMs, and the company should benefit from using a CEM with experience in higher-volume, lower-cost PC production.

GSS/Array Technology

GSS/Array Technology, formed by the acquisition of US-based Array Technology by GSS Electronics of Thailand, is to open a European production site in Gwent, Wales. GSS/Array will be investing around $19 million in the Gwent plant, performing both PCB and system assembly, and due to open in November 1995.

GSS/Array manufactures for a variety of customers, including Pace and ATML, in the consumer and industrial sectors, with a certain specialization in high-frequency technologies. The company has already announced that it will be manufacturing video editing equipment for Immix at the Welsh plant.

GSS/Array is responding to the demands of its customers (some of whom are based in Europe, and account for almost a quarter of the company's revenue), for a global manufacturing presence. Many contract manufacturers are now finding that worldwide manufacturing capability is no longer a differentiator, but a requirement in order to bid for business.

Keltek

Keltek, located in Scotland, has announced that it will pay just over $4.5 million for EDMS, a CEM based in the south of England. Keltek's managing director stated that the enlarged group was now targeting "the middle ground" of contract electronics manufacturing, and Keltek has about $8.6 million for further acquisition and investment.

The Keltek acquisition of EDMS is more of a merger than a takeover, with Keltek providing the management and investment focus of a dedicated CEM. In a similar pattern to TT Group's purchase of Race Electronics, Keltek will manage EDMS as a separate business, although the managing director has been replaced.

Both companies are of a similar size, with reasonably diverse customer bases. Keltek's telecommunications customers will complement EDMS' production of data processing equipment. However, the enlarged group remains a relatively small player in the European CEM industry, and "the middle ground" is more likely to be offering niche manufacturing services, rather than high-volume production.

Manufacturing Services Limited

In early 1994, IBM put its manufacturing site in Valencia, Spain up for sale. Then, at the beginning of September this year the company announced that it had sold the plant to Manufacturers Services Limited (MSL), a US-based contract electronics manufacturer.

MSL is a new company (formed in 1994) and has acquired three other plants: one in the United States, a former Ericsson facility in Ireland, and most recently a plant in Singapore. It has plans to open a new US plant before the end of 1995.

The IBM plant has been providing contract manufacturing services since 1993, as well as manufacturing telecommunications, storage and point-of-sale products for IBM.

The IBM/MSL deal is another disposal, by a major OEM, of a manufacturing facility to a CEM. IBM has excess manufacturing capacity, and has created CEM subsidiaries, as well as disposing of plants. Initially, the existing IBM products will continue to be manufactured at the Valencia plant. But in the longer term, it allows IBM the freedom to move production to other IBM production facilities in Europe, or to other CEMs.

MSL is one of a small but growing number of players new to the CEM industry. Facilities acquired from OEMs are likely to have a higher cost base than green-field sites. Profitability and success depend on how the management handles any necessary restructuring.

Race Electronics

The TT Group, parent company of AB Electronics and Welwyn Systems, has purchased Race Electronics, the contract electronics manufacturer which went into receivership in June this year. TT plans to run Race as an independent business, overseen by the managing director of AB Electronics. The purchase value of the business, which had sales of $69 million in 1994, could have been as low as $4.5 million.

There has been minimal investment in new surface-mount assembly equipment at Race over the last few years, and together with recent investment at AB, TT is likely to add new production technology at Race.

TT managed to turn around AB Electronics, which it picked up cheaply in 1993. And with the backing of a financially stronger parent, the Race/TT management has the opportunity to stabilize and grow the business.

However, there is more to success in the CEM business than just following common-sense management guidelines. Size is an increasingly important factor, and TT obviously sees an opportunity to leverage the combined purchasing power of the three CEM companies within the group.

Unfortunately, the three TT companies remain relatively small players on the world stage; as part of a larger conglomerate, they may be subject to further changes of ownership. The CEM sector continues to restructure, and Dataquest sees no end to this situation in the short to medium term.

For More Information...

Robin Daines .... +44 1494 422 722
Internet address .... rdaines@dqeurope.com
Via fax .... +44 1494 422 742

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Market
Analysis

Electronic Equipment Production Monitor

Quarterly Industry Review

Market Trends in European Electronic Equipment Production:
This Quarterly Industry Review looks at production of electronic equipment in Europe during the third-quarter of 1995 (July to September).

Contract Electronics Manufacturing Report

This review contains a major report, based on a survey of European contract manufacturers, assessing the size of the market, identifying the leading contract manufacturers and their services, along with trends in the market.

Introduction

Contract electronics manufacturers (CEMs) are an accepted, and growing, part of the electronic equipment production industry in 1995, due to the continuing growth in unit production of electronic equipment, and the trend of OEMs to outsource their manufacturing activities. This report, based on a survey carried out in Europe, covers:

- Reasons why original equipment manufacturers (OEMs) use CEMs
- The size of the European market for CEM services
- The leading CEMs in Europe
- Services offered by CEMs and a CEM cost model
- CEM procurement trends

The transition from OEMs carrying out their own equipment manufacture to outsourcing it to CEMs is governed by the now familiar make-or-buy decision. With current management doctrine emphasizing "do what you do best, and outsource the rest," there is more pressure than ever for OEMs to discontinue their in-house manufacturing, and pass it to CEMs.

Dataquest

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Filing: Market Analysis

The value of manufactured equipment continues to fall in proportion to the value of the intellectual property in the product and the cost of the channel. Because of this, more and more OEMs will seek to minimize the cost of equipment production, and add value at other stages of the design-through-supply chain.

In the past, many items of electronic equipment had a three- or four-year lifetime and were redesigned almost from scratch at the end of their life. Now, in order for OEMs to stay ahead of the competition, they are constantly developing and enhancing existing products, and focusing on the marketing of these sometimes minor improvements. This means that the manufacturing process has changed from producing a stable product for long periods of time, to implementing frequent engineering changes on shorter production runs of subtly different products. It is the management of this flexibility, which CEMs offer, that allows OEMs to concentrate on design and marketing.

Methodology

This report is based on a survey of European CEMs. A list of the CEMs that responded to our survey is contained in Table 1. Where necessary, survey data have been supplemented by information from other Dataquest publications and surveys, as well as information from the public domain and industry sources.

Definitions

Dataquest defines a contract electronics manufacturer as a company or division of a company that provides electronics manufacturing, design or other services to the market. CEM work predominantly (but not exclusively) includes printed circuit board assembly (PCA), system assembly, and component procurement.

Product Sectors

This section defines the product sectors used in this report. Dataquest's objective is to provide relevant data about the electronic equipment manufacturing industry, and component applications markets. For forecasting purposes, Dataquest segments the electronics industry into six broad product sectors, these six sectors are defined by the narrower product sectors they represent:

- **Electronic Data Processing**
  - Computers
  - Data storage
  - Input/output devices
  - Dedicated systems
- **Communications**
  - Premise telecoms
  - Public telecoms
  - Mobile/radio communications equipment
  - Other communications
  - Broadcast and studio equipment
- **Industrial**
  - Security and energy management systems
  - Manufacturing and instrumentation systems
  - Robot systems

Table 1
Respondents to CEM Survey

Company	Location	Country
AB Electronic Assemblies	Newport	UK
AB Mikroelektronik GmbH	Salzburg	Austria
ACW Technology	Petersfield	UK
Avex Electronics Ltd	East Kilbride	UK
Brother Industries (IRL) Ltd	Drogheda	Ireland
Celab Ltd	Bordon	UK
Chase Advanced Technology Ltd	Bradford	UK
DDL Electronics Ltd	Craigavon	UK
Design to Distribution Ltd	Stoke-on-Trent	UK
Dovatron Ireland	Cork	Ireland
EDMS Ltd	Maldon	UK
Evic Electronics	Echt	Netherlands
GEC Alsthom Electronic Service	Stafford	UK
GSPK Electronics Ltd	Knaresborough	UK
Genrad Manufacturing	Stockport	UK
Hosiden Besson Limited	Hove	UK
Hughes Microelectronics Europe	Glenrothes	UK
Jabil Circuit	Livingston	UK
Karavale Enterprises Ltd	Welwyn Garden City	UK
Kemitron Manufacturing	Deeside	UK
Kyrel Oy	Kyroskoski	Finland
Lucas Electronics	Birmingham	UK
Manufacturers Services Ltd	Athlone	Ireland
Mion Electronics	Wombwell	UK
Quantum Electronics Manufacturing	Pontsewett	UK
SPA Superior Print Assembly BV	Almelo	Netherlands
Securicor Electronics Ltd	Bath	UK
Solectron	Fife	UK
Solectron France S.A	Cestas Cedex	France
Surtech Interconnection	Basingstoke	UK
Welwyn Systems Ltd	Blyth	UK

Source: Dataquest (October 1995)

- Medical equipment
- Other industrial equipment

- **Consumer**
  - Audio
  - Video
  - Personal electronics
  - Appliances
- **Military and Civil Aerospace**
  - Transportation

Component Sectors

- **Semiconductor components**: Includes memory, microprocessors, microcontrollers, microperipherals, logic, ASICs, analog semiconductors, discrete semiconductors (diodes, transistors, and so on), optoelectronic semiconductor components (LEDs, opto-isolators, and so on), LCD display devices
- **Other components**: Includes batteries, cables, capacitors, connectors, crystals, fans, filters, fuses/protection, inductors, keypads/keyboards, microphones, oscillators, PCBs, resistors, sockets, speakers/sounders, switches, transformers, others

History

In the United States, CEMs grew up around the defense and space industries from the 1960s onwards. During the 1970s, CEMs started to diversify (to try to counter cyclical defense spending), by taking on one-off "jobs" for commercial OEMs. This "job-shop" mentality continued into the 1980s, but was being tempered by the rapid growth of the major CEM players, and the long-term strategies they were developing.

In Europe, the situation differed because the defense spending was placed with well-established, national companies which had their own manufacturing capabilities. There were few start-up companies requiring significant manufacturing capacity, and no European equivalent with NASA's budget.

During the 1980s, the proliferation of OEMs of electronic equipment in Scotland and Ireland (located in these regions for financial and other reasons) spawned a secondary industry of contract manufacturers. Many of these companies (and others located in the United Kingdom and in continental Europe) continued to serve a few major customers which were located nearby.

When the big US-based CEMs started to follow their major PC OEM customers, and invested in European plants (either by taking over existing facilities or by opening "greenfield" sites), the European CEM industry discovered that it was part of a global switch to outsourced manufacturing.

As the industry has matured in the 1990s, a few US-headquartered companies dominate the market worldwide. Europe-headquartered CEMs, with a few exceptions, tend to be smaller players focused on local customers and markets.

Why OEMs Choose to Outsource

Advantages of Using a CEM

The reasons most often cited for using a CEM are as follows (in order of importance):

- Lower total cost of materials. This includes materials management, vendor assessment and approval, just-in-time (JIT) delivery and quality control
- High level of service
- Manufacturing expertise
- Additional manufacturing capacity
- Ease of doing business

Disadvantages of Using a CEM

Paradoxically, many of the reasons for using a CEM are also given as reasons not to use one. These include:

- The cost of doing business with a CEM
- Loss of control over equipment production
- Production-cycle times too long, or inflexible

Reasons for Using a CEM

Essentially, the CEM removes the "hassle" in manufacturing electronic equipment—a complex task requiring a high level of experience and expertise. The advantage of additional manufacturing capacity has two benefits: firstly, it offers a degree of flexibility when demand rises in the short to medium term; and it also removes the need for costly capital investment.

Surface mount (SMT) assembly equipment is costly to capitalize and may have to be upgraded (or replaced) at regular intervals in order to maintain production capability. It can also be expensive to run, due to direct labor costs and the cost of equipment support.

CEMs can offer genuine cost savings to the OEM. They ensure that the use of manufacturing capacity is well planned, which ensures that capital equipment is fully utilized. And their large-scale component procurement offers scope for reduced material costs.

Market Size and Forecast

Reasons for Market Growth

European, and global, CEM growth (and the demand for CEM services) has been strengthened by two main factors:

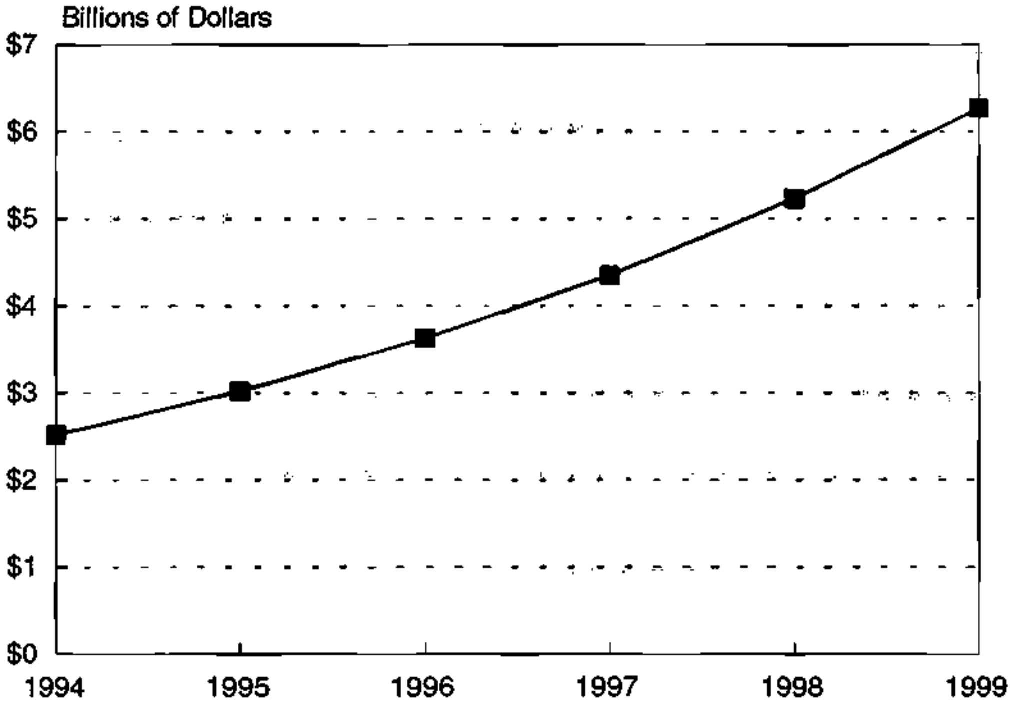
- The continuing growth in unit production of electronic equipment, due to the increasing demand for existing and emerging products. In Europe, equipment production revenue is forecast to grow with a compound annual growth rate (CAGR) of 6 percent.
- The continuing trend of OEMs to outsource their manufacturing activities.

In 1994, the total value of electronic equipment production in Europe was $156 billion (measured by factory sales revenue). European OEMs outsourced manufacturing services worth about 1.6 percent of total production; this is forecast to rise to 4.0 percent by 1999.

Factory sales revenue for European CEMs was $2.52 billion in 1994, and this is forecast to rise to $6.27 billion in 1999. Figure 1 shows the revenue generated by European CEMs from manufacturing services.

Table 2 shows factory sales revenue for manufacturing services, generated by European CEMs. CEM factory sales revenue is forecast to grow with a CAGR of 20 percent from 1994 to 1999.

Figure 1
European CEM Services
Factory Sales Revenue, History and Forecast



Source: Dataquest (October 1995 Estimates), Technology Forecasters

Table 2
European CEM Services
Factory Sales Revenues, History and Forecast
(Billions of Dollars)

Year	Revenue ($B)
1994	2.52
1995	3.02
1996	3.63
1997	4.35
1998	5.23
1999	6.27
CAGR 1994-1999	20%

Source: Dataquest (October 1995 Estimates), Technology Forecasters

European Market Share

The European market for CEM services is served by a variety of companies. These range from several companies with a turnover in excess of $200 million, to a myriad of smaller companies, many of which serve niche markets. In this report we have only included companies whose primary business is the provision of CEM services. For companies which have worldwide production sites, we have only included revenue generated from European production. Table 3 shows Europe's top 15 CEMs ranked by 1994 factory sales revenue.

Many of the large CEMs in the United Kingdom, Ireland and France are in fact plants owned by US-based CEMs. The United Kingdom and Ireland, in particular, have experienced rationalization in the CEM sector. This has included Flextronics International's purchase of Assembly and Automation, TT Group's acquisition of Race (to complement AB Electronics and Welwyn Systems), and Keltek's recent purchase of EDMS.

This has taken place alongside acquisitions by CEMs of OEM manufacturing plants, including SCI and Solectron taking over Hewlett-Packard plants in France, and the recent purchase by Ogden (a US-based CEM) of Logitech's plant in Ireland.

This has led to fewer players, with larger revenues and multiple production facilities. However, in much of continental Europe the picture is very different. Outsourcing has not occurred to the same extent as it has in the United Kingdom and Ireland, and it may be some years before there are sizeable CEMs in many European countries.

Production Share by Application Sector

Figure 2 shows how 1994 factory sales revenue is split by application sector. Just under 50 percent of revenue is from the EDP sector. Most of this revenue is derived from manufacturing PCs. The PC is a high-volume commodity product, and is an ideal candidate for outsourcing to CEMs.

Another 30 percent of revenue is derived from communications products. This reflects the explosive growth in communications equipment production, which may have exceeded OEMs' in-house manufacturing capacity.

Many CEMs report revenue growth in the sectors which currently dominate their business. Although some are trying to reduce their dependence on particular product sectors, they are attempting to achieve this by increasing alternative business, rather than reduce their existing business.

CEMs with a diverse customer base are seeing a decline in industrial and military/aerospace work. However, more focused CEMs that currently derive a significant amount of revenue from these areas are reporting growth in these sectors.

CEM Services

Scope of CEM Services

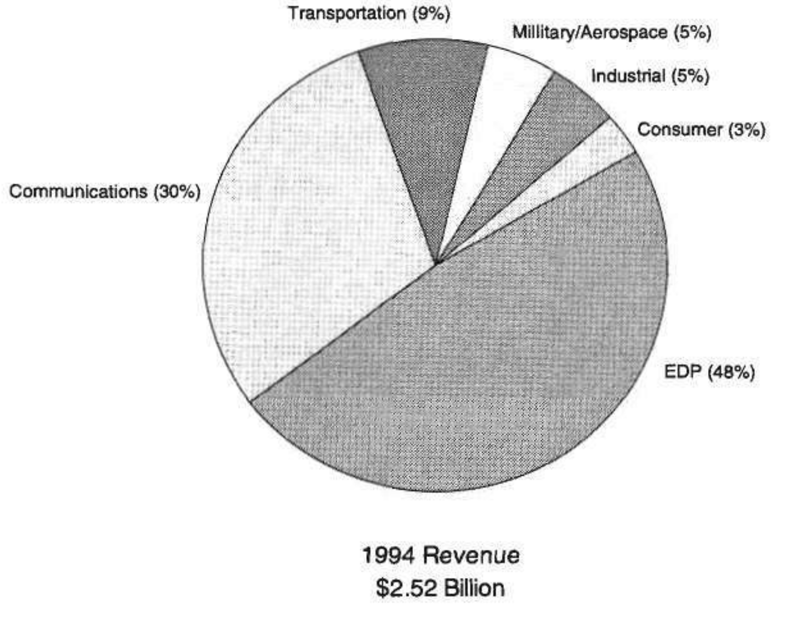
In the past, CEMs provided a PCA service to their OEM customers. In many cases this business was then augmented by system assembly. However, in addition to manufacturing, design and logistics services, most CEMs will now purchase components for their customers, in order to offer a "turnkey" service.

Table 3
Top 15 European CEMs
Ranked by 1994 Factory Sales Revenue

Rank	Company	Country
1	Solectron Corporation (Europe)	France/UK
2	SCI Systems (Europe)	France/Ireland/UK
3	Kyrel Oy	Finland
4	Design to Distribution	UK
5	Jabil Circuit (Europe)	UK
6	Avex Electronics (Europe)	UK
7	AB Electronic Assemblies	UK
8	Welwyn Systems	UK
9	Race Electronics	UK
10	Hughes Microelectronics Europa	UK/Spain
11	Dovatron (Europe)	Ireland
12	Assembly & Automation	UK
13	Keltek Electronics	UK
14	EDMS	UK
15	SM2E Electronique	France

Source: Dataquest (October 1995 Estimates)

Figure 2
European CEM Services by Application Sector
Ranked by 1994 Factory Sales Revenue



Source: Dataquest (October 1995 Estimates)

When contract manufacturing was in its infancy, OEMs would supply components free of charge (free issue), or charge them at cost to the CEM (consignment). This was done for several reasons: because the OEM had greater buying power than the CEM, and could obtain the components at lower cost; or because the component manufacturer would only supply to the OEM due to component warranty issues; or because there was a restricted supply of particular components. In many cases, though, CEMs now have greater purchasing power than their OEM customers, and component warranty has ceased to be a major issue.

By offering additional (and complementary) services, CEMs can increase their revenue and profitability. In turn, OEMs can benefit by outsourcing more of their production activities.

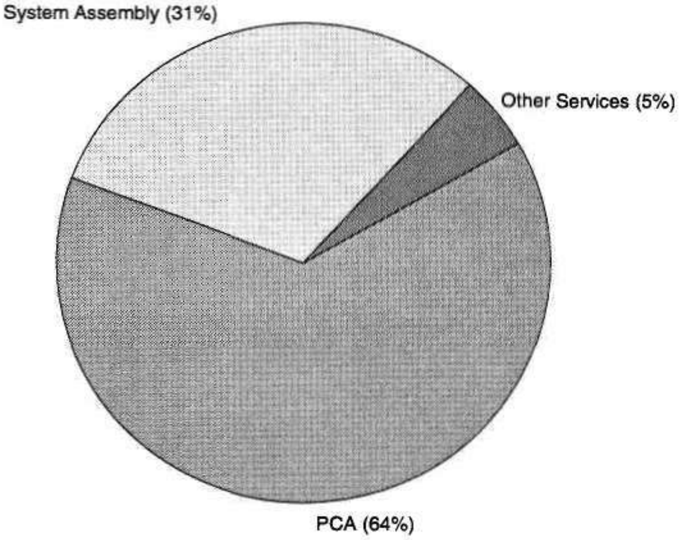
European CEMs still derive most of their revenue from PCA services. Figure 3 shows the split between PCA, system assembly and "other services." These other services include design for manufacture, product distribution, electromagnetic compatibility (EMC) testing, and full product design.

European CEMs report significant growth in both PCA and system assembly work, and a smaller increase in other work. Much of the growth over the last few years has been in PCB assembly capacity. As CEMs win PCA business to fill the new capacity, they then attempt to increase revenue by bidding for additional system assembly work.

CEM Cost Model

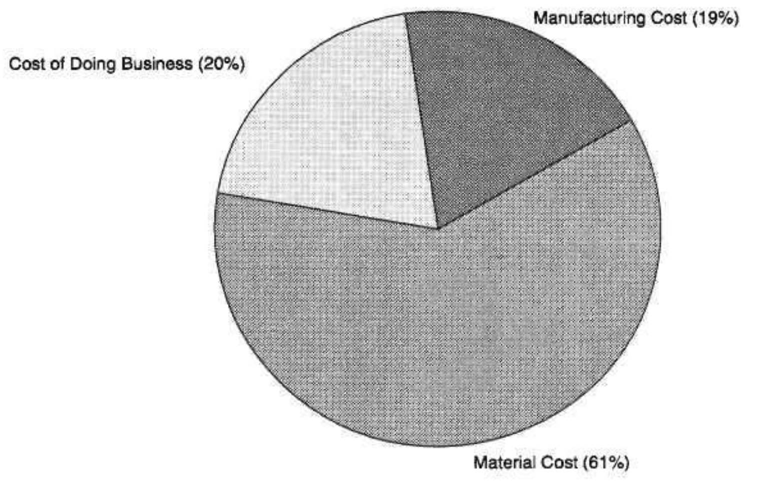
As various items of electronic equipment cease to be differentiated by proprietary intellectual property, and become commodity products which are predominantly sold on a cost per function basis, it is essential that the manufactured goods are as cost-effective as possible.

Figure 3
European CEM Services
Ranked by 1994 Factory Sales Revenue



Source: Dataquest (October 1995 Estimates)

Figure 4
CEM Cost Model



Source: Dataquest (October 1995 Estimates)

One of the major benefits of using a CEM is the lower cost of manufactured equipment. The CEM should be able to manufacture equipment more cost-effectively than an OEM, which is likely to have higher manufacturing costs for historic, or other, reasons. However, a significant part of the total cost of CEM-produced equipment is the "cost of doing business." This includes receiving, inventory and shipping costs, as well as the cost of managing the CEM.

The cost of doing business must be offset by cost savings due to material procurement and management, and lower direct manufacturing costs. Figure 4 shows the cost model for a typical CEM. The percentage split will vary among CEMs, depending on their product mix, the value of the material content, and how good their partnership is with their OEM customers.

Procurement Trends

A global procurement service means that CEMs can buy parts at favorable prices, as well as ensuring that their component supply is not interrupted. A global presence also helps CEMs understand local markets, both from a purchasing stance, and from the point of view of their customers.

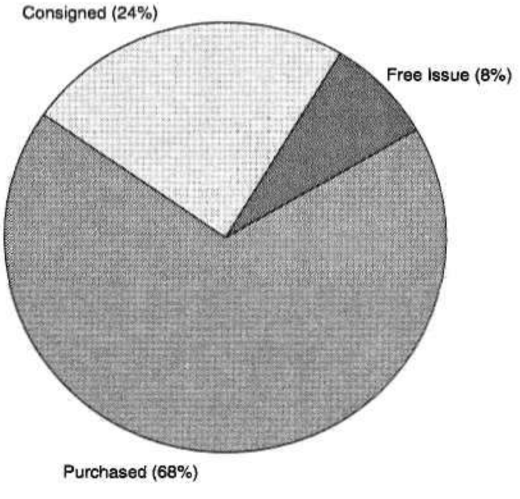
Value of Purchased Components

In 1994, the total value of semiconductors purchased was $896 million; this was 4.3 percent of the total European semiconductor market of $20.8 billion. The value of other components was $340 million (see earlier definitions). The ratio of semiconductors to other components varies between CEMs, depending on production levels of semiconductor-hungry applications such as PCs.

Component Sourcing

Most components are now purchased by the CEM on behalf of their OEM customers. In 1994, 68 percent (by value) of components were purchased,

Figure 5
1994 CEM Component Procurement (by Value)



Source: Dataquest (October 1995 Estimates)

24 percent were consigned (charged at cost by the OEM), and 8 percent were supplied at no charge (by the OEM). Figure 5 shows 1994 component procurement, by value.

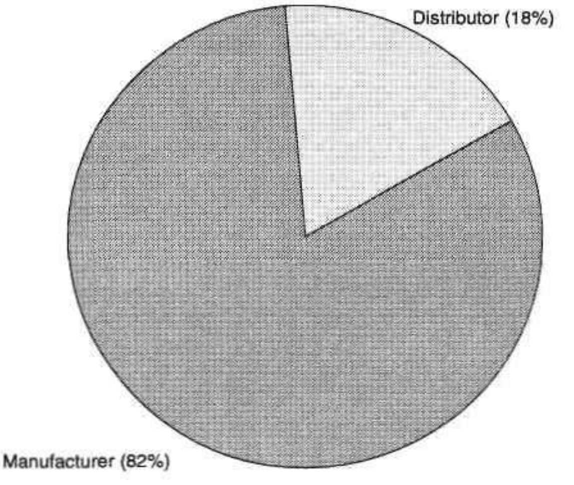
Over 90 percent of those who responded to our survey reported growth in purchased value, and 33 percent reported growth in the value of free-issue parts. About 15 percent reported growth in the value of consigned parts. These trends were not related to the size (measured by factory sales) of a CEM.

Component Suppliers

The majority of components (by value) are purchased from component manufacturers, rather than component distributors. However, this is related to the size of the CEM (measured by factory sales). Generally, CEMs with sales of more than $50 million will purchase at least 70 percent (by value) from component manufacturers. CEMs with sales less than $50 million, generally purchase the majority of their components from distributors. Figure 6 shows CEM component suppliers, by value.

Just over 70 percent of those who responded to our survey reported growth in component supplier value, and 58 percent reported growth in the value of distributor supplied parts. These trends were not related to the size (measured by factory sales) of a CEM.

Figure 6
CEM Component Supplier (by 1994 Value)



Source: Dataquest (October 1995 Estimates)

Dataquest Perspective

In addition to the overall growth in equipment production, these are the reasons why the CEM industry is growing:

- OEMs outsourcing part of their production (for capacity reasons, or for other reasons), in order to reduce the total cost of manufacturing electronic equipment
- OEMs using CEMs to manufacture equipment until it becomes cost-effective to invest in their own manufacturing capabilities
- OEMs choosing not to manufacture, either because they cannot justify manufacturing capacity, or do not see manufacturing as a strategic part of their business

While some of the newer single-product companies (such as the dedicated PC manufacturers) will build up in-house manufacturing capacity, many companies will continue to outsource. Many smaller companies will initially use CEMs, and as they grow will decide whether to add in-house capacity.

There is a continuing trend towards a handful of large, global CEM players—CEMs with a turnover of several billion dollars, worldwide production facilities and significant purchasing power. Only CEMs of this size, which can invest in sophisticated production technology and force down material costs, will be able to provide OEMs with the low-cost, high-volume products they demand.

There will be continued restructuring in the United Kingdom, Ireland and continental Europe, as larger players emerge. However, smaller players will continue to provide manufacturing services to various niches within the market, predominantly for low-volume, higher-value equipment.

OEM News

AT&T Network Systems

AT&T Network Systems is acquiring parts of Philips Communications Systems dealing with wide area networking technologies. Philips' desire to concentrate on the personal communications market has led to the disposal of businesses including Philips Kommunications Industrie, based in Germany, and manufacturing facilities in Rouen, France, producing transmission equipment, and Nürnberg, Germany which manufactures digital cellular base stations.

As with many of the announcements reported in this review, this benefits both parties in different ways. Philips continues to divest itself of peripheral businesses that it does not consider essential for future growth. This can generate cash, reduce debt, or eliminate costly investment. Philips had reached a point where it needed to make significant investment in the network systems business, and it chose to concentrate on personal technologies such as cellular and cordless telephones, faxes and smart cards.

AT&T strengthens its product portfolio, and also has a chance to gain market share in Europe, to help reduce its dependence on the US market. Although AT&T Network Systems has some European production capacity, gaining the two Philips plants should provide it with more than enough capacity to manufacture for the deregulating European telecoms market.

Canon

Canon has announced a $15.5 million investment to expand its manufacturing plant at Glenrothes, Scotland. The investment relates to Canon's plans to produce bubble jet printers from 1996 onwards, for sale in European markets. Output is forecast to reach 50,000 units per month by the end of 1996, with capacity for 100,000 per month in 1997.

The Glenrothes expansion was initially to provide assembly capacity for copiers. However, the decline in the copier market and increased competition in the ink jet printer market have forced Canon's hand. The company is losing market share in the European ink jet market, and local manufacture means it can deliver products faster to customers, with reduced freight costs.

Exabyte

After only a year, Exabyte is expanding its manufacturing and service site at Falkirk, Scotland. The facility also provides warehousing, and is a hub in Exabyte's European distribution network.

Exabyte's focus on tape storage devices has led to a significant customer base of European companies, as well as US-based companies which ship Exabyte products into Europe. Because customers frequently change their volume and technology requirements (and request customized configurations), Exabyte must be located as close as possible to the customers in order to reduce obsolescence in the supply chain.

Filtronic Comtek

Filtronic Comtek, which manufactures cellular base stations and is based in Shipley, England, has invested in a new manufacturing plant in Shipley, due to be completed in February 1996. It is also investing in its existing facility at

Stewarton, Scotland, which manufactures radio frequency components for base stations, and will also have design capability from now on.

Filtronic is using growth from cellular communications to invest in future manufacturing and design capability. As well as increasing its manufacturing capacity, it has plans to design and manufacture more of the components and subassemblies it uses. Long-term growth is coming from its support for GSM, PCN and PCS standards, as well as developing wireless local loop solutions with several other manufacturers.

Graseby Microsystems

Graseby Microsystems has agreed to acquire GEC Plessey's hybrids business (based in Lincoln, England), and will relocate equipment as well as a number of staff to its hybrid facility in Newmarket, England.

Graseby has been profitable in the hybrids business, but has found it necessary to increase market share and gain intellectual property via acquisition. GEC Plessey and Graseby have been collaborating in the manufacture of hybrids for some time, prior to GEC Plessey's divestiture of its hybrids business as part of a rationalization of the markets it operates in.

IBM

As well as selling a plant in Spain to contract manufacturer MSL (see other story), IBM has announced that it is selling its German STP subsidiary to Mayer & Cie. STP, based in Sindelfingen, manufactures bare PCBs for IBM and other companies. Mayer & Cie performs PCB surface-mount assembly, and manufactures for both IBM and other companies.

This deal should benefit both parties. IBM divests itself of yet another costly manufacturing site, but presumably with the proviso that Mayer & Cie will continue to supply high-technology PCBs. Meanwhile, Mayer & Cie vertically integrates its assembly business with one of its key suppliers (of high-technology interconnect), and gains some high-value business from IBM.

Järfälla

After announcing its intentions, back in March, to invest $11 million in Järfälla ICC (a Swedish printer company, formerly owned by IBM), Amstrad has pulled out of the deal. Instead, the plant is going to the Dallas, Texas–based company Nu-Kote Holding Inc. Nu-Kote plans to develop products in collaboration with OEMs, in most cases by licensing the piezo-electric print head technology. There is a possibility that Amstrad may opt for a licensing arrangement.

It took Canon and Hewlett-Packard almost 10 years to translate patented printer technology into a marketable product, and then several years before those products took off in the marketplace.

Amstrad was looking for a printer company which it could buy, in order to offer bundled deals with its new line of direct-sale PCs. Unfortunately, Järfälla was not that company. The print head technology offers long life, without sacrificing print quality. However, as a competitor to the market leaders, in terms of price and performance, it is likely to be several years away. In the meantime, the technology requires significant funding for technical development, which Amstrad is not prepared to pay for.

Nokia

Nokia Monitors has acquired the assets of a monitor production facility in Hungary. The plant was purchased from Hantarex SpA, an Italian company. The new company, Nokia Monitor Magyarorszag, is due to start manufacturing during the first quarter of 1996, with an initial capacity of 500,000 units annually. Nokia's existing monitor plant is in Salo, Finland.

The worldwide shortage of cathode ray tubes (CRTs) and monitors is encouraging many integrated electronics companies to invest in manufacturing capacity. The Hungarian plant will manufacture 38 cm monitors, predominantly for the worldwide PC market, although some will be used by Nokia's revitalized consumer electronics division.

Philips

Philips Display Components (PDC), part of Philips Electronics, is investing $48 million in a Russian CRT manufacturer. Philips has purchased a controlling interest, and is keen to involve the European Bank for Reconstruction and Development (EBRD) in the investment.

The company, Velt, based in Voronezh, has been manufacturing Philips' 51 cm CRTs under license since 1971. The plant currently produces 1.8 million CRTs annually; the intention is to increase this to more than 3 million within the next four years. In addition, the plant will immediately begin manufacturing glass parts for CRTs, to be assembled at other Philips plants in Europe.

Philips has also invested $25 million for an 85 percent stake in a plant at Kwidzyn in Poland, which will manufacture color televisions and tuner subassemblies. The initial production capacity will be 500,000 color TVs, and 5 million tuner subassemblies annually. The partnership is with Fabryka Telewizorow Brabork, a company which has distributed Philips products in Poland for the past seven years.

The monitor market is booming in line with PC shipments, and as monitor screen sizes increase, CRTs may be diverted from TV production. These are two factors leading to the recent acquisitions and investment in production capacity. The announcements by Philips are interesting for two reasons.

Firstly, by locating the CRT production in Russia, Philips gains all the main ingredients for cost-effective CRT production—cheap energy, cheap labor, and a plentiful supply of water. Philips claims that it can make CRTs in Russia for two-thirds of the cost of manufacturing in Western Europe. The Russian glass parts are destined for plants in Spain and Austria, and the new Polish plant may benefit from the cost-reduced CRTs manufactured in Russia.

By taking control of the Polish and Russian plants, Philips not only gains additional production capacity, but also increases its global reach. The new plants will help to serve the Central and Eastern European and Russian markets, joining plants in Western Europe, the Americas, and Asia/Pacific.

Samsung

Samsung has recently started production of microwave ovens and PC monitors at a new factory on Teesside, England. The large plant is the first stage of Samsung's plans for a major European manufacturing site, with future products including PCs and fax machines. The company also plans to set up a research and development facility in the south of England.

This scale of investment by one of the big Korean multinational companies shows how serious these companies are about manufacturing and selling in Europe. It remains to be seen whether research and development means design for manufacture and adapting products for local markets, or basic product design for local manufacture.

Contract Manufacturing News

D2D

D2D has announced contracts worth $200 million to manufacture digital satellite boxes for Pace, and networking systems for Madge. It has also announced a third contract, of unspecified value, to build Acorn's new A7000 computer.

The contract with Pace Micro Technology is valued at $110 million, for 400,000 units. The boxes are for digital broadcasting using MPEG-2 compression, and are destined for broadcasters (including Star-TV) in the Far East and Australia. When production has ramped up, D2D will manufacture 7,000 units per week, in a turnkey contract where it will procure components, assemble PCBs, and perform system assembly. All work will be carried out at D2D's plant at Kidsgrove, England, a plant which has not traditionally performed system assembly.

The contract with Madge is worth $90 million over two years, and covers networking products, including Token-Ring switches, hubs, bridges and routers. D2D will be Madge's sole CEM partner for European production, and will assemble PCBs at Kidsgrove, prior to system assembly at Ashton-Under-Lyne, England.

Until now D2D, the ICL/Fujitsu subsidiary, has primarily been a manufacturer of data processing equipment. These contracts offer it opportunities to diversify, as well as risks associated with any diversification.

Firstly, there is the Pace contract, which involves producing a high-volume product at a low, ex-factory price of about $275. Consumer products, even recently introduced units, featuring new technology are intrinsically low-margin. This unit is no exception, and because of this, D2D is offering a full "turnkey" service. By taking advantage of ICL's and Fujitsu's purchasing volumes, D2D can spread its gross margin across materials procurement, as well as PCB and system assembly.

Instead of shipping boards to its Ashton plant, D2D will build the Pace boxes at the end of the PCB assembly lines at Kidsgrove, a sensible plan for a low-margin, high-volume product. D2D will have to keep a tight control over materials on this contract, and ensure that production does not fall behind schedule.

The work for Pace appears more tactical than strategic, as the tight margins are unlikely to be paying for investment, and so it is more likely to be using current capacity, rather than promoting growth.

The Madge contract is of more strategic importance to D2D, signalling a move into networking products. Worth less overall ($90 million over two years) than the Pace deal, it is likely to be more profitable. D2D will be using its Ashton site for system assembly; this is a plant geared towards high-mix, lower-volume system production, and is also in discussions about an end-to-end service, which includes shipping to distributors.

The work for Madge is the sort of work most CEMs would jump at. It offers the chance to produce equipment for a growth market, with the opportunity to sell additional services such as distribution, and design for manufacture consultancy. One of the facts that could sour the relationship is Madge's own production facility in Ireland. As the new plant increases production, it could threaten any long-term relationship with D2D.

The Acorn contract has as much to do with Acorn's attempt to restructure its business (and reduce manufacturing costs) as D2D's attempts to widen its customer base. Acorn generally sells into different markets from those of PC OEMs, and the company should benefit from using a CEM with experience in higher-volume, lower-cost PC production.

GSS/Array Technology

GSS/Array Technology, formed by the acquisition of US-based Array Technology by GSS Electronics of Thailand, is to open a European production site in Gwent, Wales. GSS/Array will be investing around $19 million in the Gwent plant, performing both PCB and system assembly, and due to open in November 1995.

GSS/Array manufactures for a variety of customers, including Pace and ATML, in the consumer and industrial sectors, with a certain specialization in high-frequency technologies. The company has already announced that it will be manufacturing video editing equipment for Immix at the Welsh plant.

GSS/Array is responding to the demands of its customers (some of whom are based in Europe, and account for almost a quarter of the company's revenue), for a global manufacturing presence. Many contract manufacturers are now finding that worldwide manufacturing capability is no longer a differentiator, but a requirement in order to bid for business.

Keltek

Keltek, located in Scotland, has announced that it will pay just over $4.5 million for EDMS, a CEM based in the south of England. Keltek's managing director stated that the enlarged group was now targeting "the middle ground" of contract electronics manufacturing, and Keltek has about $8.6 million for further acquisition and investment.

The Keltek acquisition of EDMS is more of a merger than a takeover, with Keltek providing the management and investment focus of a dedicated CEM. In a similar pattern to TT Group's purchase of Race Electronics, Keltek will manage EDMS as a separate business, although the managing director has been replaced.

Both companies are of a similar size, with reasonably diverse customer bases. Keltek's telecommunications customers will complement EDMS' production of data processing equipment. However, the enlarged group remains a relatively small player in the European CEM industry, and "the middle ground" is more likely to be offering niche manufacturing services, rather than high-volume production.

Manufacturing Services Limited

In early 1994, IBM put its manufacturing site in Valencia, Spain up for sale. Then, at the beginning of September this year the company announced that it had sold the plant to Manufacturers Services Limited (MSL), a US-based contract electronics manufacturer.

MSL is a new company (formed in 1994) and has acquired three other plants: one in the United States, a former Ericsson facility in Ireland, and most recently a plant in Singapore. It has plans to open a new US plant before the end of 1995.

The IBM plant has been providing contract manufacturing services since 1993, as well as manufacturing telecommunications, storage and point-of-sale products for IBM.

The IBM/MSL deal is another disposal, by a major OEM, of a manufacturing facility to a CEM. IBM has excess manufacturing capacity, and has created CEM subsidiaries, as well as disposing of plants. Initially, the existing IBM products will continue to be manufactured at the Valencia plant. But in the longer term, it allows IBM the freedom to move production to other IBM production facilities in Europe, or to other CEMs.

MSL is one of a small but growing number of players new to the CEM industry. Facilities acquired from OEMs are likely to have a higher cost base than green-field sites. Profitability and success depend on how the management handles any necessary restructuring.

Race Electronics

The TT Group, parent company of AB Electronics and Welwyn Systems, has purchased Race Electronics, the contract electronics manufacturer which went into receivership in June this year. TT plans to run Race as an independent business, overseen by the managing director of AB Electronics. The purchase value of the business, which had sales of $69 million in 1994, could have been as low as $4.5 million.

There has been minimal investment in new surface-mount assembly equipment at Race over the last few years, and together with recent investment at AB, TT is likely to add new production technology at Race.

TT managed to turn around AB Electronics, which it picked up cheaply in 1993. And with the backing of a financially stronger parent, the Race/TT management has the opportunity to stabilize and grow the business.

However, there is more to success in the CEM business than just following common-sense management guidelines. Size is an increasingly important factor, and TT obviously sees an opportunity to leverage the combined purchasing power of the three CEM companies within the group.

Unfortunately, the three TT companies remain relatively small players on the world stage; as part of a larger conglomerate, they may be subject to further changes of ownership. The CEM sector continues to restructure, and Dataquest sees no end to this situation in the short to medium term.

For More Information...

Robin Daines .... +44 1494 422 722
Internet address .... rdaines@dqeurope.com
Via fax .... +44 1494 422 742

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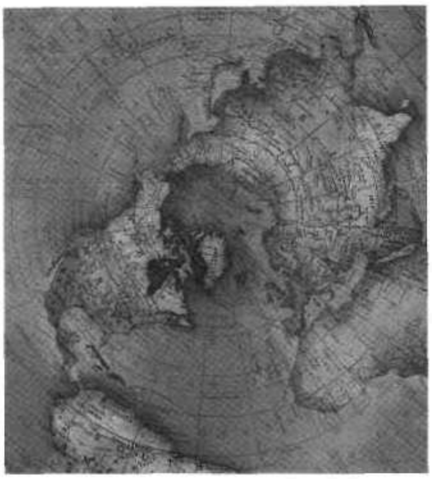

Dataquest

1995 High-Volume Electronic Equipment Unit Production Forecast—Europe

Market Statistics

1995

Program: Electronic Equipment Production Monitor
Product Code: SAPM-EU-MS-9501
Publication Date: October 20, 1995
Filing: Market Analysis

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For More Information...

Mike Williams .... +44 1494 422 722
Internet address .... mwilliams@dqeurope.com
Via fax .... +44 1494 422 742

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Chapter 1

Introduction and Definitions

Introduction

This Market Statistics report represents our first forecast for European electronic systems by value, unit volume, and market forecast. Dataquest has selected 22 key application systems that have high-volume production worldwide. These key systems are identified by Dataquest as being leading indicators of electronic component 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.

The 22 leading indicators selected by Dataquest are as follows:

- Electronic Data Processing:
  - Personal computers
  - 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 line cards
  - Cellular telephones
  - Pagers
- Consumer:
  - Personal/portable stereos
  - Color televisions
  - Videocassette recorders (VCRs)
  - Camcorders
  - Set-top boxes
- Automotive:
  - Auto stereos
  - Engine control units

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

The report contains tables detailing the spring 1995 electronics equipment production forecast. European production is estimated for the years 1994 to 1999. Production tables contain both historical data and forecasts. In most tables, historical data begin with 1994, while forecast data provide estimates for 1995 through 1999. 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; thus, we maintain exchange rates at constant 1994 calendar year. This prevents any inconsistencies in the conversion of growth projections and currency fluctuations. The 1994 exchange rate estimate uses actual average monthly exchange rates from January through December (these data are gathered and supplied by the Dun & Bradstreet Corporation). The annual rate is estimated as the arithmetic mean of the 12 monthly rates. Exchange rates are provided in Table 1-1 for your reference. Exchange rates for historical years are available on request.

Table 1-1
1994 Exchange Rates Table

	Foreign Currency per US Dollar	US Dollar per Foreign Currency
Austria (Schilling)	11.40	0.08784
Belgium (Franc)	33.36	0.03003
Denmark (Krone)	6.35	0.15772
ECU	0.84	1.18691
Finland (Markka)	5.21	0.19278
France (Franc)	5.54	0.18090
Germany (Mark)	1.62	0.61828
Greece (Drachma)	242.06	0.00413
Ireland (Punt)	0.67	1.50115
Italy (Lira)	1609.34	0.00062
Netherlands (Gulden)	1.82	0.55137
Norway (Krone)	7.04	0.14218
Portugal (Escudo)	165.63	0.00605
Spain (Peseta)	133.48	0.00750
Sweden (Krona)	7.70	0.13004
Switzerland (Franc)	1.37	0.73356
United Kingdom (Pound)	0.65	1.53068

Source: Dun & Bradstreet, Dataquest (October 1995)

Definitions

Regional Definitions

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

Line Item Definitions

The objective of analysing electronic systems production is to estimate its important implications for component 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 purposes of this report Dataquest defines factory revenue as the derived production revenue—from the factory value.

The equipment production data presented here are used in conjunction with estimated average component 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 component procurement, their captive production, and their relationships to the equipment or divisions in which the devices are used.

Data Sources

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

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

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

Forecast Methodology

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

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

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

Because the time series data contained in this document 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 judgements, expert opinions, and subjective probabilities) or technological models (that is, curve fitting and the use of analogous data).

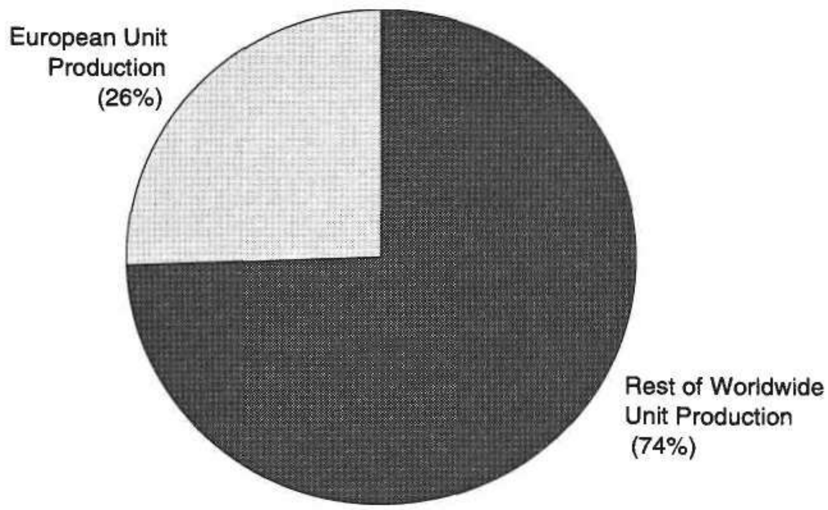
Chapter 2
Electronic Data Processing

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
PCs							
Units (K)	13,000	16,300	18,400	21,500	24,700	28,300	16.8%
Factory ASP ($)	1,502	1,552	1,527	1,521	1,498	1,494	-0.1%
Factory Revenue ($M)	19,526	25,298	28,097	32,702	37,001	42,280	16.7%

Source: Dataquest (October 1995 Estimates)

Figure 2-1
1995 European PC Production as Percentage of Worldwide Forecast



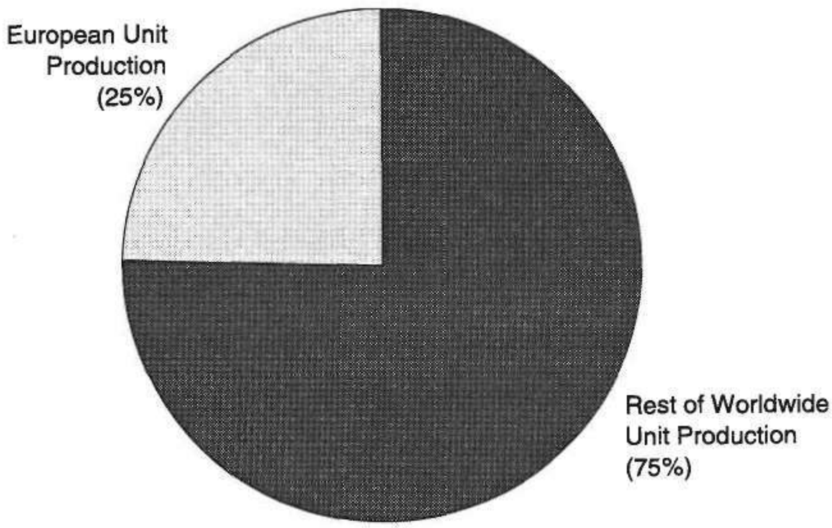
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Workstations							
Units (K)	193	211	227	242	291	358	13.2%
Factory ASP ($)	11,968	12,656	13,422	12,779	13,378	13,828	2.9%
Factory Revenue ($M)	2,310	2,670	3,047	3,093	3,893	4,950	16.5%

Source: Dataquest (October 1995 Estimates)

Figure 2-2
1995 European Workstation Production as Percentage of Worldwide Forecast



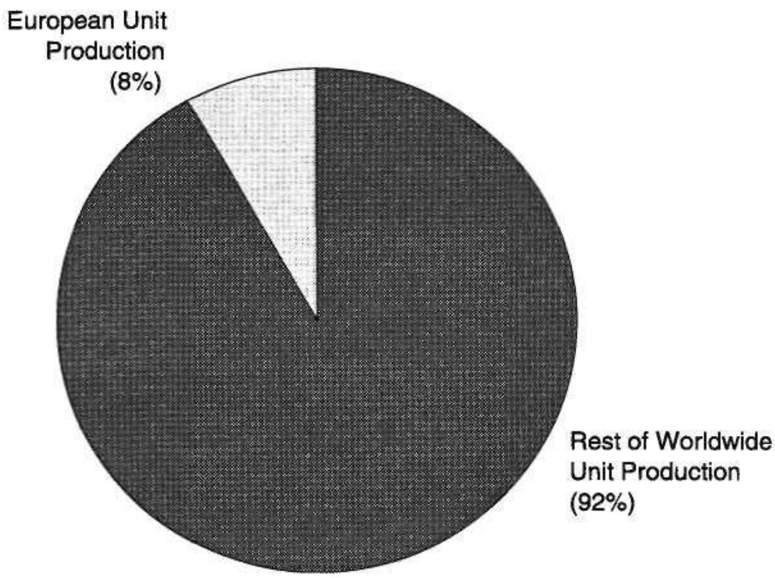
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Rigid Disk Drives							
Units (K)	4,530	6,610	8,922	11,393	15,115	16,963	30.2%
Factory ASP ($)	265	230	215	195	180	175	-8.0%
Factory Revenue ($M)	1,200	1,520	1,918	2,222	2,721	2,969	19.9%

Source: Dataquest (October 1995 Estimates)

Figure 2-3
1995 European Rigid Disk Drive Production as Percentage of Worldwide Forecast



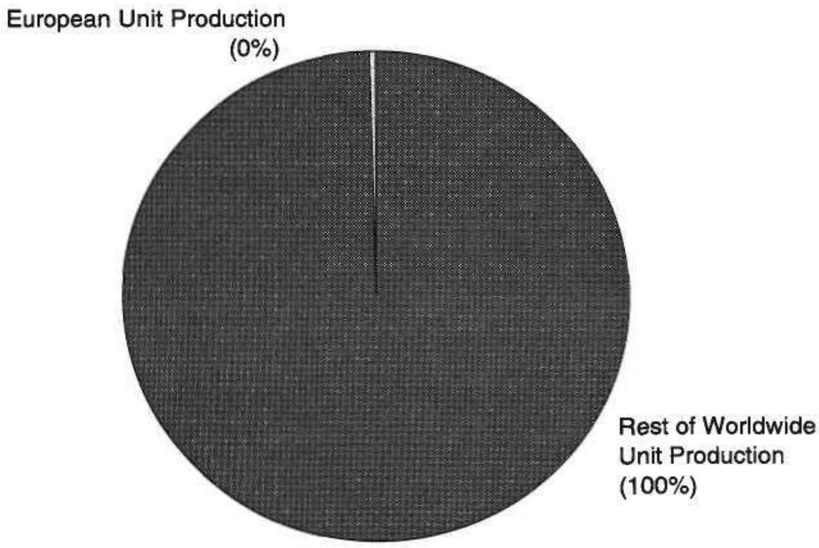
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Optical Disk Drives							
Units (K)	91	108	118	122	125	129	7.2%
Factory ASP ($)	362	379	333	397	233	210	-10.3%
Factory Revenue ($M)	33	41	39	48	29	27	-3.8%

Source: Dataquest (October 1995 Estimates)

Figure 2-4
1995 European Optical Disk Drive Production as Percentage of Worldwide Forecast



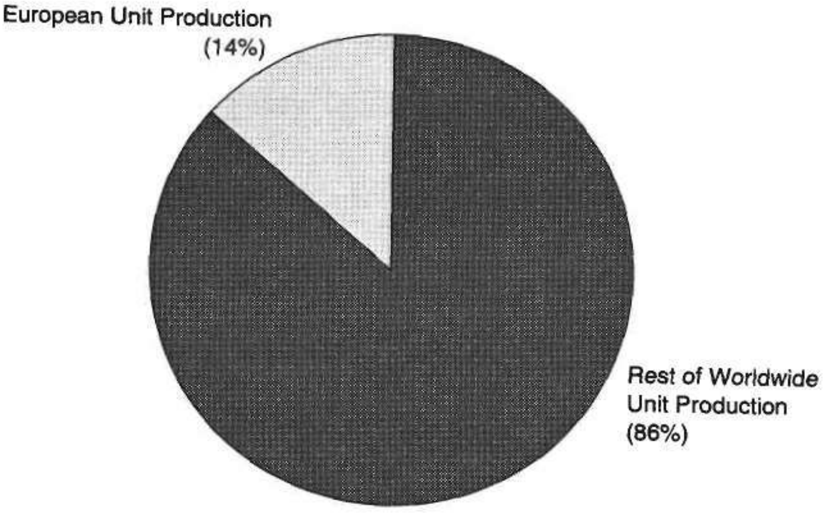
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Page (Laser) Printers							
Units (K)	906	1,087	1,251	1,376	1,486	1,575	11.7%
Factory ASP ($)	827	765	726	698	678	651	-4.7%
Factory Revenue ($M)	750	832	908	961	1,007	1,025	6.5%

Source: Dataquest (October 1995 Estimates)

Figure 2-5
1995 European Page (Laser) Printer Production as Percentage of Worldwide Forecast



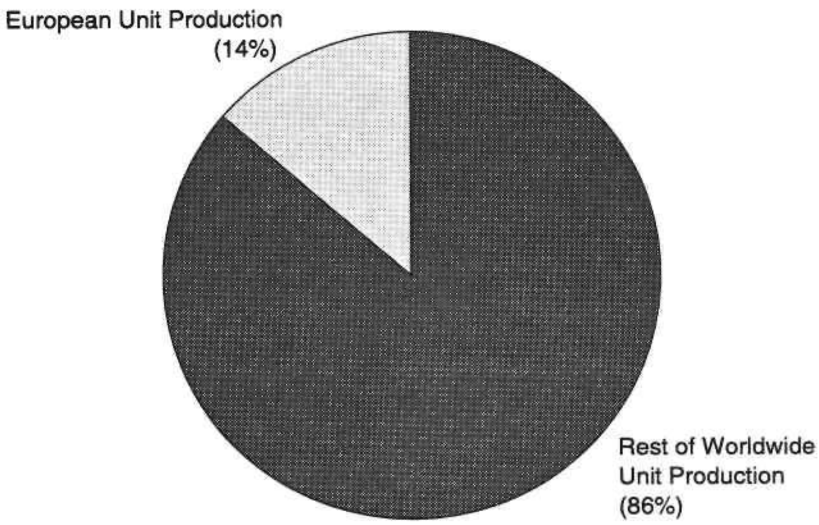
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Serial Printers							
Units (K)	2,945	3,323	3,400	4,226	5,979	7,688	21.2%
Factory ASP ($)	296	297	291	289	285	283	-0.9%
Factory Revenue ($M)	872	987	990	1,221	1,704	2,176	20.1%

Source: Dataquest (October 1995 Estimates)

Figure 2-6
1995 European Serial Printer Production as Percentage of Worldwide Forecast



Source: Dataquest (October 1995 Estimates)

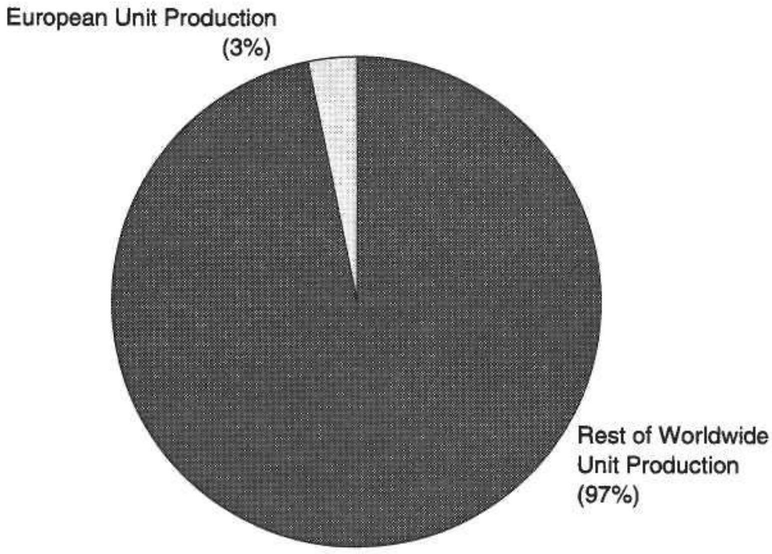
Chapter 3
Communications

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Fax Machines							
Units (K)	262	319	378	464	525	610	18.4%
Factory ASP ($)	597	545	480	426	380	321	-11.7%
Factory Revenue ($M)	156	174	182	198	199	196	4.6%

Source: Dataquest (October 1995 Estimates)

Figure 3-1
1995 European Fax Machine Production as Percentage of Worldwide Forecast



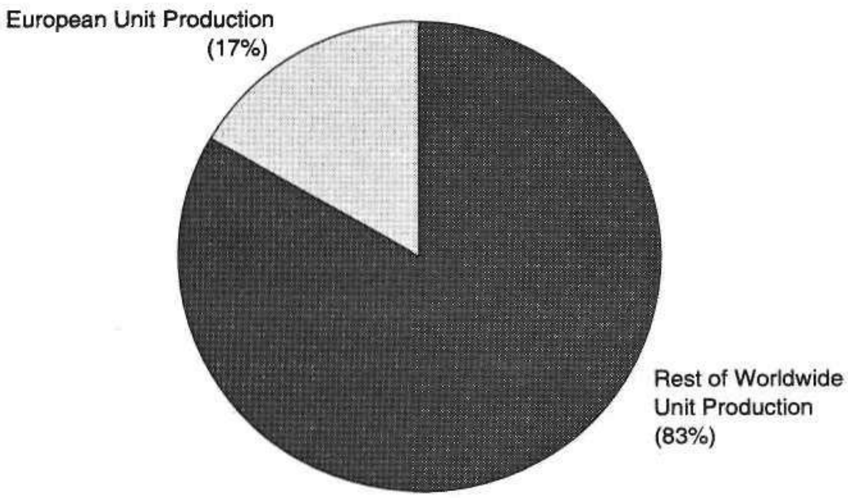
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
LAN Cards							
Units (K)	4,060	5,480	7,000	8,670	10,530	11,960	24.1%
Factory ASP ($)	146	141	129	120	108	95	-8.1%
Factory Revenue ($M)	591	775	900	1,042	1,138	1,142	14.1%

Source: Dataquest (October 1995 Estimates)

Figure 3-2
1995 European LAN Card Production as Percentage of Worldwide Forecast



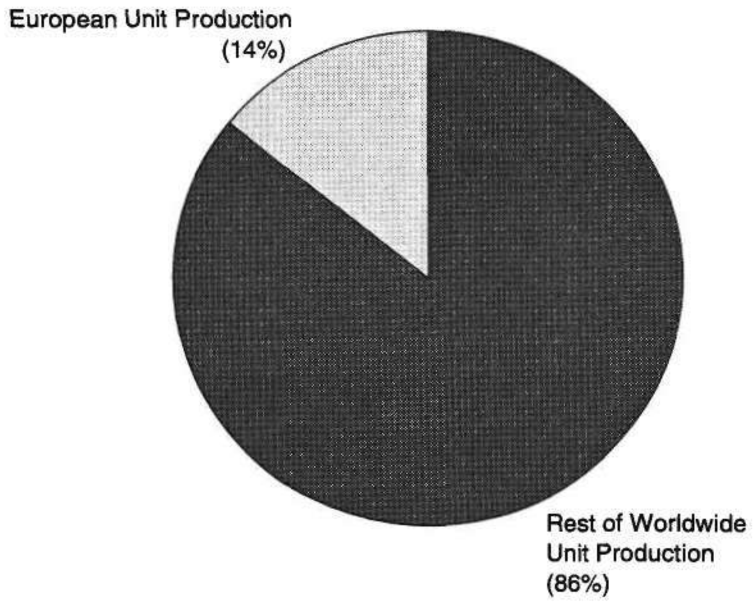
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Modems*							
Units (K)	1,640	2,074	2,486	2,896	3,186	3,476	16.2%
Factory ASP ($)	197	148	114	94	83	74	-17.8%
Factory Revenue ($M)	323	306	283	271	263	258	-4.4%

* External and internal, data and fax
Source: Dataquest (October 1995 Estimates)

Figure 3-3
1995 European Modem Production as Percentage of Worldwide Forecast



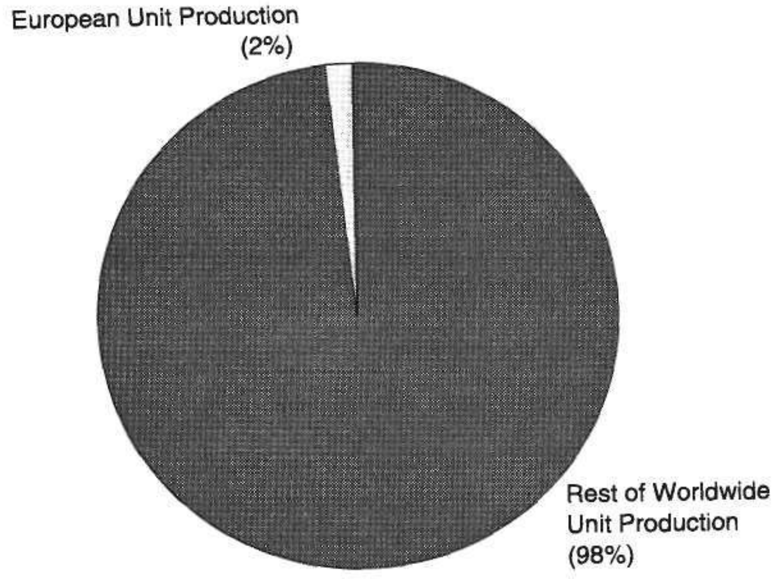
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Answering Machines							
Units (K)	378	472	628	818	1,048	1,256	27.1%
Factory ASP ($)	113	107	102	94	88	81	-6.4%
Factory Revenue ($M)	43	51	64	77	92	102	19.0%

Source: Dataquest (October 1995 Estimates)

Figure 3-4
1995 European Answering Machine Production as Percentage of Worldwide Forecast



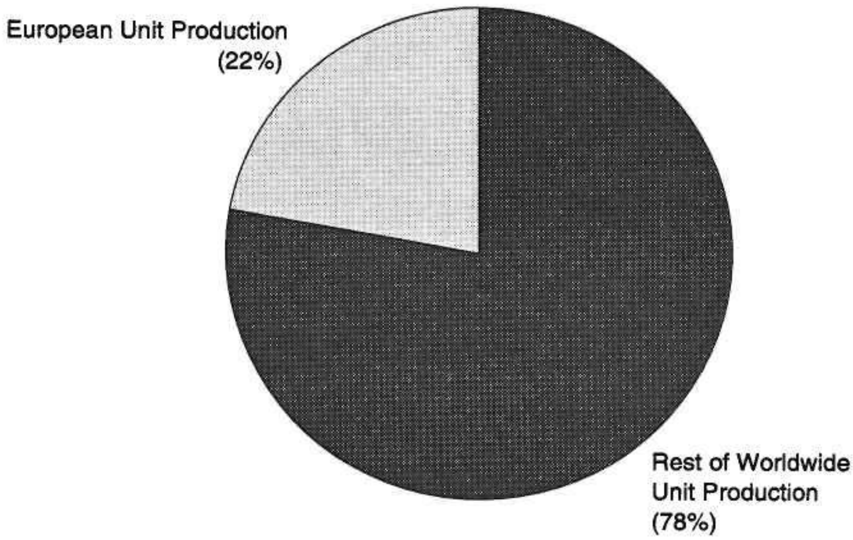
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Corded Telephones							
Units (K)	23,670	22,070	21,663	21,732	21,879	22,040	-1.4%
Factory ASP ($)	33	33	33	32	32	32	-0.6%
Factory Revenue ($M)	781	728	715	695	700	705	-2.0%

Source: Dataquest (October 1995 Estimates)

Figure 3-5
1995 European Corded Telephone Production as Percentage of Worldwide Forecast



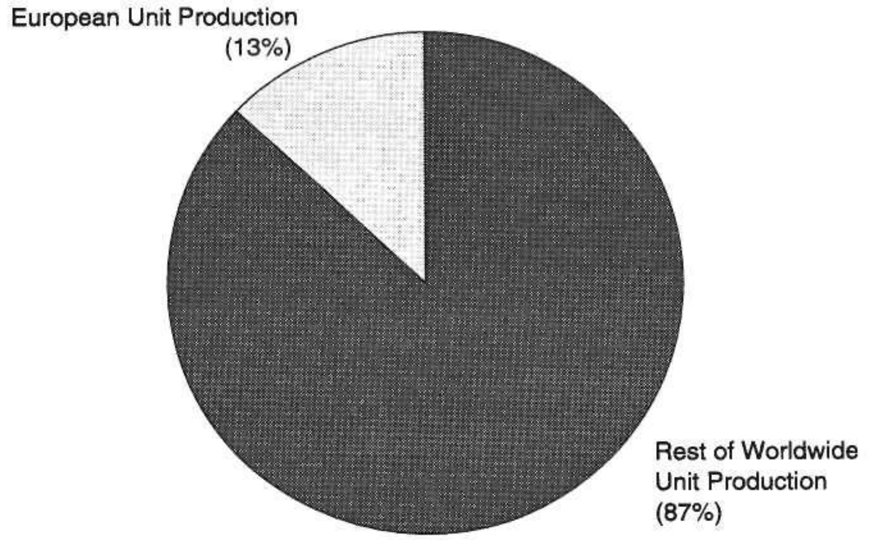
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Cordless Telephones							
Units (K)	3,839	5,029	6,113	7,147	8,243	9,350	19.5%
Factory ASP ($)	116	110	103	99	95	90	-4.9%
Factory Revenue ($M)	445	553	630	708	783	841	13.6%

Source: Dataquest (October 1995 Estimates)

Figure 3-6
1995 European Cordless Telephone Production as Percentage of Worldwide Forecast



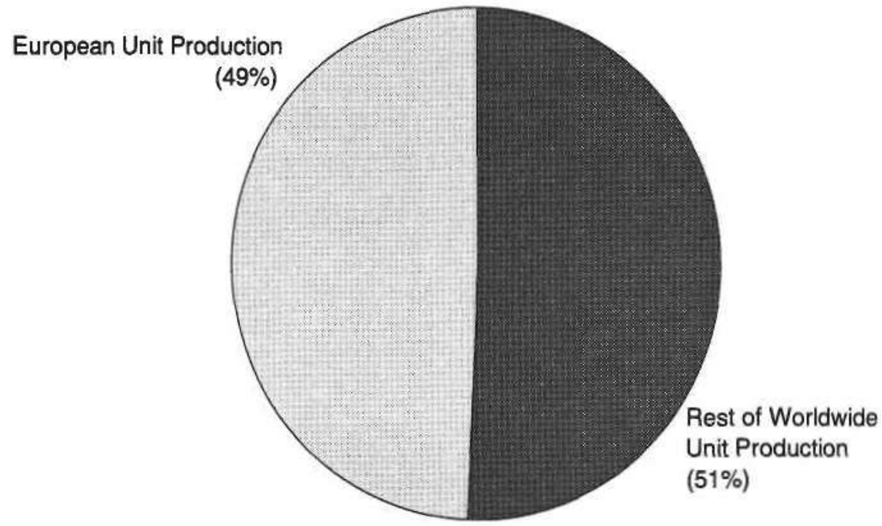
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
CO/Premise Line Cards							
Units (K) [Lines]	42,335	43,681	45,246	46,423	47,898	49,643	3.2%
Factory ASP ($) [per Line]	113	108	102	97	92	90	-4.4%
Factory Revenue ($M)	4,784	4,718	4,615	4,503	4,407	4,468	-1.4%

Source: Dataquest (October 1995 Estimates)

Figure 3-7
1995 European CO/Premise Line Card Production as Percentage of Worldwide Forecast



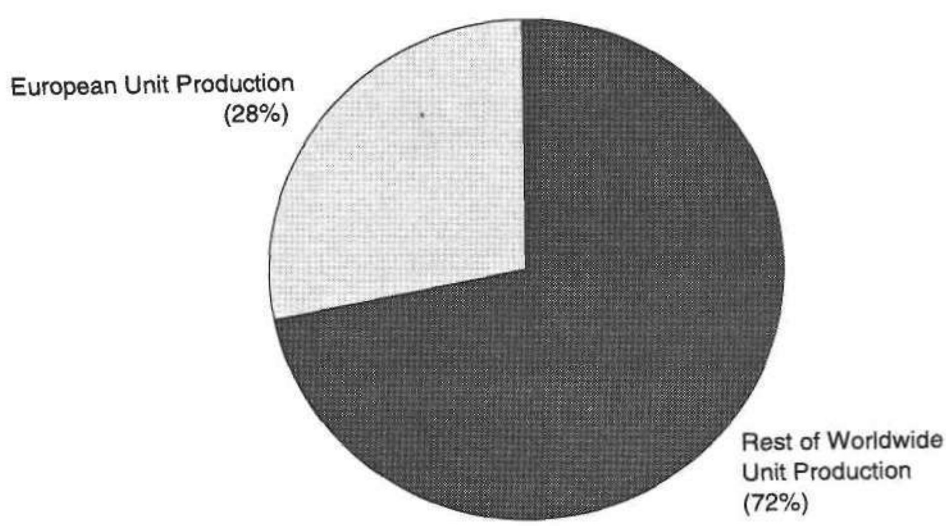
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Cellular Telephones							
Units (K)	7,497	10,583	14,963	20,170	26,807	32,077	33.7%
Factory ASP ($)	458	414	377	338	301	261	-10.6%
Factory Revenue ($M)	3,432	4,386	5,639	6,823	8,063	8,381	19.6%

Source: Dataquest (October 1995 Estimates)

Figure 3-8
1995 European Cellular Telephone Production as Percentage of Worldwide Forecast



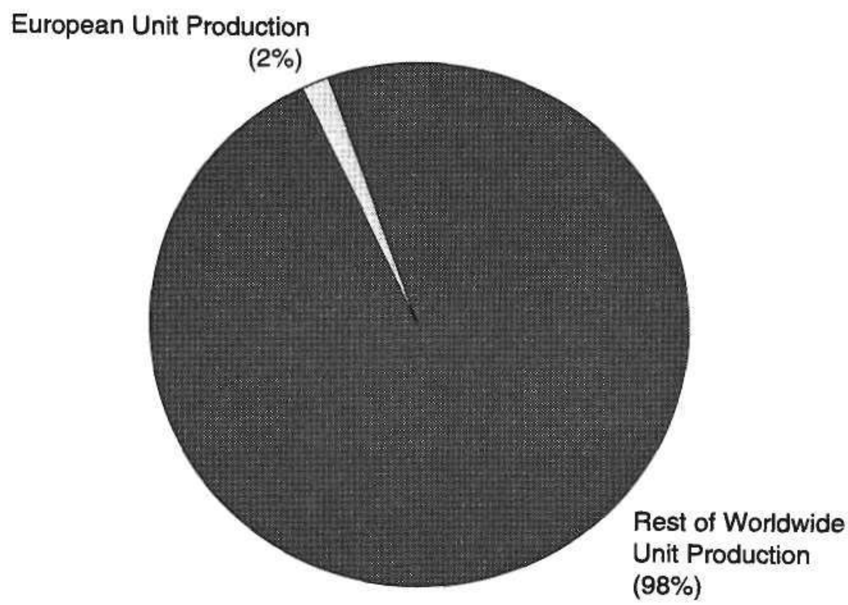
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Pagers							
Units (K)	395	502	676	860	1,110	1,471	30.1%
Factory ASP ($)	129	124	120	116	113	109	-3.4%
Factory Revenue ($M)	51	62	81	100	125	160	25.7%

Source: Dataquest (October 1995 Estimates)

Figure 3-9
1995 European Pager Production as Percentage of Worldwide Forecast



Source: Dataquest (October 1995 Estimates)

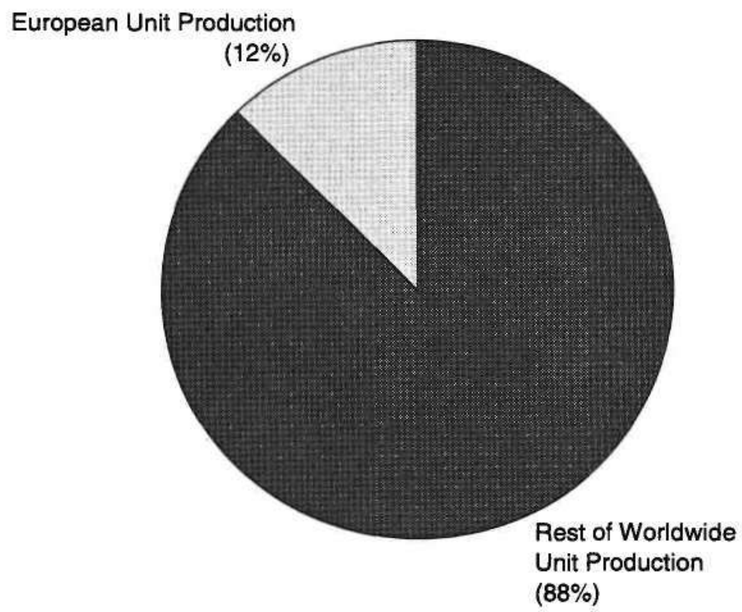
Chapter 4
Consumer

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Personal/Portable Stereos							
Units (K)	15,366	15,383	15,400	15,396	15,398	16,014	0.8%
Factory ASP ($)	21	21	21	21	21	21	0.4%
Factory Revenue ($M)	317	316	319	319	323	336	1.2%

Source: Dataquest (October 1995 Estimates)

Figure 4-1
1995 European Personal/Portable Stereo Production Percentage of Worldwide Forecast



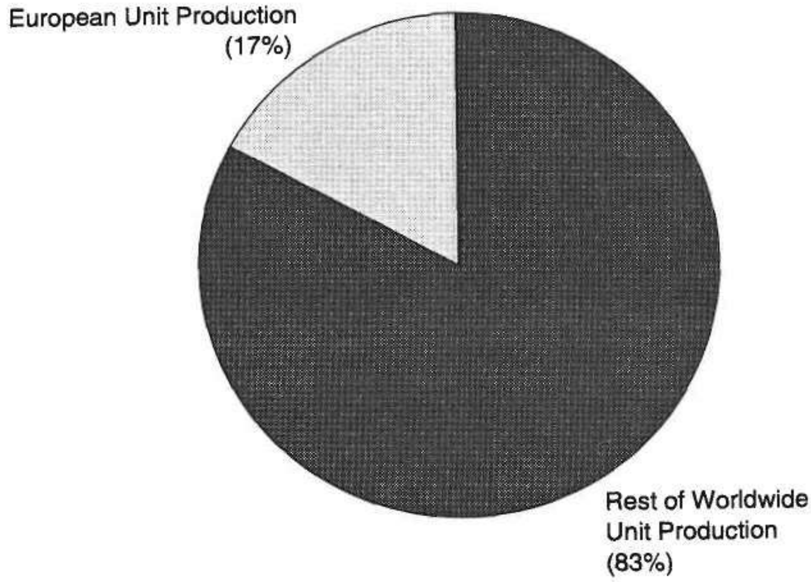
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Color TVs							
Units (K)	19,692	19,998	20,740	20,796	21,034	21,271	1.6%
Factory ASP ($)	130	135	145	150	160	170	5.5%
Factory Revenue ($M)	2,560	2,700	3,007	3,119	3,365	3,616	7.2%

Source: Dataquest (October 1995 Estimates)

Figure 4-2
1995 European Color TV Production as Percentage of Worldwide Forecast



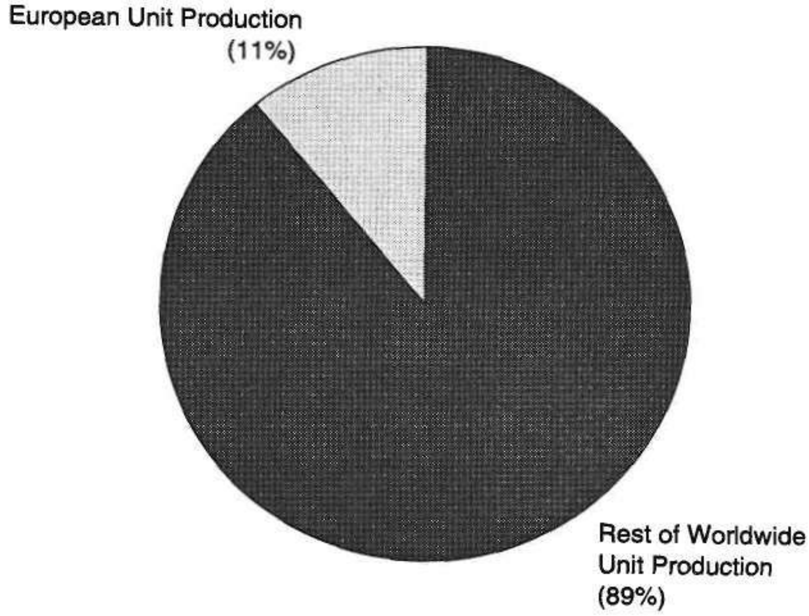
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
VCRs							
Units (K)	5,929	6,888	8,004	8,951	9,384	10,526	12.2%
Factory ASP ($)	165	160	158	158	158	158	-0.9%
Factory Revenue ($M)	978	1,102	1,265	1,414	1,483	1,663	11.2%

Source: Dataquest (October 1995 Estimates)

Figure 4-3
1995 European VCR Production as Percentage of Worldwide Forecast



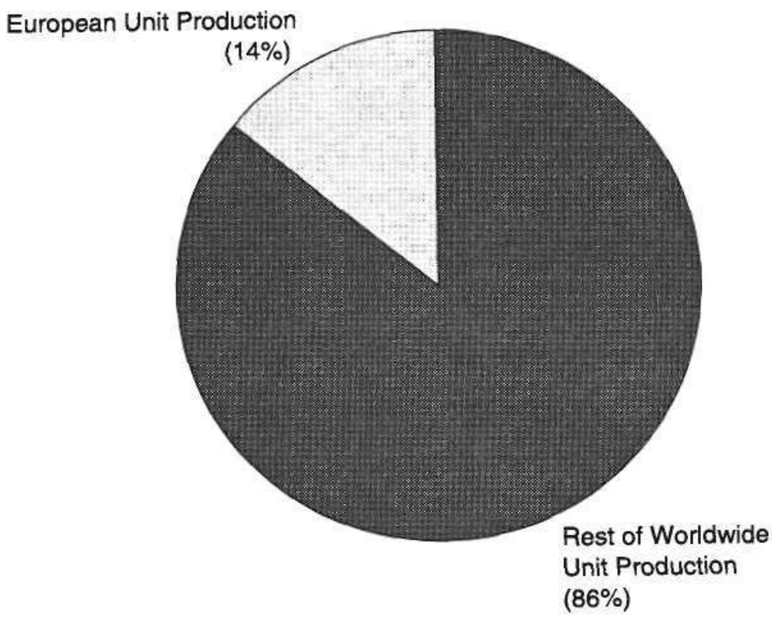
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Camcorders							
Units (K)	1,174	1,601	1,954	2,251	2,650	2,996	20.6%
Factory ASP ($)	350	340	335	330	320	315	-2.1%
Factory Revenue ($M)	411	544	655	743	848	942	18.1%

Source: Dataquest (October 1995 Estimates)

Figure 4-4
1995 European Camcorder Production as Percentage of Worldwide Forecast



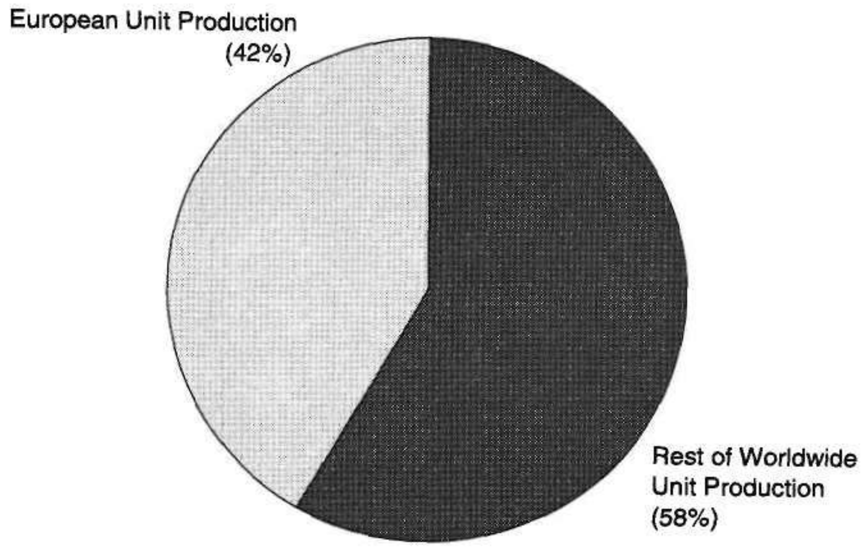
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Set-Top Boxes							
Units (K)	5,010	5,874	6,746	7,701	8,690	9,840	14.5%
Factory ASP ($)	194	202	210	222	229	229	3.3%
Factory Revenue ($M)	974	1,188	1,418	1,706	1,993	2,250	18.2%

Source: Dataquest (October 1995 Estimates)

Figure 4-5
1995 European Set-Top Box Production as Percentage of Worldwide Forecast



Source: Dataquest (October 1995 Estimates)

Chapter 5

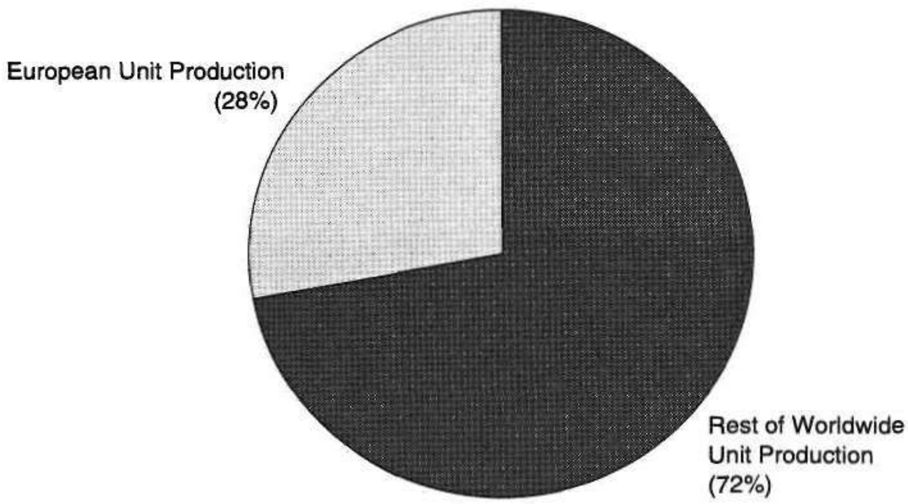
Automotive

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Auto Stereo (All)							
Units (K)	14,160	14,125	14,300	14,388	14,417	14,607	0.6%
Factory ASP ($)	55	57	59	61	63	66	3.7%
Factory Revenue ($M)	779	805	844	878	908	964	4.4%

Source: Dataquest (October 1995 Estimates)

Figure 5-1
1995 European Auto Stereo Production as Percentage of Worldwide Forecast



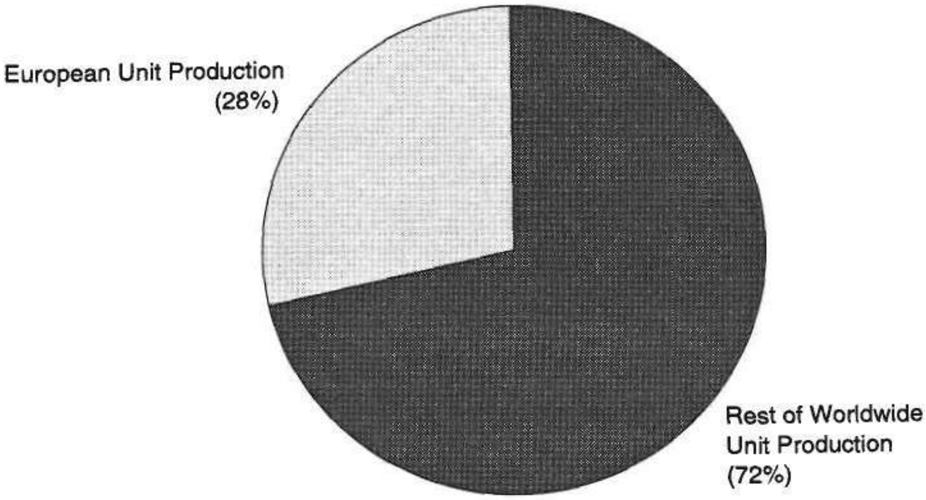
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Engine Control Units							
Units (K)	9,500	10,790	11,299	11,685	12,190	12,210	5.1%
Factory ASP ($)	245	230	222	218	215	210	-3.0%
Factory Revenue ($M)	2,328	2,482	2,508	2,547	2,621	2,564	2.0%

Source: Dataquest (October 1995 Estimates)

Figure 5-2
1995 European Engine Control Unit Production as Percentage of Worldwide Forecast



Source: Dataquest (October 1995 Estimates)

Dataquest

a company of
The Dun & Bradstreet Corporation

DATAQUEST WORLDWIDE OFFICES

EUROPE

European Headquarters
Dataquest Europe Limited
Holmers Farm Way
High Wycombe, Bucks HP12 4XH
United Kingdom
Phone: +44 1494 422 722
Facsimile: +44 1494 422 742

Dataquest Europe SA
Immeuble Défense Bergères
345, avenue Georges Clémenceau
TSA 40002
92882 - Nanterre CTC Cedex 9
France
Phone: +33 1 41 35 13 00
Facsimile: +33 1 41 35 13 13

Dataquest GmbH
Kronstadter Strasse 9
81677 München
Germany
Phone: +49 89 93 09 09 0
Facsimile: +49 89 93 03 27 7

Sales Offices:
Brussels, Belgium
Kfar Saba, Israel
Milan, Italy
Randburg, South Africa
Madrid, Spain

LATIN AMERICA

Research Affiliates and Sales Offices:
Buenos Aires, Argentina
Sao Paulo, Brazil
Santiago, Chile
Mexico City, Mexico

NORTH AMERICA

Worldwide Headquarters
Dataquest Incorporated
251 River Oaks Parkway
San Jose, California 95134-1913
United States
Phone: 1-408-468-8000
Facsimile: 1-408-954-1780

Dataquest Incorporated
Nine Technology Drive
P.O. Box 5093
Westborough, Massachusetts
01581-5093
United States
Phone: 1-508-871-5555
Facsimile: 1-508-871-6262

Dataquest Global Events
3990 Westerly Place, Suite 100
Newport Beach, California 92660
United States
Phone: 1-714-476-9117
Facsimile: 1-714-476-9969

Sales Offices:
Washington, DC (Federal)
New York, NY (Financial)
Dallas, TX

JAPAN

Japan Headquarters
Dataquest Japan K.K.
Shinkawa Sanko Building
6th Floor
1-3-17, Shinkawa
Chuo-ku, Tokyo 104
Japan
Phone: 81-3-5566-0411
Facsimile: 81-3-5566-0425

ASIA/PACIFIC

Asia/Pacific Headquarters
7/F China Underwriters Centre
88 Gloucester Road
Wan Chai
Hong Kong
Phone: 852-2824-6168
Facsimile: 852-2824-6138

Dataquest Korea
Suite 2407, Trade Tower
159 Samsung-dong, Kangnam-gu
Seoul 135-729
Korea
Phone: 822-551-1331
Facsimile: 822-551-1330

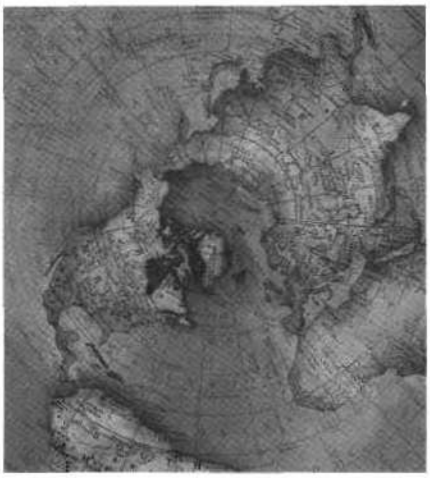
Dataquest Taiwan
11F-2, No. 188, Section 5
Nan King East Road
Taipei
Taiwan, R.O.C.
Phone: 8862-756-0389
Facsimile: 8862-756-2663

Dataquest Singapore
105 Cecil Street
#06-01/02 The Octagon
Singapore 0106
Phone: 65-227-1213
Facsimile: 65-227-4607

Dataquest Thailand
12/F, Vanissa Building
29 Soi Chidlom
Ploenchit Road
Patumwan, Bangkok 10330
Thailand
Phone: 662-655-0577
Facsimile: 662-655-0576

Research Affiliates and Sales Offices:
Melbourne, Australia
Beijing, China

50135



Dataquest

1995 High-Volume Electronic Equipment Unit Production Forecast—Europe

Market Statistics

1995

Program: Electronic Equipment Production Monitor
Product Code: SAPM-EU-MS-9501
Publication Date: October 20, 1995
Filing: Market Analysis

1995 High-Volume Electronic Equipment Unit Production Forecast—Europe

Market Statistics

1995

Program: Electronic Equipment Production Monitor
Product Code: SAPM-EU-MS-9501
Publication Date: October 20, 1995
Filing: Market Analysis

For More Information...

Mike Williams .... +44 1494 422 722
Internet address ....mwilliams@dqeurope.com
Via fax .... +44 1494 422 742

 50135

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a company of The Dun & Bradstreet Corporation

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Chapter 1

Introduction and Definitions

Introduction

This Market Statistics report represents our first forecast for European electronic systems by value, unit volume, and market forecast. Dataquest has selected 22 key application systems that have high-volume production worldwide. These key systems are identified by Dataquest as being leading indicators of electronic component 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.

The 22 leading indicators selected by Dataquest are as follows:

- Electronic Data Processing:
  - Personal computers
  - 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 line cards
  - Cellular telephones
  - Pagers
- Consumer:
  - Personal/portable stereos
  - Color televisions
  - Videocassette recorders (VCRs)
  - Camcorders
  - Set-top boxes
- Automotive:
  - Auto stereos
  - Engine control units

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

The report contains tables detailing the spring 1995 electronics equipment production forecast. European production is estimated for the years 1994 to 1999. Production tables contain both historical data and forecasts. In most tables, historical data begin with 1994, while forecast data provide estimates for 1995 through 1999. 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; thus, we maintain exchange rates at constant 1994 calendar year. This prevents any inconsistencies in the conversion of growth projections and currency fluctuations. The 1994 exchange rate estimate uses actual average monthly exchange rates from January through December (these data are gathered and supplied by the Dun & Bradstreet Corporation). The annual rate is estimated as the arithmetic mean of the 12 monthly rates. Exchange rates are provided in Table 1-1 for your reference. Exchange rates for historical years are available on request.

Table 1-1
1994 Exchange Rates Table

	Foreign Currency per US Dollar	US Dollar per Foreign Currency
Austria (Schilling)	11.40	0.08784
Belgium (Franc)	33.36	0.03003
Denmark (Krone)	6.35	0.15772
ECU	0.84	1.18691
Finland (Markka)	5.21	0.19278
France (Franc)	5.54	0.18090
Germany (Mark)	1.62	0.61828
Greece (Drachma)	242.06	0.00413
Ireland (Punt)	0.67	1.50115
Italy (Lira)	1609.34	0.00062
Netherlands (Gulden)	1.82	0.55137
Norway (Krone)	7.04	0.14218
Portugal (Escudo)	165.63	0.00605
Spain (Peseta)	133.48	0.00750
Sweden (Krona)	7.70	0.13004
Switzerland (Franc)	1.37	0.73356
United Kingdom (Pound)	0.65	1.53068

Source: Dun & Bradstreet, Dataquest (October 1995)

Definitions

Regional Definitions

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

Line Item Definitions

The objective of analysing electronic systems production is to estimate its important implications for component 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 purposes of this report Dataquest defines factory revenue as the derived production revenue—from the factory value.

The equipment production data presented here are used in conjunction with estimated average component 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 component procurement, their captive production, and their relationships to the equipment or divisions in which the devices are used.

Data Sources

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

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

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

Forecast Methodology

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

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

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

Because the time series data contained in this document 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 judgements, expert opinions, and subjective probabilities) or technological models (that is, curve fitting and the use of analogous data).

Chapter 2

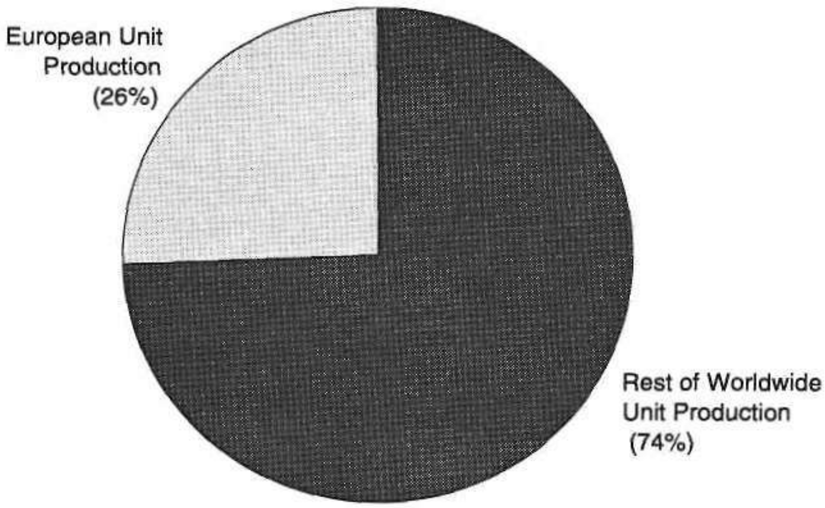
Electronic Data Processing

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
PCs							
Units (K)	13,000	16,300	18,400	21,500	24,700	28,300	16.8%
Factory ASP ($)	1,502	1,552	1,527	1,521	1,498	1,494	-0.1%
Factory Revenue ($M)	19,526	25,298	28,097	32,702	37,001	42,280	16.7%

Source: Dataquest (October 1995 Estimates)

Figure 2-1
1995 European PC Production as Percentage of Worldwide Forecast



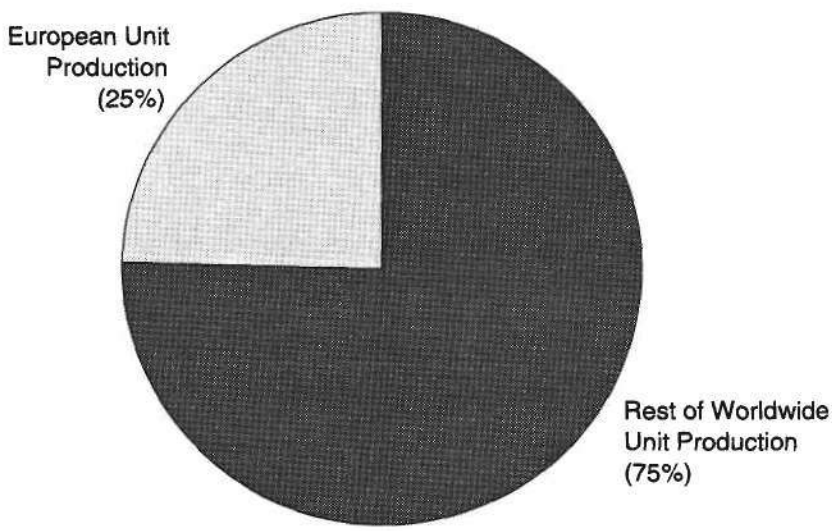
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Workstations							
Units (K)	193	211	227	242	291	358	13.2%
Factory ASP ($)	11,968	12,656	13,422	12,779	13,378	13,828	2.9%
Factory Revenue ($M)	2,310	2,670	3,047	3,093	3,893	4,950	16.5%

Source: Dataquest (October 1995 Estimates)

Figure 2-2
1995 European Workstation Production as Percentage of Worldwide Forecast



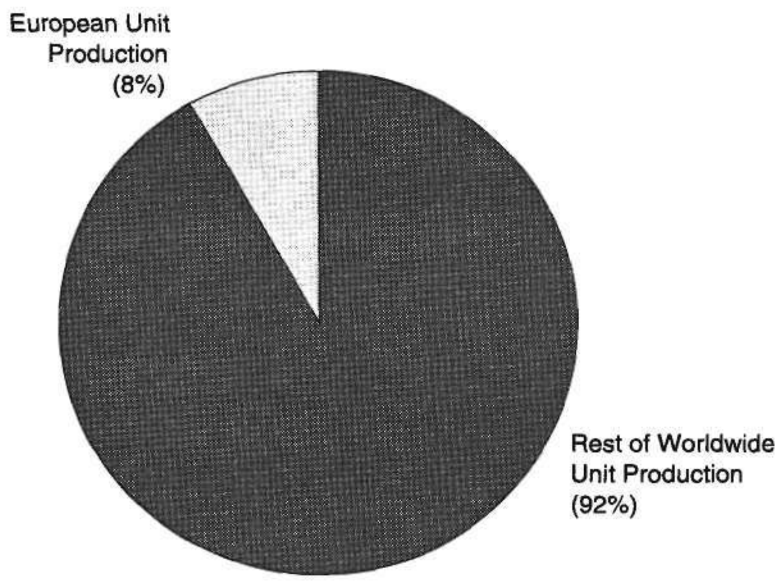
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Rigid Disk Drives							
Units (K)	4,530	6,610	8,922	11,393	15,115	16,963	30.2%
Factory ASP ($)	265	230	215	195	180	175	-8.0%
Factory Revenue ($M)	1,200	1,520	1,918	2,222	2,721	2,969	19.9%

Source: Dataquest (October 1995 Estimates)

Figure 2-3
1995 European Rigid Disk Drive Production as Percentage of Worldwide Forecast



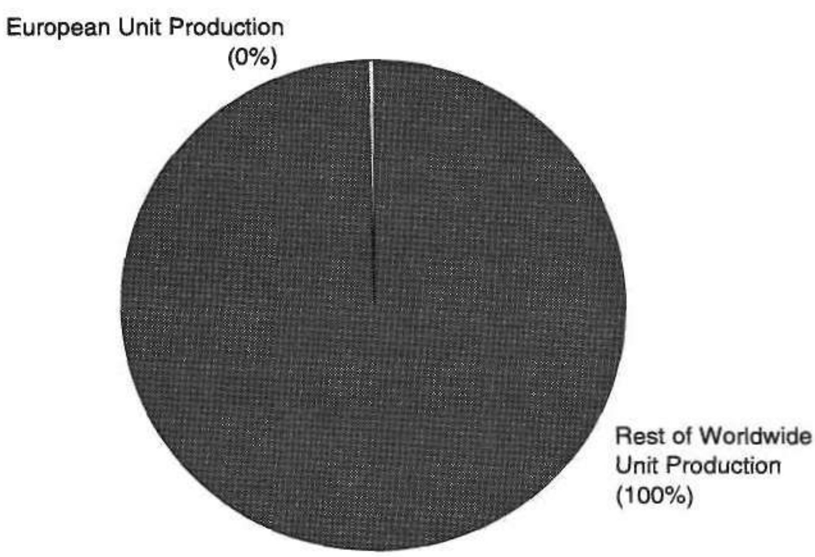
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Optical Disk Drives							
Units (K)	91	108	118	122	125	129	7.2%
Factory ASP ($)	362	379	333	397	233	210	-10.3%
Factory Revenue ($M)	33	41	39	48	29	27	-3.8%

Source: Dataquest (October 1995 Estimates)

Figure 2-4
1995 European Optical Disk Drive Production as Percentage of Worldwide Forecast



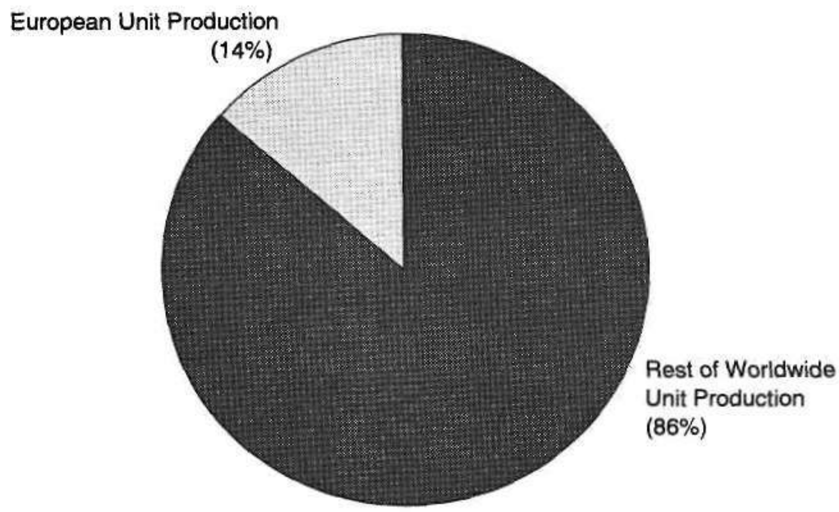
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Page (Laser) Printers							
Units (K)	906	1,087	1,251	1,376	1,486	1,575	11.7%
Factory ASP ($)	827	765	726	698	678	651	-4.7%
Factory Revenue ($M)	750	832	908	961	1,007	1,025	6.5%

Source: Dataquest (October 1995 Estimates)

Figure 2-5
1995 European Page (Laser) Printer Production as Percentage of Worldwide Forecast



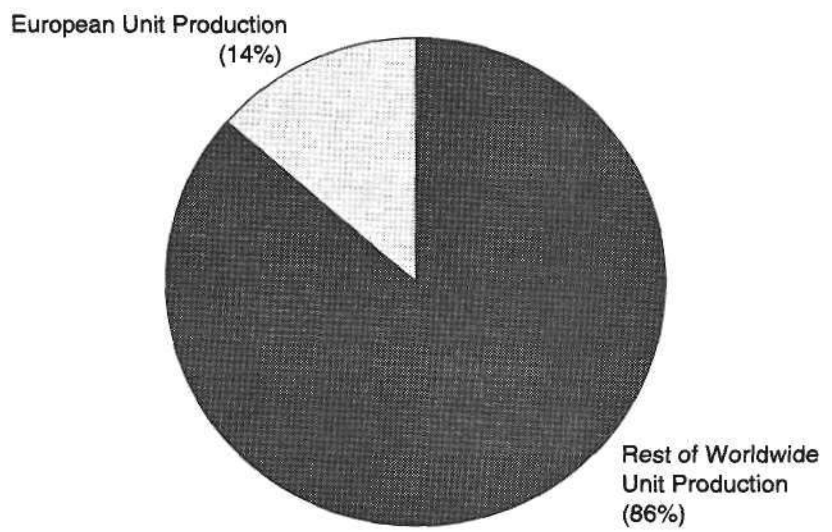
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Serial Printers							
Units (K)	2,945	3,323	3,400	4,226	5,979	7,688	21.2%
Factory ASP ($)	296	297	291	289	285	283	-0.9%
Factory Revenue ($M)	872	987	990	1,221	1,704	2,176	20.1%

Source: Dataquest (October 1995 Estimates)

Figure 2-6
1995 European Serial Printer Production as Percentage of Worldwide Forecast



Source: Dataquest (October 1995 Estimates)

Chapter 3

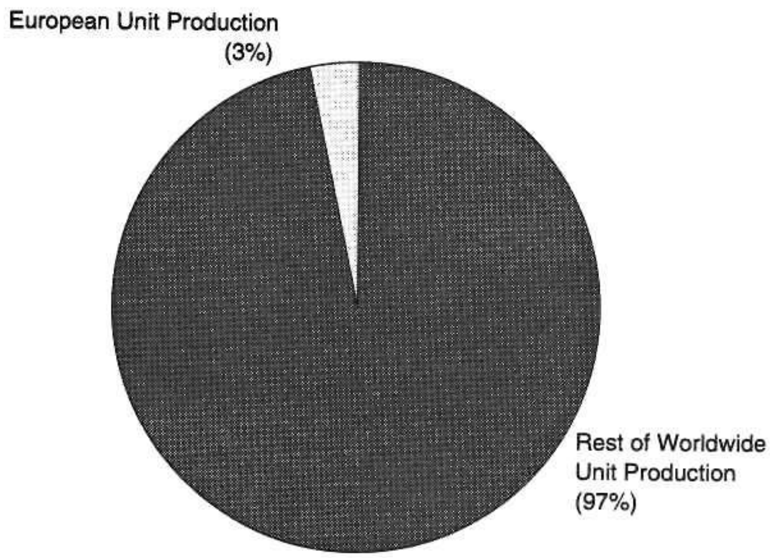
Communications

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Fax Machines							
Units (K)	262	319	378	464	525	610	18.4%
Factory ASP ($)	597	545	480	426	380	321	-11.7%
Factory Revenue ($M)	156	174	182	198	199	196	4.6%

Source: Dataquest (October 1995 Estimates)

Figure 3-1
1995 European Fax Machine Production as Percentage of Worldwide Forecast



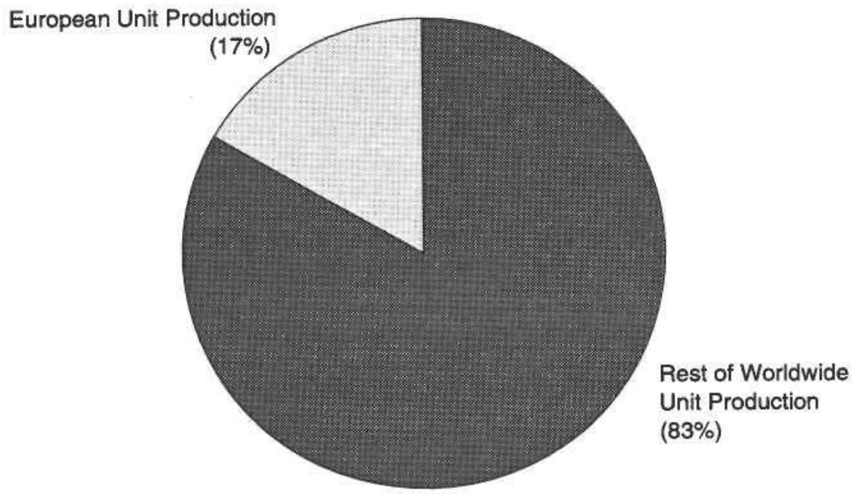
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
LAN Cards							
Units (K)	4,060	5,480	7,000	8,670	10,530	11,960	24.1%
Factory ASP ($)	146	141	129	120	108	95	-8.1%
Factory Revenue ($M)	591	775	900	1,042	1,138	1,142	14.1%

Source: Dataquest (October 1995 Estimates)

Figure 3-2
1995 European LAN Card Production as Percentage of Worldwide Forecast



Source: Dataquest (October 1995 Estimates)

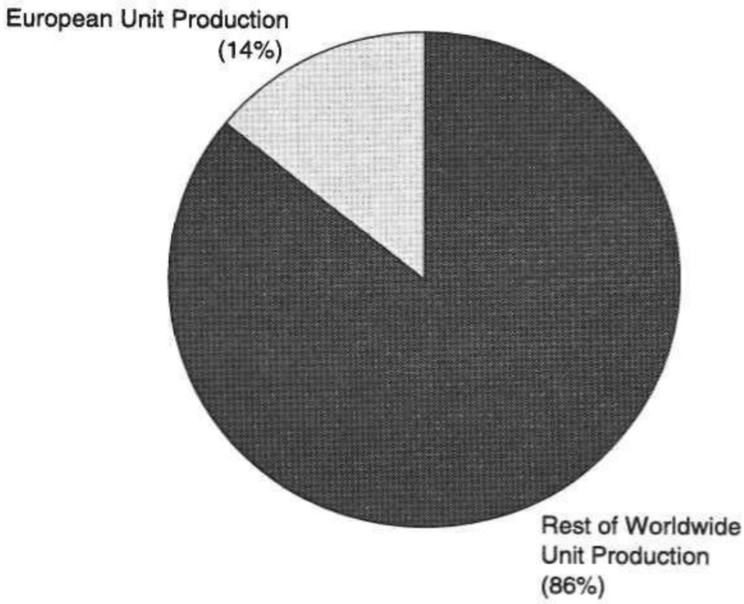
Table 3-3
High-Volume Electronic Equipment Production
Region: Europe
Category: Communications—Modems

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Modems*							
Units (K)	1,640	2,074	2,486	2,896	3,186	3,476	16.2%
Factory ASP ($)	197	148	114	94	83	74	-17.8%
Factory Revenue ($M)	323	306	283	271	263	258	-4.4%

* External and internal, data and fax

Source: Dataquest (October 1995 Estimates)

Figure 3-3
1995 European Modem Production as Percentage of Worldwide Forecast



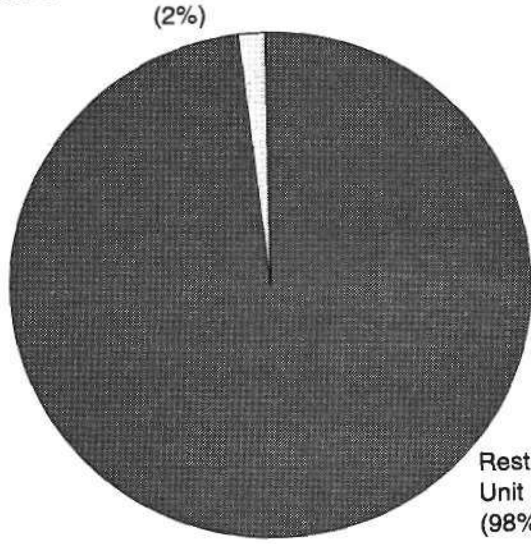
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Answering Machines							
Units (K)	378	472	628	818	1,048	1,256	27.1%
Factory ASP ($)	113	107	102	94	88	81	-6.4%
Factory Revenue ($M)	43	51	64	77	92	102	19.0%

Source: Dataquest (October 1995 Estimates)

Figure 3-4
1995 European Answering Machine Production as Percentage of Worldwide Forecast



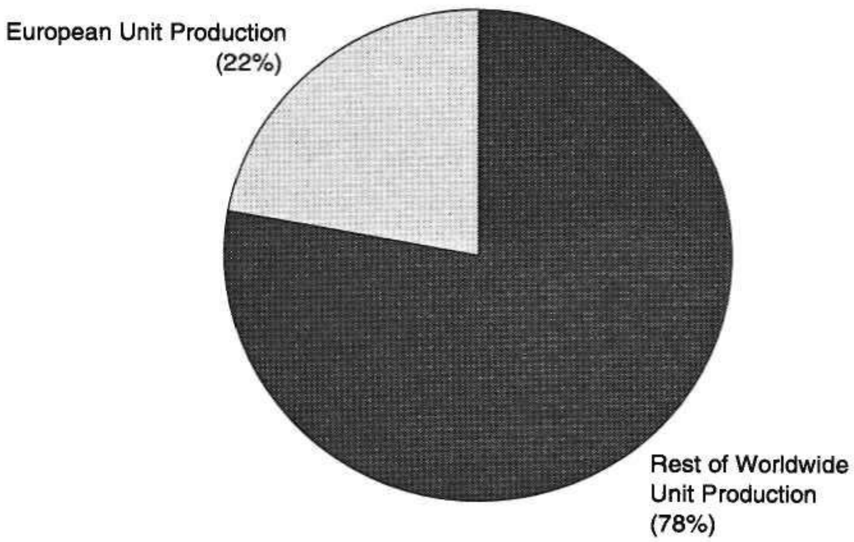
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Corded Telephones							
Units (K)	23,670	22,070	21,663	21,732	21,879	22,040	-1.4%
Factory ASP ($)	33	33	33	32	32	32	-0.6%
Factory Revenue ($M)	781	728	715	695	700	705	-2.0%

Source: Dataquest (October 1995 Estimates)

Figure 3-5
1995 European Corded Telephone Production as Percentage of Worldwide Forecast



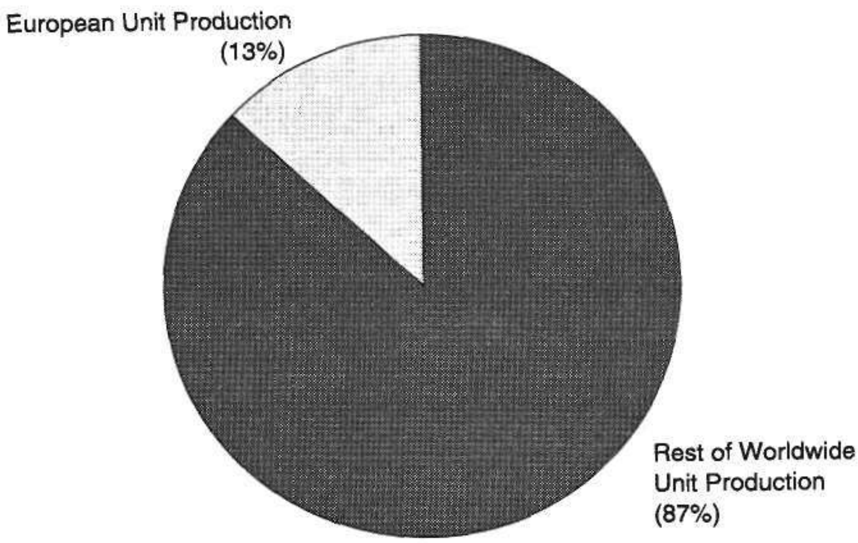
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Cordless Telephones							
Units (K)	3,839	5,029	6,113	7,147	8,243	9,350	19.5%
Factory ASP ($)	116	110	103	99	95	90	-4.9%
Factory Revenue ($M)	445	553	630	708	783	841	13.6%

Source: Dataquest (October 1995 Estimates)

Figure 3-6
1995 European Cordless Telephone Production as Percentage of Worldwide Forecast



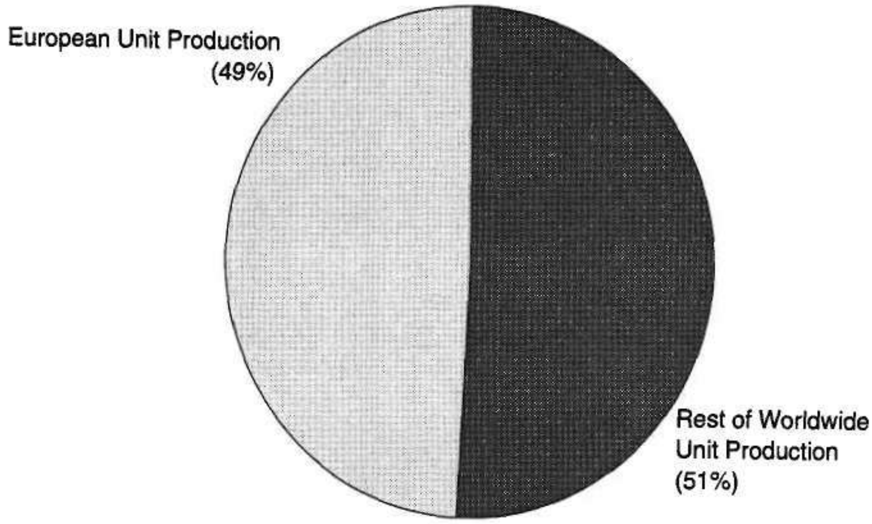
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
CO/Premise Line Cards							
Units (K) [Lines]	42,335	43,681	45,246	46,423	47,898	49,643	3.2%
Factory ASP ($) [per Line]	113	108	102	97	92	90	-4.4%
Factory Revenue ($M)	4,784	4,718	4,615	4,503	4,407	4,468	-1.4%

Source: Dataquest (October 1995 Estimates)

Figure 3-7
1995 European CO/Premise Line Card Production as Percentage of Worldwide Forecast



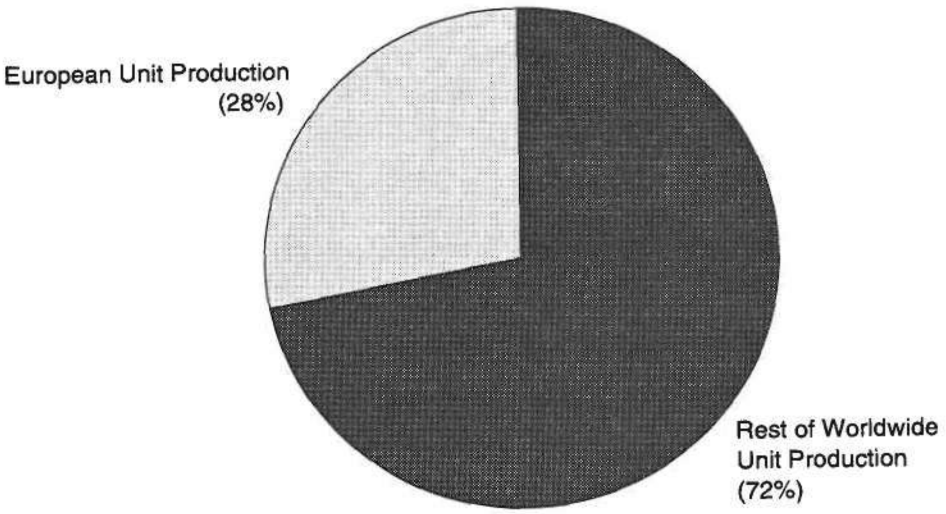
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Cellular Telephones							
Units (K)	7,497	10,583	14,963	20,170	26,807	32,077	33.7%
Factory ASP ($)	458	414	377	338	301	261	-10.6%
Factory Revenue ($M)	3,432	4,386	5,639	6,823	8,063	8,381	19.6%

Source: Dataquest (October 1995 Estimates)

Figure 3-8
1995 European Cellular Telephone Production as Percentage of Worldwide Forecast



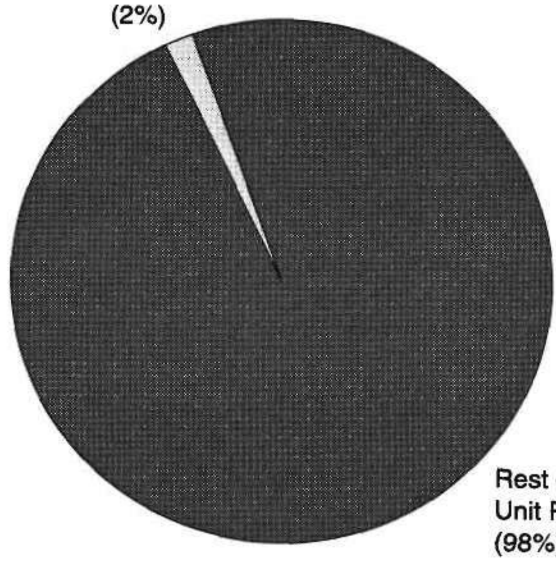
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Pagers							
Units (K)	395	502	676	860	1,110	1,471	30.1%
Factory ASP ($)	129	124	120	116	113	109	-3.4%
Factory Revenue ($M)	51	62	81	100	125	160	25.7%

Source: Dataquest (October 1995 Estimates)

Figure 3-9
1995 European Pager Production as Percentage of Worldwide Forecast



Source: Dataquest (October 1995 Estimates)

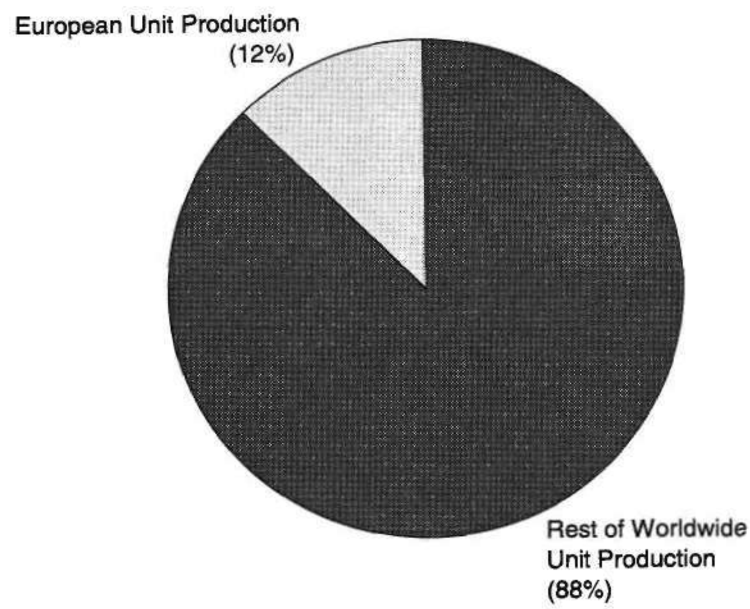
Chapter 4
Consumer

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Personal/Portable Stereos							
Units (K)	15,366	15,383	15,400	15,396	15,398	16,014	0.8%
Factory ASP ($)	21	21	21	21	21	21	0.4%
Factory Revenue ($M)	317	316	319	319	323	336	1.2%

Source: Dataquest (October 1995 Estimates)

Figure 4-1
1995 European Personal/Portable Stereo Production Percentage of Worldwide Forecast



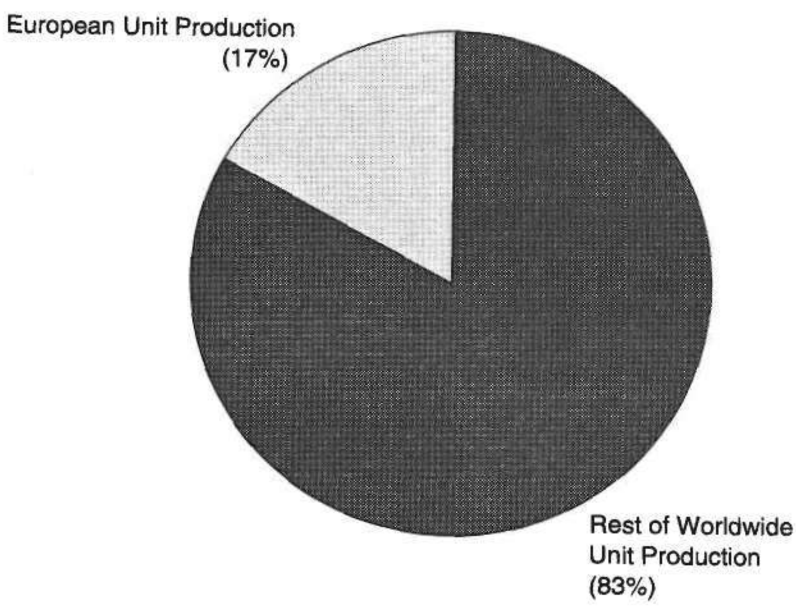
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Color TVs							
Units (K)	19,692	19,998	20,740	20,796	21,034	21,271	1.6%
Factory ASP ($)	130	135	145	150	160	170	5.5%
Factory Revenue ($M)	2,560	2,700	3,007	3,119	3,365	3,616	7.2%

Source: Dataquest (October 1995 Estimates)

Figure 4-2
1995 European Color TV Production as Percentage of Worldwide Forecast



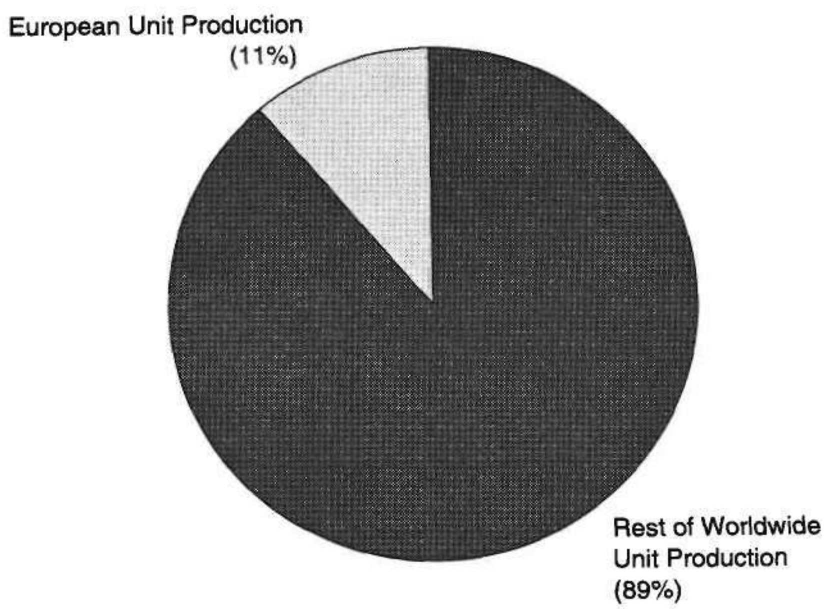
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
VCRs							
Units (K)	5,929	6,888	8,004	8,951	9,384	10,526	12.2%
Factory ASP ($)	165	160	158	158	158	158	-0.9%
Factory Revenue ($M)	978	1,102	1,265	1,414	1,483	1,663	11.2%

Source: Dataquest (October 1995 Estimates)

Figure 4-3
1995 European VCR Production as Percentage of Worldwide Forecast



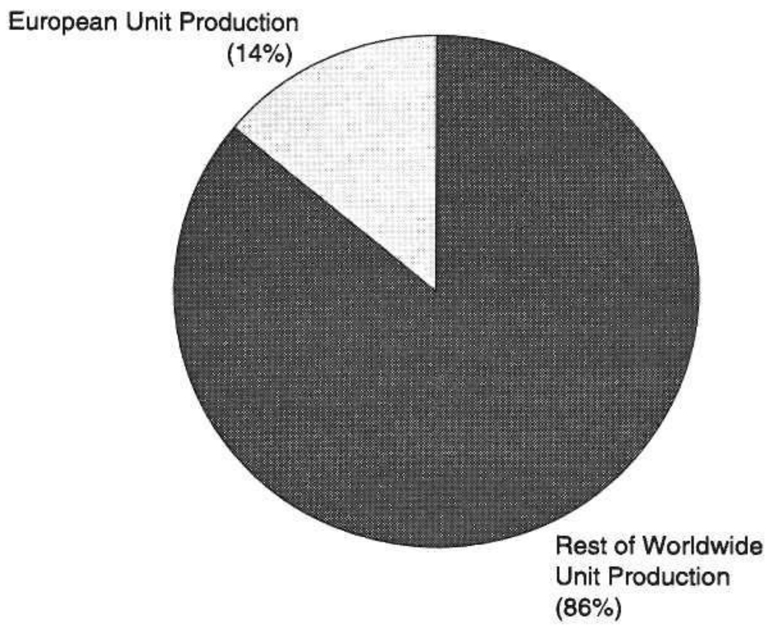
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Camcorders							
Units (K)	1,174	1,601	1,954	2,251	2,650	2,996	20.6%
Factory ASP ($)	350	340	335	330	320	315	-2.1%
Factory Revenue ($M)	411	544	655	743	848	942	18.1%

Source: Dataquest (October 1995 Estimates)

Figure 4-4
1995 European Camcorder Production as Percentage of Worldwide Forecast



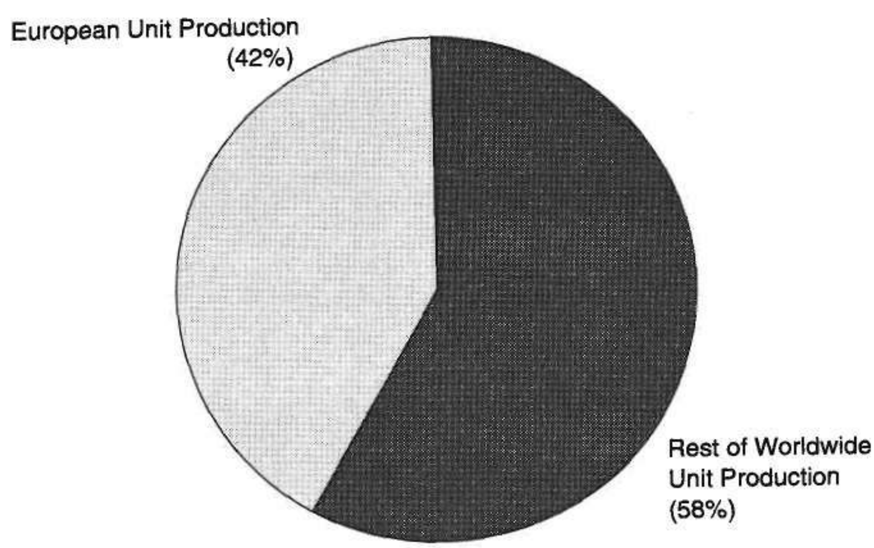
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Set-Top Boxes							
Units (K)	5,010	5,874	6,746	7,701	8,690	9,840	14.5%
Factory ASP ($)	194	202	210	222	229	229	3.3%
Factory Revenue ($M)	974	1,188	1,418	1,706	1,993	2,250	18.2%

Source: Dataquest (October 1995 Estimates)

Figure 4-5
1995 European Set-Top Box Production as Percentage of Worldwide Forecast



Source: Dataquest (October 1995 Estimates)

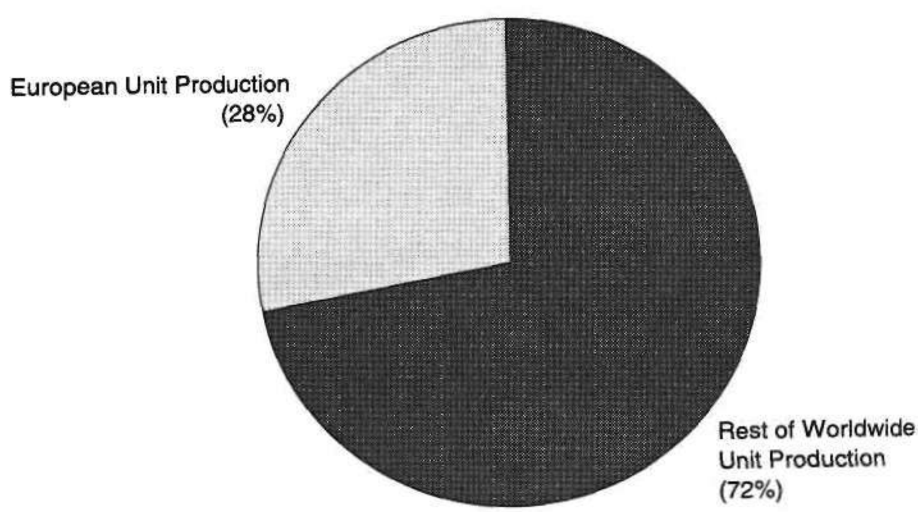
Chapter 5
Automotive

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Auto Stereo (All)							
Units (K)	14,160	14,125	14,300	14,388	14,417	14,607	0.6%
Factory ASP ($)	55	57	59	61	63	66	3.7%
Factory Revenue ($M)	779	805	844	878	908	964	4.4%

Source: Dataquest (October 1995 Estimates)

Figure 5-1
1995 European Auto Stereo Production as Percentage of Worldwide Forecast



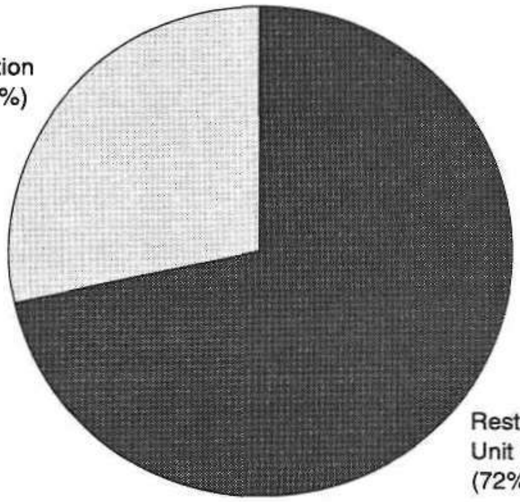
Source: Dataquest (October 1995 Estimates)

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

	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Engine Control Units							
Units (K)	9,500	10,790	11,299	11,685	12,190	12,210	5.1%
Factory ASP ($)	245	230	222	218	215	210	-3.0%
Factory Revenue ($M)	2,328	2,482	2,508	2,547	2,621	2,564	2.0%

Source: Dataquest (October 1995 Estimates)

Figure 5-2
1995 European Engine Control Unit Production as Percentage of Worldwide Forecast



Source: Dataquest (October 1995 Estimates)

Dataquest

a company of
The Dun & Bradstreet Corporation

DATAQUEST WORLDWIDE OFFICES

EUROPE

European Headquarters
Dataquest Europe Limited
Holmers Farm Way
High Wycombe, Bucks HP12 4XH
United Kingdom
Phone: +44 1494 422 722
Facsimile: +44 1494 422 742

Dataquest Europe SA
Immeuble Défense Bergères
345, avenue Georges Clémenceau
TSA 40002
92882 - Nanterre CTC Cedex 9
France
Phone: +33 1 41 35 13 00
Facsimile: +33 1 41 35 13 13

Dataquest GmbH
Kronstadter Strasse 9
81677 München
Germany
Phone: +49 89 93 09 09 0
Facsimile: +49 89 93 03 27 7

Sales Offices:
Brussels, Belgium
Kfar Saba, Israel
Milan, Italy
Randburg, South Africa
Madrid, Spain

LATIN AMERICA

Research Affiliates and Sales Offices:
Buenos Aires, Argentina
Sao Paulo, Brazil
Santiago, Chile
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NORTH AMERICA

Worldwide Headquarters
Dataquest Incorporated
251 River Oaks Parkway
San Jose, California 95134-1913
United States
Phone: 1-408-468-8000
Facsimile: 1-408-954-1780

Dataquest Incorporated
Nine Technology Drive
P.O. Box 5093
Westborough, Massachusetts
01581-5093
United States
Phone: 1-508-871-5555
Facsimile: 1-508-871-6262

Dataquest Global Events
3990 Westerly Place, Suite 100
Newport Beach, California 92660
United States
Phone: 1-714-476-9117
Facsimile: 1-714-476-9969

Sales Offices:
Washington, DC (Federal)
New York, NY (Financial)
Dallas, TX

JAPAN

Japan Headquarters
Dataquest Japan K.K.
Shinkawa Sanko Building
6th Floor
1-3-17, Shinkawa
Chuo-ku, Tokyo 104
Japan
Phone: 81-3-5566-0411
Facsimile: 81-3-5566-0425

ASIA/PACIFIC

Asia/Pacific Headquarters
7/F China Underwriters Centre
88 Gloucester Road
Wan Chai
Hong Kong
Phone: 852-2824-6168
Facsimile: 852-2824-6138

Dataquest Korea
Suite 2407, Trade Tower
159 Samsung-dong, Kangnam-gu
Seoul 135-729
Korea
Phone: 822-551-1331
Facsimile: 822-551-1330

Dataquest Taiwan
11F-2, No. 188, Section 5
Nan King East Road
Taipei
Taiwan, R.O.C.
Phone: 8862-756-0389
Facsimile: 8862-756-2663

Dataquest Singapore
105 Cecil Street
#06-01/02 The Octagon
Singapore 0106
Phone: 65-227-1213
Facsimile: 65-227-4607

Dataquest Thailand
12/F, Vanissa Building
29 Soi Chidlom
Ploenchit Road
Patumwan, Bangkok 10330
Thailand
Phone: 662-655-0577
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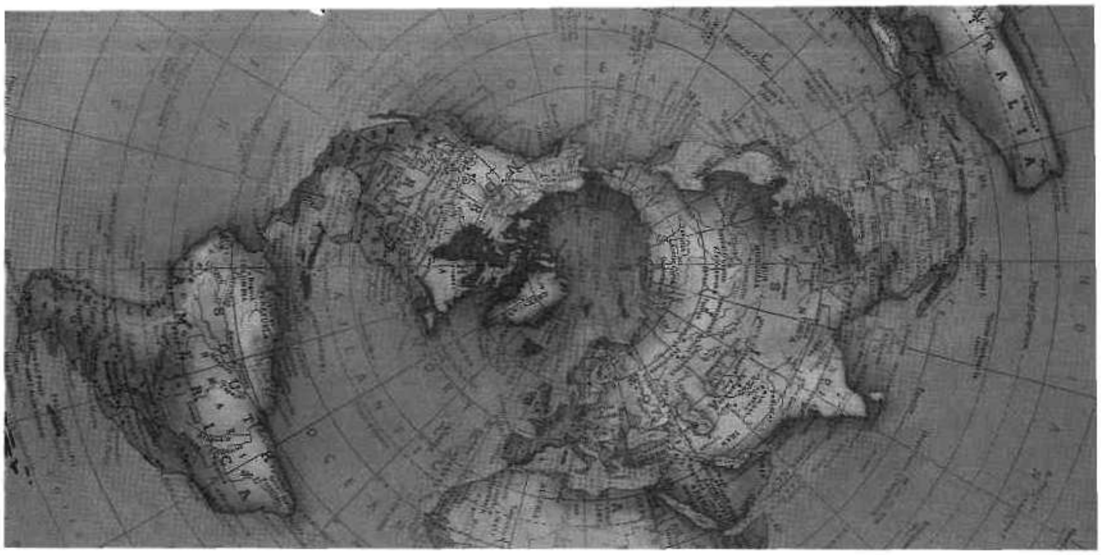
Market Analysis



Electronic Equipment Production Monitor

Quarterly Industry Review

Market Trends in European Electronic Equipment Production

This Quarterly Industry Review looks at production of electronic equipment in Europe during the second quarter of 1995 (April to June).

PC Production in Europe: A Golden Opportunity

The last issue of the EEPM Quarterly Industry Review included Dataquest's forecast of total electronic equipment production within Europe. In this issue we take a closer look at the main driver behind the growth in the electronic data processing (EDP) sector, namely personal computers (PCs).

PCs Move into the Mainstream

The last 18 months have seen the PC move from the office into the home. A combination of factors, including the falling price of multimedia components (such as CD-ROM drives), widespread coverage of the Internet in the media, and intensive marketing by Intel, Microsoft and major PC manufacturers such as Compaq and IBM, have significantly increased the demand for PCs in Europe.

The concept of using a PC at home has been gaining ground for several years now, but until recently it was still perceived as a work tool. However, the PC is now perceived as a machine for people to play games on, as well as offering information, education and entertainment for the whole family.

The convergence of the TV and PC is still in its early stages, but already many manufacturers are offering a combined PC and TV in a portable-TV-style case. This trend will continue, and as more services become available (via teletext, the telephone or other service providers) these combination systems will become even more integrated.

Dataquest

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Publication Date: July 31, 1995
Filing: Market Analysis

It is up to manufacturers (of equipment as diverse as telephone answering machines and photocopiers, to games consoles) that may be threatened by this convergence to take action now in order to exploit the growing opportunities of PC production.

European Production

The factory sales revenue from PCs dominates the EDP sector. PCs will make up 42 percent of the EDP sector in 1995, and this is forecast to grow to 55 percent in 1999. This is a reflection of the continuing trend towards client/server computing, away from mainframe-based systems. PCs make up 11 percent of all electronic equipment production in Europe in 1995; this share is forecast to grow to 15 percent in 1999.

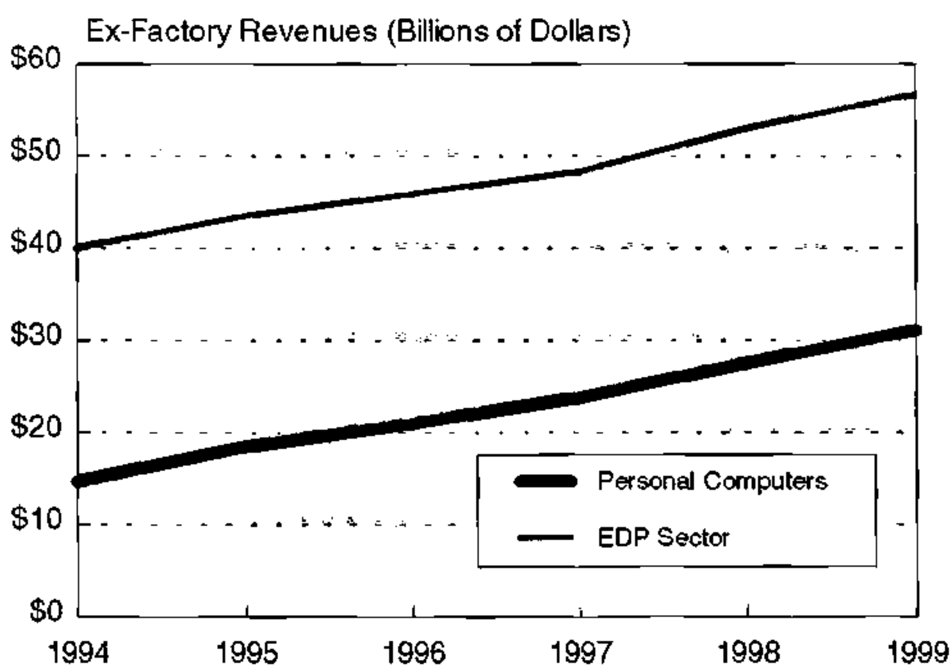
Table 1 shows the forecast for European factory sales revenue for PCs, together with figures for the electronic data processing (EDP) sector and total equipment production. Figure 1 shows the forecast of European factory sales revenue for PCs and the EDP sector.

Table 1
European PC, EDP, and Total Equipment Production—Forecast
(Millions of Dollars, Ex-Factory Revenues)

	1994	1995	1996	1997	1998	1999	1994-1999 CAGR
Personal Computers	$14,750	$18,460	$20,935	$23,760	$27,500	$31,080	16.1%
EDP Sector	$39,982	$43,475	$45,875	$48,285	$52,940	$56,715	7.2%
Total Equipment Production	$156,716	$166,831	$176,992	$186,880	$199,476	$211,637	6.2%

Source: Dataquest (July 1995 Estimates)

Figure 1
European PC, EDP, and Total Equipment Production—Forecast



Source: Dataquest (July 1995 Estimates)

1994 PC Production Growth Continues

PC production in Europe is rising fast. In 1994, 13 million PCs were produced in Europe, and Dataquest forecasts production of 16.3 million units in 1995—a 25 percent increase on the previous year.

Production in Europe outpaced shipments during 1994. This was due to PC manufacturers setting up, or expanding, production facilities. Western European production is used to supply markets in the Middle East and Africa, as well as Central and Eastern Europe.

Most major manufacturers now have some form of production facility within Europe. And now this extra manufacturing capacity is on stream, production is less likely to outpace shipments.

Why Manufacture in Europe?

With the shift away from supplying large numbers of PCs to corporate clients, to selling individual machines to the home market, PC manufacturers have had to change the way they distribute and manufacture PCs. Selling through retailers, which want to minimize inventory in the sales channel, has led to PC producers trying to operate a build-to-order system.

Most manufacturers have found that the only way to supply customers with constantly fluctuating order books is to produce close to that customer base. This means they can implement flexible manufacturing and distribution processes, as well as staying in touch with the demands of the local end user (a great benefit in the notoriously fickle PC marketplace).

However, a constantly changing order book at the PC manufacturer has consequences for component suppliers. This trend has been reflected in recent years by the implementation of sophisticated resource planning tools, and the growing use of electronic data interchange (EDI) to automatically place orders.

Full-Build and the Pentium

PC production falls into the following two categories:

- Full-build, where the motherboard is assembled, and then boxed with power supply unit, disk drives and add-in cards
- System build, where the assembled motherboard is imported (usually from the Far East), has a processor and memory added, and is then boxed

Full-build production may take place at the original equipment manufacturer (OEM, the brand owner), or at a contract electronics manufacturer (CEM). There is a growing trend towards full-build in Europe. This trend is driven by the greater flexibility (demanded by the sales channel) it offers, as well as the narrowing gap between Europe and the Far East in the cost-effective production of increasingly complex machines.

In 1994, 85 percent of PCs produced in Europe contained a 486 processor; the Pentium processor had only a 5 percent share of production. In 1995, this is forecast to change dramatically, with the Pentium in as many machines as the 486. This has implications for all the components on the motherboard, and in the machine.

Many of the Pentium processors being introduced run at higher clock speeds than their 486 predecessors. In addition, the bus carrying signals around the board also runs faster; thus, the components must be able to provide at least as much functionality as those in a 486-based machine, while being placed under more stress. This has obvious implications for component tolerances.

Manufacturers and Locations

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In 1994, 1.6 million PCs were sold in Central and Eastern Europe, and local production accounted for just over 1 million units. Most PC production in the region is system build, and on a relatively small scale.

Apart from IBM in Russia and Escom in the Czech Republic, most production is carried out by small, local companies. In the longer term, it is likely that several of the major manufacturers will establish significant production facilities in Central and Eastern Europe. The entry of large, international manufacturers will trigger rationalization among the many local companies currently manufacturing in the region.

In the short term, numerous obstacles hinder production in the region. One of the major issues is tariffs. Each country sets its own tariffs, which can vary significantly between components and assembled products. Tariffs can also differ depending on where the assembled equipment is being shipped to.

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- Reliability. The quality of PCs is now considered important.
- Industry-standard networking capabilities. Dataquest estimates that around 70 percent of PCs shipped in the region during the last 18 months are being networked.
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All these factors present significant opportunities for any company selling to the PC industry. The need for high-reliability machines requires high-quality components. Many local component manufacturers, unused to producing high-quality devices at low cost, will be unable to compete with components from Western Europe. This opens a window of opportunity, before local PC and component manufacturers start producing high-reliability, high-quality, very low-cost PCs.

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IBM

Having freed Xyratex (Havant, England) in a management buyout (MBO), IBM continues the trend by putting its plant in Valencia, Spain up for sale. The plant used to assemble IBM mainframes for the European market, but now assembles disk drives, communications products and point-of-sale equipment.

As IBM continues to rationalize its business, it also looks at what manufacturing capacity it requires to support that business. The (IBM-specific) product mix at the Spanish plant is more likely to lead to an MBO than a purchase by one of the major CEMs.

IBM has also started to assemble RS/6000 machines at its plant in Kvant, Zelenograd (Russia). It already assembles PCs there, and produces about 70 percent of the IBM PCs shipped in Russia.

There are several reasons why it is worthwhile to assemble either RS/6000s or PCs in Russia. PCs are a product where the ex-factory cost is dominated by the material content—a cost which is largely fixed. It therefore makes sense to reduce costs which are subject to more variation (such as labor and factory overheads), by manufacturing in Russia. Another reason is a new law "encouraging" state-owned companies to purchase goods (including computers) manufactured inside Russia. It may be that IBM's pioneering venture will prove to be a winner in the long-term development of Russian PC production.

ICL/Aquarius

ICL's PC arm, ICL Volume Products, has purchased Aquarius Robotron Systems, Germany's fifth-largest PC supplier. In 1994, Aquarius sold 150,000 PCs, while ICL sold twice that number. Aquarius manufactures PCs to order at its factory in Sömmerda (in former east Germany). The factory's maximum production capacity currently stands at 500,000 units annually.

Although it was the sales channels that were most attractive to ICL, together with the gain in market share in Europe (and especially Germany), the purchase also brings much-needed manufacturing capacity. It effectively doubles ICL Volume Products' PC production capacity, which is currently made up of ex-Nokia Data plants in Scandinavia. The factory in Germany also reduces ICL Volume Products' reliance on its sister company, Design to Distribution (D2D). ICL is placing the ownership of PC production facilities with the PC business, rather than a CEM, however close the ties with the CEM may be.

Madge

Madge, the UK-based networking company, registered in the Netherlands, has announced a series of expansions. Having used contract manufacturers to produce all Madge products until now, the company has decided to set up its own manufacturing plant at Swords, Ireland. It intends to invest $14 million in the facility, initially to support printed circuit board (PCB) assembly and testing. The production facility will be in addition to CEM capacity. A second announcement related to an R&D center that the company has opened in Stoke Poges, England.

Both of these announcements were made less than a month before Madge's acquisition of Lannet, an Israeli networking company. Lannet brings expertise in asynchronous transfer mode (ATM) technology to Madge, which historically has had expertise in Token-Ring technology. This will enable Madge to migrate customers from Token-Ring to ATM, using the combined expertise of the two companies.

Madge has an aggressive growth strategy, and until now has concentrated on R&D, marketing, and managing its supply chain. However, it has now grown to a size where it can financially justify the investment in a manufacturing plant, which helps it to guarantee product supply to its customers.

Nortel

Nortel, the renamed Northern Telecom, is expanding its R&D and manufacturing site at Paignton, England. The expansion will cover a new facility for technical development, low-volume manufacturing, and marketing and management of a new fixed radio access (FRA) system.

The FRA system offers an alternative to cable-to-house as a means of delivering telecommunications services. It offers ISDN-quality (and capacity) via a fixed radio link. In the United Kingdom, British Telecommunications plc (BT) continues to dominate the local loop, even with competition from cable TV companies, and it is likely that most of the Paignton production is destined for export.

Pace

Pace has linked with a Carlton Communications subsidiary, Carlton Cabletime, to design, manufacture and sell digital and analog cable STBs. Carlton will manage the marketing and selling of the products, while Pace will manage the manufacture of the boxes. Although Pace has its own production capacity (at Saltaire, England), it also uses CEMs including Mion and D2D.

Philips

Philips TRT, a French subsidiary of Philips Electronics specializing in telecoms equipment, has announced job cuts. The company plans to shed just over 150 jobs, from a total of 1,244, at its Plessis-Robinson plant, Paris, France.

Rank Xerox

Rank Xerox has invested in a new surface-mount production line as part of a $4 million investment in its Mitcheldean, England plant. The site manufactures many types of PCB, for worldwide consumption in various photocopier-based machines.

Rank Xerox is moving to position itself as "the document company," and with its history of equipment production, it is unlikely to stop (at least in the short term) manufacturing hardware to support its new digital document software and services. Investing in a key manufacturing site (which supports worldwide equipment production) suggests that Rank Xerox has a long-term manufacturing strategy in supports of its business strategy.

Seagate

Seagate has announced plans to invest $35 million in a rigid disk drive manufacturing facility at Clonmel, Ireland. The capacity of the plant is anticipated to exceed 5 million units annually. Production is scheduled to begin in mid-October 1995, with a projected output of 3 million disk drives in 1996. The Clonmel facility will feature some of the industry's most advanced automated process technologies. It is thought that the first products manufactured will be a new generation of low-cost, high-capacity drives.

One of the major factors in selecting the location was the need to supply major customers effectively. The United Kingdom and Ireland represented 46.7 percent of the 13 million PCs made in Europe during 1994. Many of the PC manufacturers are implementing build-to-order, using just-in-time (JIT) delivery scheduling to minimize their inventory. These customer requirements are best fulfilled through local manufacture.

Dataquest estimates that more than one in four disk drives consumed in Europe during 1995 will be made locally; and with this announcement (from Seagate) the ratio will become one in three in 1996.

Storage Technology

Storage Technology, which as the name suggests, specializes in storage products such as tape backup units, has opened a new plant in Toulouse, France.

The plant will manufacture current products, such as tape-cartridge devices, as well as developing new hardware and software for future storage products.

Tulip

Tulip, the PC producer based in Hertogenbosch, Netherlands, has added a second surface-mount PCB-assembly line at a cost of $4 million. This provides capacity of 250,000 boards annually.

Tulip has been assembling PCBs for some time, and now feels confident enough in the rising demand for PCs in Europe to invest a significant sum in board assembly equipment.

Contract Manufacturing News

AB

AB has invested $1.6 million in surface-mount production capacity. The investment in Fuji equipment doubles the company's capacity to place very fine-pitch components, including ball grid array (BGA) devices.

This investment by AB is in line with trends in the CEM industry. As BGA and fine-pitch devices become more widespread (driven predominantly by the IT industry) there will be a need to place these devices on PCBs. The critical task for CEMs is to balance the investment in equipment which supports current customer requirements, with investment in technology which enables CEMs to stay ahead of the competition and differentiate themselves.

AB's choice of Fuji equipment is an industry trend. SCI, for example, has more than 150 production lines, many based on Fuji equipment. And other major manufacturers, including Motorola, Compaq and Nokia, use Fuji equipment.

Jabil

The Jabil plant in Livingston, Scotland is investing in production capacity, including a surface-mount production line, in order to assemble PCBs for Motorola's mobile telephone plant at Easter Inch, Scotland. In addition to the Motorola arrangement, Jabil also has a major contract, to manufacture network products for 3Com.

Jabil's first plant outside the United States has been expanding rapidly over the past couple of years, and the company has almost outgrown the current facilities. It faces a decision between expanding the present plant, or building a new, larger, purpose-built plant.

Jabil (Scotland) has picked up a significant amount of work (in less than three years) from US corporations that are familiar with Jabil in the United States. Because US-based OEMs work with CEMs in the United States, they are more likely to place overseas business with a CEM they are familiar with. This makes it harder for European-headquartered CEMs, with little global coverage, to win high-value contracts from US-based OEMs.

Mion

Mion, the Barnsley, England–based CEM, recently opened a new purpose-built production facility, worth $17.5 million. Mion also announced a new contract to produce modems for Pace, in addition to satellite decoder boxes which Mion already manufactures for Pace.

Contract electronics manufacturing is a growth sector, and new investment is to be welcomed. A greenfield site and low labor costs, coupled with a high degree of automation and competent management, are the best chances a start-up CEM can have. However, any investment is for the long term, as payback periods can be long and the CEM sector remains volatile.

Ogden

Ogden, a US-based company, is taking over the manufacturing facilities of Logitech in Ireland, in order to provide CEM services. The company will continue to manufacture products (including mice and scanners) for Logitech, as well as offering its services to other OEMs.

Solectron

Hewlett-Packard is selling its PC manufacturing plant at Böblingen, Germany to Solectron. Solectron will continue to manufacture for Hewlett-Packard, as well as looking for contract work. This announcement follows Solectron's purchase of a Philips manufacturing plant in Scotland, and Hewlett-Packard's disposal of a surface-mount assembly plant in Grenoble, France to SCI (both during 1994).

CEM Focus: The Race/Gooding Collapse

Race Electronics, the UK-based CEM, has gone into receivership. This is an event that demonstrates the precarious nature of the business, and is a warning to other CEMs of what can go wrong.

In April this year, Alf Gooding (chairman of Race) sold a majority interest in part of Gooding Consumer Electronics (a plant manufacturing satellite receiving equipment), to Grundig. It seems that this was an attempt to raise funds to support Race, a company with cash flow problems.

However, in early June, Race Electronics called in the receivers. The company owed several million pounds, and although it had full order books, it was struggling to source components and generate cash. Race had grown rapidly during the late 1980s, but got caught in the downturn of the early 1990s, and lost $12 million between 1992 and 1994.

At the end of June, another part of Gooding Consumer Electronics—a TV manufacturing plant, in Creutzwald, France—went into administration. The plant (formerly owned by Grundig), was again hit by poor cash flow, and the worldwide shortage of cathode ray tubes.

At the time of writing, no announcement has been made about the future of the businesses. There is speculation that Grundig may financially support or even repurchase the TV factory. As for Race Electronics, several companies have expressed interest in the business, and it is likely that an announcement will be made during the next month.

Dataquest Perspective

The announcement that Race Electronics had called in the receivers may have been a surprise to some. However, the writing has been on the wall for the whole CEM sector for some time. An industry which requires high levels of capital expenditure, funded by thin margins, is always going to find it tough staying in business.

The CEM industry has been in a state of flux for the last few years, with OEMs setting up CEM businesses, and in several cases subsequently selling these "new" businesses to large, established CEM players such as SCI, Jabil and Solectron. Some companies, notably Hewlett-Packard, sell their manufacturing plants direct to the CEMs.

The main problems faced by Race are known throughout the industry. The first is shortage of working capital, which can be hard to come by in an industry that is perceived as low-margin and volatile. Component shortages are critical for any manufacturing company, and for Race a halt in production means a similar halt in cash flow, leading to further problems purchasing components or servicing debt. It is a situation that can easily spiral out of control.

With the consolidation of the CEM sector into a handful of global players, it is inevitable that their buying power starts to command more respect than that of their smaller competitors. Every manufacturer should be using sophisticated supply chain management techniques such as JIT and MRPII as a matter of course. They need an experienced and aggressive purchasing team, with good worldwide connections. Problems with component supply was just one of several factors that forced Race out of business, but it is a critical issue within the industry. An industry where the material cost makes up most of the factory selling price needs total control over that cost.

It is an unfortunate, but necessary, consequence of the market that big players tend to broke the best deals. And although the larger players are not immune, it is likely to be the middle-tier and smaller companies that really feel the effects of the phenomenal worldwide demand for electronic goods.

By Robin Daines

For More Information...
Robin Daines .... +44 1494 422 725
Internet address .... rdaines@dqeurope.com
Via fax .... +44 1494 422 742

Market
Analysis

Electronic Equipment Production Monitor

Quarterly Industry Review

Market Trends in European Electronic Equipment Production

This Quarterly Industry Review looks at production of electronic equipment in Europe during the second quarter of 1995 (April to June).

PC Production in Europe: A Golden Opportunity

The last issue of the EEPM Quarterly Industry Review included Dataquest's forecast of total electronic equipment production within Europe. In this issue we take a closer look at the main driver behind the growth in the electronic data processing (EDP) sector, namely personal computers (PCs).

PCs Move into the Mainstream

The last 18 months have seen the PC move from the office into the home. A combination of factors, including the falling price of multimedia components (such as CD-ROM drives), widespread coverage of the Internet in the media, and intensive marketing by Intel, Microsoft and major PC manufacturers such as Compaq and IBM, have significantly increased the demand for PCs in Europe.

The concept of using a PC at home has been gaining ground for several years now, but until recently it was still perceived as a work tool. However, the PC is now perceived as a machine for people to play games on, as well as offering information, education and entertainment for the whole family.

The convergence of the TV and PC is still in its early stages, but already many manufacturers are offering a combined PC and TV in a portable-TV-style case. This trend will continue, and as more services become available (via teletext, the telephone or other service providers) these combination systems will become even more integrated.

Dataquest

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Filing: Market Analysis

It is up to manufacturers (of equipment as diverse as telephone answering machines and photocopiers, to games consoles) that may be threatened by this convergence to take action now in order to exploit the growing opportunities of PC production.

European Production

The factory sales revenue from PCs dominates the EDP sector. PCs will make up 42 percent of the EDP sector in 1995, and this is forecast to grow to 55 percent in 1999. This is a reflection of the continuing trend towards client/server computing, away from mainframe-based systems. PCs make up 11 percent of all electronic equipment production in Europe in 1995; this share is forecast to grow to 15 percent in 1999.

Table 1 shows the forecast for European factory sales revenue for PCs, together with figures for the electronic data processing (EDP) sector and total equipment production. Figure 1 shows the forecast of European factory sales revenue for PCs and the EDP sector.

Table 1
European PC, EDP, and Total Equipment Production—Forecast
(Millions of Dollars, Ex-Factory Revenues)

	1994	1995	1996	1997	1998	1999	1994-1999 CAGR
Personal Computers	$14,750	$18,460	$20,935	$23,760	$27,500	$31,080	16.1%
EDP Sector	$39,982	$43,475	$45,875	$48,285	$52,940	$56,715	7.2%
Total Equipment Production	$156,716	$166,831	$176,992	$186,880	$199,476	$211,637	6.2%

Source: Dataquest (July 1995 Estimates)

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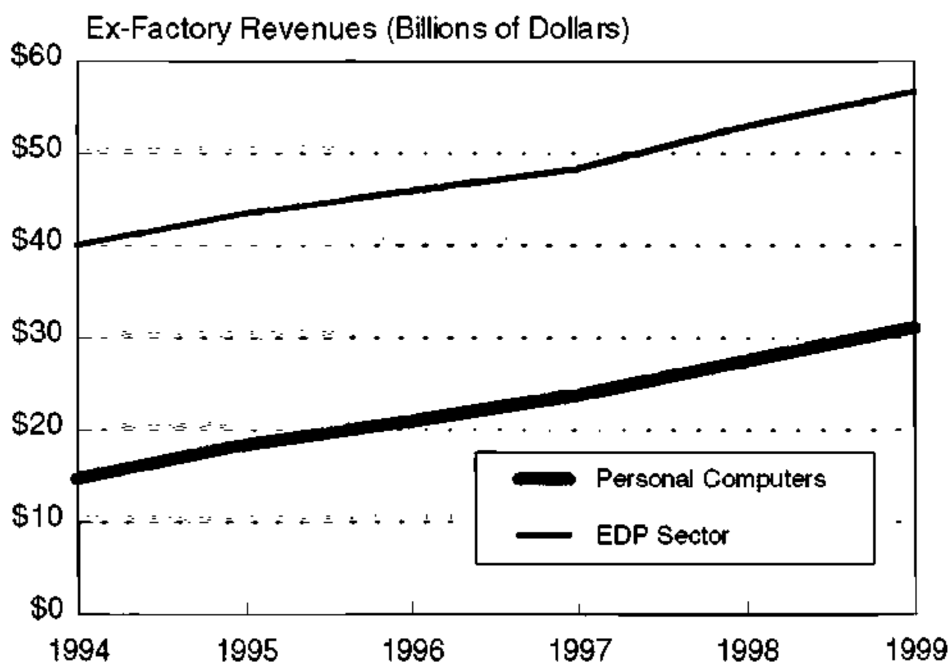

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1994 PC Production Growth Continues

PC production in Europe is rising fast. In 1994, 13 million PCs were produced in Europe, and Dataquest forecasts production of 16.3 million units in 1995—a 25 percent increase on the previous year.

Production in Europe outpaced shipments during 1994. This was due to PC manufacturers setting up, or expanding, production facilities. Western European production is used to supply markets in the Middle East and Africa, as well as Central and Eastern Europe.

Most major manufacturers now have some form of production facility within Europe. And now this extra manufacturing capacity is on stream, production is less likely to outpace shipments.

Why Manufacture in Europe?

With the shift away from supplying large numbers of PCs to corporate clients, to selling individual machines to the home market, PC manufacturers have had to change the way they distribute and manufacture PCs. Selling through retailers, which want to minimize inventory in the sales channel, has led to PC producers trying to operate a build-to-order system.

Most manufacturers have found that the only way to supply customers with constantly fluctuating order books is to produce close to that customer base. This means they can implement flexible manufacturing and distribution processes, as well as staying in touch with the demands of the local end user (a great benefit in the notoriously fickle PC marketplace).

However, a constantly changing order book at the PC manufacturer has consequences for component suppliers. This trend has been reflected in recent years by the implementation of sophisticated resource planning tools, and the growing use of electronic data interchange (EDI) to automatically place orders.

Full-Build and the Pentium

PC production falls into the following two categories:

- Full-build, where the motherboard is assembled, and then boxed with power supply unit, disk drives and add-in cards
- System build, where the assembled motherboard is imported (usually from the Far East), has a processor and memory added, and is then boxed

Full-build production may take place at the original equipment manufacturer (OEM, the brand owner), or at a contract electronics manufacturer (CEM). There is a growing trend towards full-build in Europe. This trend is driven by the greater flexibility (demanded by the sales channel) it offers, as well as the narrowing gap between Europe and the Far East in the cost-effective production of increasingly complex machines.

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Hyundai has chosen this market for strategic reasons. There are many players in the emerging STB market. Other companies tend to have technical expertise in the new technologies (such as digital broadcasting and data compression), or have many years' experience with current (cable TV) STB technology. Hyundai has its single-chip MPEG-2 solution, has a partnership with an established STB manufacturer, and owns a cable-TV channel in Korea. It has plans in place to support its entry into STB production, and will use its purchasing clout and manufacturing experience to produce a cheap box for a price-conscious market.

IBM

Having freed Xyratex (Havant, England) in a management buyout (MBO), IBM continues the trend by putting its plant in Valencia, Spain up for sale. The plant used to assemble IBM mainframes for the European market, but now assembles disk drives, communications products and point-of-sale equipment.

As IBM continues to rationalize its business, it also looks at what manufacturing capacity it requires to support that business. The (IBM-specific) product mix at the Spanish plant is more likely to lead to an MBO than a purchase by one of the major CEMs.

IBM has also started to assemble RS/6000 machines at its plant in Kvant, Zelenograd (Russia). It already assembles PCs there, and produces about 70 percent of the IBM PCs shipped in Russia.

There are several reasons why it is worthwhile to assemble either RS/6000s or PCs in Russia. PCs are a product where the ex-factory cost is dominated by the material content—a cost which is largely fixed. It therefore makes sense to reduce costs which are subject to more variation (such as labor and factory overheads), by manufacturing in Russia. Another reason is a new law "encouraging" state-owned companies to purchase goods (including computers) manufactured inside Russia. It may be that IBM's pioneering venture will prove to be a winner in the long-term development of Russian PC production.

ICL/Aquarius

ICL's PC arm, ICL Volume Products, has purchased Aquarius Robotron Systems, Germany's fifth-largest PC supplier. In 1994, Aquarius sold 150,000 PCs, while ICL sold twice that number. Aquarius manufactures PCs to order at its factory in Sömmerda (in former east Germany). The factory's maximum production capacity currently stands at 500,000 units annually.

Although it was the sales channels that were most attractive to ICL, together with the gain in market share in Europe (and especially Germany), the purchase also brings much-needed manufacturing capacity. It effectively doubles ICL Volume Products' PC production capacity, which is currently made up of ex–Nokia Data plants in Scandinavia. The factory in Germany also reduces ICL Volume Products' reliance on its sister company, Design to Distribution (D2D). ICL is placing the ownership of PC production facilities with the PC business, rather than a CEM, however close the ties with the CEM may be.

Madge

Madge, the UK-based networking company, registered in the Netherlands, has announced a series of expansions. Having used contract manufacturers to produce all Madge products until now, the company has decided to set up its own manufacturing plant at Swords, Ireland. It intends to invest $14 million in the facility, initially to support printed circuit board (PCB) assembly and testing. The production facility will be in addition to CEM capacity. A second announcement related to an R&D center that the company has opened in Stoke Poges, England.

Both of these announcements were made less than a month before Madge's acquisition of Lannet, an Israeli networking company. Lannet brings expertise in asynchronous transfer mode (ATM) technology to Madge, which historically has had expertise in Token-Ring technology. This will enable Madge to migrate customers from Token-Ring to ATM, using the combined expertise of the two companies.

Madge has an aggressive growth strategy, and until now has concentrated on R&D, marketing, and managing its supply chain. However, it has now grown to a size where it can financially justify the investment in a manufacturing plant, which helps it to guarantee product supply to its customers.

Nortel

Nortel, the renamed Northern Telecom, is expanding its R&D and manufacturing site at Paignton, England. The expansion will cover a new facility for technical development, low-volume manufacturing, and marketing and management of a new fixed radio access (FRA) system.

The FRA system offers an alternative to cable-to-house as a means of delivering telecommunications services. It offers ISDN-quality (and capacity) via a fixed radio link. In the United Kingdom, British Telecommunications plc (BT) continues to dominate the local loop, even with competition from cable TV companies, and it is likely that most of the Paignton production is destined for export.

Pace

Pace has linked with a Carlton Communications subsidiary, Carlton Cabletime, to design, manufacture and sell digital and analog cable STBs. Carlton will manage the marketing and selling of the products, while Pace will manage the manufacture of the boxes. Although Pace has its own production capacity (at Saltaire, England), it also uses CEMs including Mion and D2D.

Philips

Philips TRT, a French subsidiary of Philips Electronics specializing in telecoms equipment, has announced job cuts. The company plans to shed just over 150 jobs, from a total of 1,244, at its Plessis-Robinson plant, Paris, France.

Rank Xerox

Rank Xerox has invested in a new surface-mount production line as part of a $4 million investment in its Mitcheldean, England plant. The site manufactures many types of PCB, for worldwide consumption in various photocopier-based machines.

Rank Xerox is moving to position itself as "the document company," and with its history of equipment production, it is unlikely to stop (at least in the short term) manufacturing hardware to support its new digital document software and services. Investing in a key manufacturing site (which supports worldwide equipment production) suggests that Rank Xerox has a long-term manufacturing strategy in supports of its business strategy.

Seagate

Seagate has announced plans to invest $35 million in a rigid disk drive manufacturing facility at Clonmel, Ireland. The capacity of the plant is anticipated to exceed 5 million units annually. Production is scheduled to begin in mid-October 1995, with a projected output of 3 million disk drives in 1996. The Clonmel facility will feature some of the industry's most advanced automated process technologies. It is thought that the first products manufactured will be a new generation of low-cost, high-capacity drives.

One of the major factors in selecting the location was the need to supply major customers effectively. The United Kingdom and Ireland represented 46.7 percent of the 13 million PCs made in Europe during 1994. Many of the PC manufacturers are implementing build-to-order, using just-in-time (JIT) delivery scheduling to minimize their inventory. These customer requirements are best fulfilled through local manufacture.

Dataquest estimates that more than one in four disk drives consumed in Europe during 1995 will be made locally; and with this announcement (from Seagate) the ratio will become one in three in 1996.

Storage Technology

Storage Technology, which as the name suggests, specializes in storage products such as tape backup units, has opened a new plant in Toulouse, France.

The plant will manufacture current products, such as tape-cartridge devices, as well as developing new hardware and software for future storage products.

Tulip

Tulip, the PC producer based in Hertogenbosch, Netherlands, has added a second surface-mount PCB-assembly line at a cost of $4 million. This provides capacity of 250,000 boards annually.

Tulip has been assembling PCBs for some time, and now feels confident enough in the rising demand for PCs in Europe to invest a significant sum in board assembly equipment.

Contract Manufacturing News

AB

AB has invested $1.6 million in surface-mount production capacity. The investment in Fuji equipment doubles the company's capacity to place very fine-pitch components, including ball grid array (BGA) devices.

This investment by AB is in line with trends in the CEM industry. As BGA and fine-pitch devices become more widespread (driven predominantly by the IT industry) there will be a need to place these devices on PCBs. The critical task for CEMs is to balance the investment in equipment which supports current customer requirements, with investment in technology which enables CEMs to stay ahead of the competition and differentiate themselves.

AB's choice of Fuji equipment is an industry trend. SCI, for example, has more than 150 production lines, many based on Fuji equipment. And other major manufacturers, including Motorola, Compaq and Nokia, use Fuji equipment.

Jabil

The Jabil plant in Livingston, Scotland is investing in production capacity, including a surface-mount production line, in order to assemble PCBs for Motorola's mobile telephone plant at Easter Inch, Scotland. In addition to the Motorola arrangement, Jabil also has a major contract, to manufacture network products for 3Com.

Jabil's first plant outside the United States has been expanding rapidly over the past couple of years, and the company has almost outgrown the current facilities. It faces a decision between expanding the present plant, or building a new, larger, purpose-built plant.

Jabil (Scotland) has picked up a significant amount of work (in less than three years) from US corporations that are familiar with Jabil in the United States. Because US-based OEMs work with CEMs in the United States, they are more likely to place overseas business with a CEM they are familiar with. This makes it harder for European-headquartered CEMs, with little global coverage, to win high-value contracts from US-based OEMs.

Mion

Mion, the Barnsley, England–based CEM, recently opened a new purpose-built production facility, worth $17.5 million. Mion also announced a new contract to produce modems for Pace, in addition to satellite decoder boxes which Mion already manufactures for Pace.

Contract electronics manufacturing is a growth sector, and new investment is to be welcomed. A greenfield site and low labor costs, coupled with a high degree of automation and competent management, are the best chances a start-up CEM can have. However, any investment is for the long term, as pay-back periods can be long and the CEM sector remains volatile.

Ogden

Ogden, a US-based company, is taking over the manufacturing facilities of Logitech in Ireland, in order to provide CEM services. The company will continue to manufacture products (including mice and scanners) for Logitech, as well as offering its services to other OEMs.

Solectron

Hewlett-Packard is selling its PC manufacturing plant at Böblingen, Germany to Solectron. Solectron will continue to manufacture for Hewlett-Packard, as well as looking for contract work. This announcement follows Solectron's purchase of a Philips manufacturing plant in Scotland, and Hewlett-Packard's disposal of a surface-mount assembly plant in Grenoble, France to SCI (both during 1994).

CEM Focus: The Race/Gooding Collapse

Race Electronics, the UK-based CEM, has gone into receivership. This is an event that demonstrates the precarious nature of the business, and is a warning to other CEMs of what can go wrong.

In April this year, Alf Gooding (chairman of Race) sold a majority interest in part of Gooding Consumer Electronics (a plant manufacturing satellite receiving equipment), to Grundig. It seems that this was an attempt to raise funds to support Race, a company with cash flow problems.

However, in early June, Race Electronics called in the receivers. The company owed several million pounds, and although it had full order books, it was struggling to source components and generate cash. Race had grown rapidly during the late 1980s, but got caught in the downturn of the early 1990s, and lost $12 million between 1992 and 1994.

At the end of June, another part of Gooding Consumer Electronics—a TV manufacturing plant, in Creutzwald, France—went into administration. The plant (formerly owned by Grundig), was again hit by poor cash flow, and the worldwide shortage of cathode ray tubes.

At the time of writing, no announcement has been made about the future of the businesses. There is speculation that Grundig may financially support or even repurchase the TV factory. As for Race Electronics, several companies have expressed interest in the business, and it is likely that an announcement will be made during the next month.

Dataquest Perspective

The announcement that Race Electronics had called in the receivers may have been a surprise to some. However, the writing has been on the wall for the whole CEM sector for some time. An industry which requires high levels of capital expenditure, funded by thin margins, is always going to find it tough staying in business.

The CEM industry has been in a state of flux for the last few years, with OEMs setting up CEM businesses, and in several cases subsequently selling these "new" businesses to large, established CEM players such as SCI, Jabil and Solectron. Some companies, notably Hewlett-Packard, sell their manufacturing plants direct to the CEMs.

The main problems faced by Race are known throughout the industry. The first is shortage of working capital, which can be hard to come by in an industry that is perceived as low-margin and volatile. Component shortages are critical for any manufacturing company, and for Race a halt in production means a similar halt in cash flow, leading to further problems purchasing components or servicing debt. It is a situation that can easily spiral out of control.

With the consolidation of the CEM sector into a handful of global players, it is inevitable that their buying power starts to command more respect than that of their smaller competitors. Every manufacturer should be using sophisticated supply chain management techniques such as JIT and MRPII as a matter of course. They need an experienced and aggressive purchasing team, with good worldwide connections. Problems with component supply was just one of several factors that forced Race out of business, but it is a critical issue within the industry. An industry where the material cost makes up most of the factory selling price needs total control over that cost.

It is an unfortunate, but necessary, consequence of the market that big players tend to broke the best deals. And although the larger players are not immune, it is likely to be the middle-tier and smaller companies that really feel the effects of the phenomenal worldwide demand for electronic goods.

By Robin Daines

For More Information...

Robin Daines .... +44 1494 422 725
Internet address .... rdaines@dqeurope.com
Via fax .... +44 1494 422 742

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Market Analysis

Electronic Equipment Production Monitor

Quarterly Industry Review

Market Trends in European Electronic Equipment Production

This Quarterly Industry Review looks at production of electronic equipment in Europe during the first quarter of 1995 (January to March).

European Electronic Equipment Production: 1994-1999

Factory Revenue Forecasts

PCs, mobile communications, domestic video, and in-car electronics are the products driving European electronic equipment production into the 21st century. Dataquest tracks component consumption by each sector of the electronics industry, and forecasts production volumes for each product category. Market statistics have been collected for 1994, and forecasts adjusted for 1995 through 1999.

Table 1 contains Dataquest's forecast for electronic equipment production, by industry sector, within Europe until 1999. Total equipment production shows a compound annual growth rate (CAGR) of 6 percent for the period. Factory revenue stands at $166 billion during 1995. Figure 1 shows factory revenue for each sector—electronic data processing, communications, consumer, transportation, and other (industrial and military/aerospace). Data processing and communications (and their interdependence) are the two sectors driving component consumption, and production, within Europe.

Dataquest

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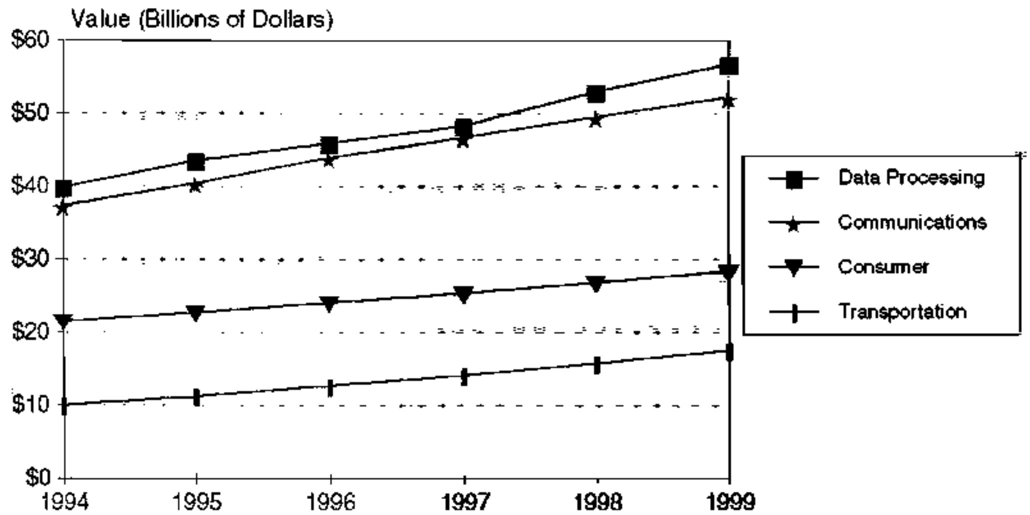
Table 1
European Electronic Equipment Production by Industry Sector
(Factory Revenue, Billions of Dollars)

Year	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Total Equipment Production	**156.7**	**166.8**	**177.0**	**186.9**	**199.5**	**211.6**	**6.2%**
Data Processing Equipment	39.9	43.5	45.9	48.3	52.9	56.7	7.2%
Communications Equipment	37.3	40.4	43.9	46.7	49.4	52.1	6.9%
Consumer Equipment	21.4	22.6	23.9	25.3	26.8	28.2	5.7%
Transportation Equipment	10.0	11.2	12.6	14.1	15.8	17.5	12.0%
Other Equipment	48.1	49.1	50.7	52.5	54.6	57.1	3.5%

Source: Dataquest (May 1995 Estimates)

Figure 1
European Electronic Equipment Production by Industry Sector
(Ex-Factory Revenue)



Source: Dataquest (May 1995 Estimates)

Data Processing Equipment

Dataquest's forecast for data processing equipment production within Europe until 1999 shows a CAGR of just over 7 percent for the period. The data processing sector is being driven by PC production. After selling into the small office, home office (SOHO) market, the next target for PC manufacturers is the family home. For example, Intel is marketing Pentium (via TV advertisements within the home) as its entry-level processor. PCs designated for the home are multimedia-based systems, and tend to have a higher specification than the average business machine (for example, during 1995, more PCs equipped with CD-ROM will ship to the home than the office). In general, most of the home PCs are equipped with CD-ROM, and sound capabilities, a DX2, DX4 or Pentium processsor, and 8MB of RAM.

European production of PCs featuring low-specification CPUs (25 to 50 MHz) is small, representing just over 11 percent of production. It is merely an opportunity for both PC and CPU manufacturers to clear inventory which is now considered obsolete. However, motherboards for these low-specification

PCs are likely to be sourced from outside Europe for this very price-sensitive market.

In contrast to a business consumer, a home user is unlikely to upgrade by purchasing a completely new PC every three years. And one of the key selling points of the home PCs is that they are internally upgradable. A combination of frustration, and new operating systems, will fuel demand for both CPU and memory upgrades. Home users are likely to buy both modems and printers, and these products will contribute to increased production within the sector.

With PC production within Europe running at an all time high, almost all of the high-value board-level components (such as DRAMs, CPUs and chipsets) are now sourced within Europe. The picture is not the same for some peripherals such as video cards and disk drives. For example, a combination of technology and demand have caused disk storage prices to drop. The fall in prices means that in many cases it is uneconomical to assemble rigid disk drives (RDDs) within Europe; thus, leading to a long-term decline in European RDD production, similar to the extinction of floppy disk drive (FDD) production within Europe.

Communications Equipment

Dataquest's forecast for communications equipment production within Europe until 1999 shows a CAGR of just under 7 percent for the period. There is strong growth in the production value of all types of telecommunications equipment, except for public infrastructure equipment. Deregulation in European telecoms markets will accelerate over the next few years, leading to increased production volumes. However, the increasingly competitive market faced by the suppliers will result in the value of factory output remaining flat, as producers sacrifice margin in order to win business.

The strongest growth within the communications sector is from mobile products. The investment in GSM and DCS-1800 networks across Europe, together with a sharp increase in demand for digital handsets, is fuelling phenomenal growth in manufacturing output. European production levels are attempting to keep up with domestic demand, as well as supplying markets outside Europe.

As personal wireless communications and PCs converge, there will be demand for products offering simple messaging, e-mail and multimedia direct to the handset. Any sort of embedded PC functionality within mobile communication devices has implications for handset design and manufacture.

Portable devices will use more complex PCBs, with increasing layer count and finer track geometry. Increasingly, the components assembled will be exclusively low-profile, fine-pitch, surface-mount devices. Display subsystems and system I/O connectors will be more sophisticated. There may be a move to support multimedia-type applications with more advanced audio transducers. Very small (0402 profile) surface-mount passive components are already being used on handset devices, and we expect this trend to continue.

Digital communication products are an area where Europe has a lead in design and manufacturing expertise.

Consumer Equipment

Dataquest's forecast for consumer equipment production within Europe until 1999 shows a CAGR of 5.7 percent for the period. The increase in production of consumer equipment is helped by the two old stalwarts, audio and video. Audio growth will come from emerging digital audio products, coupled with increased penetration of CD players. European licensees of Sony (MiniDisc) and Philips (with its competing DCC product) technology, selling players and systems built around the new formats, will account for the bulk of new production.

The growth in production of video equipment (a CAGR of more than 10 percent) for the period 1994 to 1999 is nearly twice the rate for the consumer sector as a whole. The growth is being driven by domestic production of set-top boxes, for satellite TV and cable TV, as well as emerging interactive TV and video-on-demand applications. Home cinema is another area experiencing strong growth. High-definition (HDTV), wide-screen and digital television, together with surround sound, are emerging products, for which manufacturers anticipate high demand.

The products (such as HDTV and set-top boxes) based on regional hardware and transmission standards, are likely to remain relatively expensive to manufacture. Products which cannot reach a worldwide market will continue to be manufactured in their home market, with all the implications this represents.

Components in demand for the new wave of digital consumer products include the ubiquitous DRAM ICs, together with their attendant digital audio/video chipsets, media transport mechanisms, and new wide-screen CRT displays.

Design for manufacturing expertise will be essential for the new consumer audio products. In order to stimulate demand, prices must be low, and to offer low prices while still ramping to volume is difficult. The products themselves marry a compact and sophisticated transport mechanism to a complex assembled PCB. It is the process of taking cost out of the entire manufacturing and supply operation that will bring success or failure to players in this market.

Transportation Equipment

Dataquest's forecast for transportation-related equipment production within Europe until 1999 shows a CAGR of 12 percent for the period. The high level of growth in automotive equipment production is being driven by more sophisticated engine management units (EMUs), and safety-related devices. Californian legislation is driving a variety of automotive design parameters (including safety and emission control) in all regional markets.

Engine management and fuel injection will become standard features on even the smallest vehicles, particularly as these tend to be driven in polluted city centers. The engine management systems will have to become more sophisticated as they provide more functionality, in order to further reduce unwanted emissions.

Safety features such as antilock braking systems (ABS), traction control and airbags will be more prevalent on even basic vehicles, due to a mixture of legislation and marketing necessity. All these items require control electronics. And as more parts of a vehicle are controlled, or monitored, by electronic systems, there will be increased integration into a central control function.

Vehicle electronics will demand ever more sophisticated sensors, microcontrollers and power semiconductor devices.

Automotive electronics will increasingly involve assembling components (including highly integrated ICs) onto small, irregularly shaped (and in some cases flexible) PCBs. The circuits will be required to perform reliably, under harsh conditions, for the lifetime of the vehicle. Safety-critical electronics require environmental and electrical stress, in order to accelerate the early lifetime of the device. This has to be done cost-effectively, as electronics are just one of many costs incurred in designing and building a vehicle.

OEM News

Company Updates

Acorn

Acorn is starting to reposition itself as a company aimed at RISC-CPU applications. Its subsidiary Online Media is taking part in video-on-demand trials in Cambridge, England. Online is currently looking for a manufacturing partner for its set-top boxes.

Amstrad

In line with Amstrad's decision to sell direct, and to use its experience of marketing consumer-oriented products, the company has made several recent announcements. First on the shopping list was Dancall, the Danish manufacturer of GSM handsets. Amstrad has invested just over $30 million at the manufacturing site at Pandrup in Denmark. The investment in surface-mount equipment should see production of 1.5 million units in 1996.

Amstrad has also taken over troubled modem manufacturer Dataflex. Dataflex is the biggest domestic producer of modems within the United Kingdom. The move should ensure that production of modems and Integrated Services Digital Network (ISDN) products continues. Amstrad is likely to combine data communication expertise from Dataflex with personal communications technology from Dancall in order to launch a new consumer product.

Finally, Amstrad has also purchased a stake in Jarfalla ICC AB. Jarfalla (formerly IBM's Swedish printer factory) was launched as a going concern last year, in a similar way to IBM's disk drive plant at Havant, England.

Apricot

Apricot, Mitsubishi's PC subsidiary, is boosting production at its Glenrothes, Scotland plant. A new surface-mount production line, costing the best part of $1.5 million will double the plant capacity to 300,000 PC units shipped in 1996. Mitsubishi will be exporting some of the Apricot PC production to Japan.

Daewoo

Daewoo is part of the current wave of Korean inward investment in Europe. The company plans electronics manufacturing capacity, rather than silicon fabrication. It intends to invest $5.8 million in a European R&D center at Metz in France. It also plans to invest $26.3 million in its manufacturing plant in Northern Ireland; the plant will manufacture television and VCR tuner subassemblies.

Hewlett-Packard

Hewlett-Packard's domination of the printer market continues. It has announced further expansion of R&D and manufacturing capacity in Spain and Italy. The company praised "Europe's world-class research and manufacturing capabilities," and vowed to make full use of "those valuable resources."

IBM

IBM is releasing its recently created subcontract manufacturing company Xyratex. The company (formerly IBM's disk drive manufacturing plant at Havant, England), has been the subject of a management buyout. IBM is planning to move the production of disk drives to Hungary, where the new plant near Budapest is due to start production in the fourth quarter of 1995, with a 1996 output of 1 million units. The perceived benefit is the lower cost of labor in Central and Eastern Europe.

IBM has also put its German manufacturing subsidiary STP up for sale. The plant fabricates bare PCBs as well as populating the boards. STP forecasts 1995 revenue of $160 million, of which $60 million should be for contract electronics equipment (CEM) work.

Mitsubishi

Mitsubishi is joining the scramble for a piece of the European GSM market—a market with factory revenue forecast to top $3.5 billion during 1995. Mitsubishi Electric plans to build GSM handsets at its plant near Rennes in France. The plant currently produces analog cellular handsets, and will become the company's worldwide source for GSM products.

Motorola

Motorola is expanding its manufacturing facility in Crawley, England. The plant will produce V.34 modems and routers for the European market. It is also investing at its mobile phone manufacturing site at Easter Inch, Scotland.

Nokia

Nokia has announced plans to build a new factory to manufacture base stations for the GSM and DCS-1800 standards. The greenfield site near Camberley, England will take over production from Nokia's existing Camberley site. Production is scheduled to start early in 1996. Nokia is likely to add to its base station manufacturing capacity within Europe. It has shortlisted Italy, Scotland and the Republic of Ireland as possible sites for a new plant.

Sony

Sony's move into GSM handsets will be supported by European production at its factory near Colmar, in the Alsace region of France (close to the German border). Production is forecast to start in September, estimated at 10,000 units a month.

With continuing hype around multimedia delivery channels and equipment, interest in multimedia set-top boxes is currently running high. It is highly likely that Sony will be manufacturing a set-top box for the European market at one its manufacturing plants in France, Spain or Wales.

Sun Microsystems

Sun Microsystems will build all server products not destined for US markets at its Linlithgow, Scotland plant. The 1000 and 2000 lines of servers will have system assembly carried out in Scotland, with populated PCBs coming from the United States. Linlithgow currently assembles workstation products, as well as the transportable Voyager product. D2D acts as a supplier to Linlithgow, providing both populated and unpopulated PCBs.

Dataquest Perspective

Japanese companies continue to invest in European manufacturing sites. The inexorable rise of the yen is one reason for Japanese companies' fondness for Europe. But the need to respond to regional markets has also played a part in persuading Japanese OEMs that they need to manufacture locally.

In addition, we are seeing the entry of other Far Eastern manufacturing concerns, such as Daewoo, into the European manufacturing arena.

GSM handsets are the cause of much of the immediate investment. But in the medium term it is likely to be PCs and entertainment products, such as satellite decoders, VCRs and TVs which join GSM handsets at these new European manufacturing sites. In the longer term, set-top decoder boxes are a logical extension to a company's expertise in manufacturing both PC and TV products.

Contract Manufacturing News

Company Updates

Jabil

Jabil has reported a loss in two of the last three quarters, and ended fiscal 1994 with a thin 0.3 percent profit. The company's performance for the first half of fiscal 1995 has been patchy. It closes the half year with a net profit margin of less than 0.5 percent. Although revenue in the second quarter was up 27 percent on first-quarter income, it remains below last year's fourth-quarter revenue.

SCI

SCI has announced half-year profits of $20 million. This represents just over 1.5 percent of sales ($1,240 million) for the period; and compares with income of $843 million, and a 4 percent profit for the same period in fiscal 1994. SCI has purchased Digital Equipment's CEM business in the United States. This follows SCI's 1994 acquisition of Hewlett-Packard's manufacturing plant at Grenoble in France.

Solectron

Solectron's performance for the first half of fiscal 1995 produced profits of $36.2 million. This is 3.7 percent of revenue, which at $978 million was up 50 percent on the first half of 1994.

Dataquest Perspective

The marketplace for CEM services remains extremely tough. Most of the big players continue to sacrifice profit in order to gain, or even maintain, market share. Dataquest believes that restructuring will continue within the industry. Acquisitions and other announcements will be ongoing features of the marketplace during 1995.

Second-tier CEMs active in only one country or region, and producing in volume, will find it necessary to acquire other manufacturers. They need to maintain high production volumes to continue to be cost-competitive, and to maintain credibility with their customers.

Manufacturing Industry News

ACEM Affiliates with PCIF

The Association of Contract Electronics Manufacturers (ACEM) is the UK-based trade association charged with representing the interests of UK CEMs to the OEMs, as well as lobbying the UK government and the European Union (EU). Historically affiliated with the Federation of Electronics Industries (FEI), recently it felt that its voice was not being heard sufficiently.

ACEM floated the idea of moving under the umbrella of the Printed Circuit Interconnection Federation (PCIF), which represents PCB manufacturers. This was warmly received by members, with 90 percent of ACEM members voting to join the PCIF—an overwhelming vote of confidence in the new alliance, or a vote of no-confidence in the previous arrangement.

The PCIF has been instrumental in getting bare PCBs reclassified under the European Union's generalized system of preferences (GSP) scheme. PCBs have been upgraded from semi-sensitive, to sensitive. This puts them on a par with semiconductors, and ensures that imports from developing countries are subject to the same level of tariffs as semiconductors.

The PCIF has also been involved with bringing together PCB fabricators, material suppliers and equipment manufacturers, in order to bid for EU research funds. Manufacturers have been bidding for a slice of ESPRIT IVth Framework money, allocated for research and technical development of "electronic subsystems" (that is, PCBs).

Dataquest Perspective

ACEM perceives that the PCIF's involvement with the EU has brought significant benefits to its members. The bare PCB is one of the few critical components in electronics assembly which is predominantly sourced from within the United Kingdom and continental Europe. Contract assemblers of PCBs believe they will benefit from closer association with one of their key suppliers.

It may be that perception is not reality. The PCIF understands the PCB industry, and has raised awareness of PCBs within the EU. However, it is difficult to see exactly what expertise it can bring to the representation of assemblers, other than its knowledge of a similar low-margin, and highly competitive, business.

Technology Update: Ball Grid Array

Information overload? It is (obviously) essential that virtually everyone involved in the design and manufacture of electronic products should keep up to date with new technologies, and the benefits they offer. IC packaging technology is an area overflowing with acronyms; quad flat pack (QFP) and small-outline (SO) are now well understood, while tape automated bonding (TAB) and ball grid array (BGA) are relatively new. It is the emerging BGA technology, to which complex devices will migrate over the next five years, which is examined here.

When will BGA enter the mainstream? Why do we need it, who is going to use it, and what can go wrong? We investigate some of the issues surrounding BGA packaged silicon, and high-volume assembly of BGA devices.

BGA versus PGA/QFP

SO and QFP IC packages are cost-effective, functionally effective and robust solutions for the (relatively mature) surface-mount process. Between them, the two package types account for almost 80 percent of the market. But it is not the bulk of QFP and SO type packaging which BGA threatens to displace. Initially, BGA offers an alternative to the staggered pin grid array (PGA) package, particularly for pin counts higher than the range of 208 to 304, as well as challenging QFPs which have a pitch of 0.5 mm or less. QFP and SO will remain the package of choice for (current) commodity memory devices, and low-gate-count ASICs.

The small size of the package means that coplanarity issues related to PCB (or package) surface flatness are less than for an equivalent (number of pins) fine-pitch QFP device. The package can tolerate a significant degree of placement variation, because during the reflow (assembly) process, the surface tension of the solder balls on the underside of the package will pull the device back into alignment.

Benefits

The benefits of BGA as a packaging technology stem from mounting the silicon die face-down, and bonding direct to the BGA substrate. The solder-bumped die makes direct connections with the PCB-derived substrate, which in turn routes the signals to a bumped matrix on the underside of the substrate. Mounting face-down, eliminates two problems associated with face-up dies which are wire-bonded around the periphery. Firstly, the ability to route using a (multilayer) PCB rather than bonding wires reduces the routing area required. And secondly, the thermal management of the device is easier, because it is straightforward to mount some form of heat spreader on the back side of the die.

The die-down benefits of BGA can be summarized as follows:

- Improved signal I/O density
- Improved thermal management
- Smaller package size
- Improved electrical characteristics, due to shorter interconnect
- Tolerant of placement variations
- More cost-effective to use BGA than QFP for greater than 300 pins
- Assembly using existing SMT equipment
- Improved yield, using an assembly process under control

Disadvantages

With any new technology there are associated drawbacks, but most of the problems with a new process are associated with its implementation, rather than any underlying problem with the technology. This is true for BGA. There has been a great deal of development, over many years, on BGA substrates, and the interconnect within the package. For example, problems with popcorning (where moisture in the BGA substrate can explode during reflow) have been solved through the choice of substrate base material, and substrate manufacture.

From a design point of view, the use of BGA rather than PGA only causes problems when the increasing pin counts possible with BGA are considered. Routing away from the BGA device is unlikely to cause problems in PCBs with a high layer count. Currently, just over 80 percent of BGA devices have their solder balls on a contact pitch of 1.00 mm or greater, which should not cause problems with the number of tracks between pads on a multilayer PCB. Thermal management should be also be simplified with BGA.

For companies assembling BGA devices onto PCBs, inspection and rework are the key issues. Because the solder joints are all hidden from sight, below the package, it is more difficult first to inspect the solder joints, and then to rework the joints, or even to replace the device if it fails at electrical test. An effective inspection process is needed both to identify when a component needs reworking, and for process control, in order to keep any device rework to a minimum.

Work on medium- to high-volume assembly of BGA devices has led to the development of several in-line inspection techniques using both ultrasound, and X-rays. However, it is the X-ray technique which has been widely adopted by the manufacturers of inspection equipment. Automated in-line inspection equipment is priced in the region of $500,000 and is supplied by specialist US manufacturers, as well as some of the traditional Japanese SMT assembly-equipment vendors.

The inspection issue is critical to ensuring the assembly process is under control. Once the assembly process is running smoothly, solder joint defect levels below 5 parts per million (ppm) are possible.

Market Growth

BGAs currently make up less than half of 1 percent of device packages. This is forecast to reach almost 4 percent by 1999. Functionally, the products using BGA packaging will be DRAMs of 64M and above, ASICs with gate counts above 500,000, and the next generation of CPUs.

Manufacturers that will be specifying BGA include Intel and IBM for microprocessors, LSI and Compaq for ASICs, and Motorola, Micron and Texas Instruments for memory products. Processors such as Sun Microsystems' UltraSPARC, IBM/Motorola's PowerPC, and Hewlett-Packard's PA-RISC series are destined for BGA packaging. BGA has benefits (due to the shorter interconnect) for high-frequency (above 150 MHz) devices. Again, this lends itself to advanced CPUs, and their associated components.

Dataquest Perspective

Two or three years ago, it was TAB which was heralded as the great hope to bridge the device package/board interconnect divide. However, the widespread adoption of TAB has failed to materialize, and instead it has found a stable niche in laptop and handheld applications.

At the moment, equipment, some of it still under development, remains expensive, and BGA expertise is also quite rare (and therefore expensive). Expect to see BGA capability being used as a unique selling point by several board assembler for some time to come.

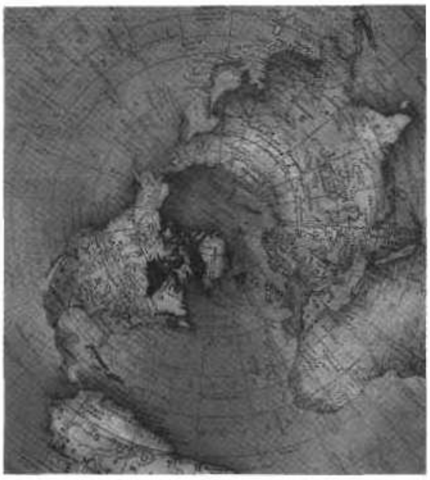
But with high-volume IC manufacturers such as Intel, IBM, Motorola and Hitachi all starting to use BGA, it is only a matter of time before it becomes a mainstream surface-mount package. In the meantime, it is an opportunity for manufacturers to perfect their inspection and rework methods, and ensure they can run a tightly controlled process which will not flood expensive rework resources.

Until now it has been the large CEMs and OEMs which could afford to invest in BGA. However, as BGA moves into the mainstream, expect manufacturing equipment prices to drop, and more board manufacturers and assemblers offering BGA as a service.

By Robin Daines

For More Information...

Robin Daines .... +44 1494 422 725
Internet address .... rdaines@dqeurope.com
Via fax .... +44 1494 422 742



Dataquest

V.32 bis/V.34 Modem Production in Europe: Turn On, Log In and Reach Out

Focus Report

1995

Program: Electronic Equipment Production Monitor
Product Code: SAPM-EU-FR-9505
Publication Date: November 27, 1995
Filing: Focus Studies

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Robin Daines .... +44 1494 422 725
Internet address .... rdaines@dqeurope.com
Via fax .... +44 1494 422 742

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Executive Summary and Introduction

V.32 bis/V.34 Modems: Market Overview

- In 1994, 1.9 million V.32 bis/V.34 modems were shipped in Europe.
- V.32 bis/V.34 modem shipments as a percentage of total voiceband modem shipments are estimated as follows:
  - 1994: 69 percent
  - 1995: 89 percent
  - 1999: 98 percent

V.32 bis/V.34 Modems: Production Overview

- V.32 bis/V.34 modem production in Europe was 1.1 million units in 1994, and is forecast to rise to 3.0 million units in 1999. This represents a compound annual growth rate (CAGR) of 22 percent.
- In 1994, the leading V.32 bis/V.34 modem producers (by units) were:
  - Creatix: 38.2 percent
  - SAT: 5.5 percent
  - Philips: 4.1 percent
- The average factory selling price (ASP) of a V.32 bis/V.34 modem is estimated to be:
  - 1995: $152
  - 1999: $64

V.32 bis/V.34 Modems: Component Market Overview

- The 1995 average component-sector costs (component volume of 100,000 units for pricing purposes) are estimated as follows:
  - ICs: $65.104
  - Discretes: $2.753
  - Passives: $5.067
  - RF/Passive: $0.708
  - Miscellaneous: $11.267
- The 1995 average component-sector costs (component volume of 1 million units for pricing purposes) are estimated as follows:
  - ICs: $54.036
  - Discretes: $2.202
  - Passives: $4.206
  - RF/Passive: $0.609
  - Miscellaneous: $9.690
- The 1999 average component-sector costs (component volume of 1 million units for pricing purposes) are estimated as follows:
  - ICs: $43.229
  - Discretes: $2.026

  - Passives: $3.659
  - RF/Passive: $0.566
  - Miscellaneous: $9.206
- The 1995 market values (component volume of 100,000 units for pricing purposes) are estimated as follows:
  - ICs: $162.8 million
  - Discretes: $6.9 million
  - Passives: $12.7 million
  - RF/Passive: $1.8 million
  - Miscellaneous: $28.2 million
- The 1999 market values (component volume of 1 million units for pricing purposes) are estimated as follows:
  - ICs: $129.7 million
  - Discretes: $6.1 million
  - Passives: $11.0 million
  - RF/Passive: $1.7 million
  - Miscellaneous: $27.6 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 who 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 (BOM) and typical high-volume component pricing.

Evaluation Methodology

Representative, leading-edge, 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 Procurement Service
- Dataquest's Mass Storage Service
- Cost models
- Press releases
- Industry quotes and surveys

- Catalogues and distributor information
- Industry sources

Component prices are based on 100,000-component quantities (not product quantities). These prices are usually (though not always) based on prices supported by the component-vendor, obtained via component distributors. In addition, component prices based on 1 million–component quantities (not product quantities) are provided. These prices are partly based on prices supported by the component vendor, and partly based 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 V.32 bis/V.34 Modem Market in Europe

The ownership patterns and the use of PCs has changed dramatically over the past five years. Although networks of PCs in the corporate environment have been common for some time, the rapid growth of standalone PCs in the small office and home environments has brought with it a need to connect to the outside world.

Using a modem for PC communication is not a new concept, but in the past modems tended to be restricted to corporate networks, and a limited number of home computer enthusiasts. Now, however, modem shipments have soared as a result of the following factors: companies encouraging teleworking and mobile computing; along with the use of electronic mail, PC fax technology and widespread access to the Internet by both home and corporate users.

Modern modems offer exceptional price performance, and the increasing number of networked applications and services will lead to further growth in European modem shipments and production.

Product Definition

This report deals with V.32 bis and V.34 voiceband* modems. The V.32 bis and V.34 modem standards are explained in more detail in chapter 3. This report does not cover modems which do not support these standards.

Market Opportunity

The voiceband modem market is dominated by modems which support the V.32 bis and (more recent) V.34 standards. V.32 bis and V.34 modems made up 69 percent of total voiceband shipments in Europe during 1994. This is forecast to rise to 89 percent in 1995 and to 98 percent by 1999.

In Europe, over the period 1990 to 1994, the average shipment price of a V.32 bis modem fell with a CAGR of minus 34 percent, and the average shipment price of a V.34 modem fell with a CAGR of minus 38 percent. Over the same period, shipments of V.32 bis modems rose with a CAGR of 213 percent, and shipments of V.34 modems rose with a CAGR of 382 percent.

The fall in price is both a result of the large increase in demand, and has also helped to fuel the demand. Booming PC shipments, and a large untapped home-user market, offer a massive opportunity to bundle modems with multimedia PCs, or sell as add-ons through retail channels.

The ISDN Threat

The technical aspects of Integrated Services Digital Network (ISDN) are briefly covered in chapter 3; but put simply, this technology offers faster data transfer speeds than current (or future) modem technology. The widespread use of ISDN depends as much on the connection costs charged by public telecoms operators (PTOs) as on the cost of the equipment. Reduced PTO charges and equipment costs (together with the requirement to send more data in less time) will lead to a decline in modem shipments (and production) towards the end of the forecast period.

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* Voiceband modems use the available bandwidth (usually about 3 kHz) of a "standard" voice-grade telephone-network line (or other networks with similar characteristics).

European Production

In 1994, 59 percent of V.32 bis/V.34 modems shipped in Europe were manufactured in Europe. This will rise to 65 percent in 1995, and eventually fall back to 56 percent in 1999. There are several reasons why OEMs choose to manufacture in Europe:

- Higher-value modems (using state-of-the art-technology) need to reach the market as soon as possible, in order to command a price premium for any performance advantage.
- Modems require approval (from a PTO approvals board) in each country in which they are sold. It is easier (and quicker) to carry this out in close collaboration with the design and manufacturing facilities.
- Modems are telecommunications products, and fit within Europe's historically strong manufacturing base for telecoms equipment.

Unit Production

The CAGR from 1994 to 1999 for V.32 bis/V.34 modem production in Europe is 22 percent. This growth is made up of the decline in V.32 bis production, by minus 27 percent over the period, and the very rapid growth of V.34 production, growing by 84 percent over the period. Table 2-1 shows production of V.32 bis/V.34 modems in Europe from 1993 to 1999.

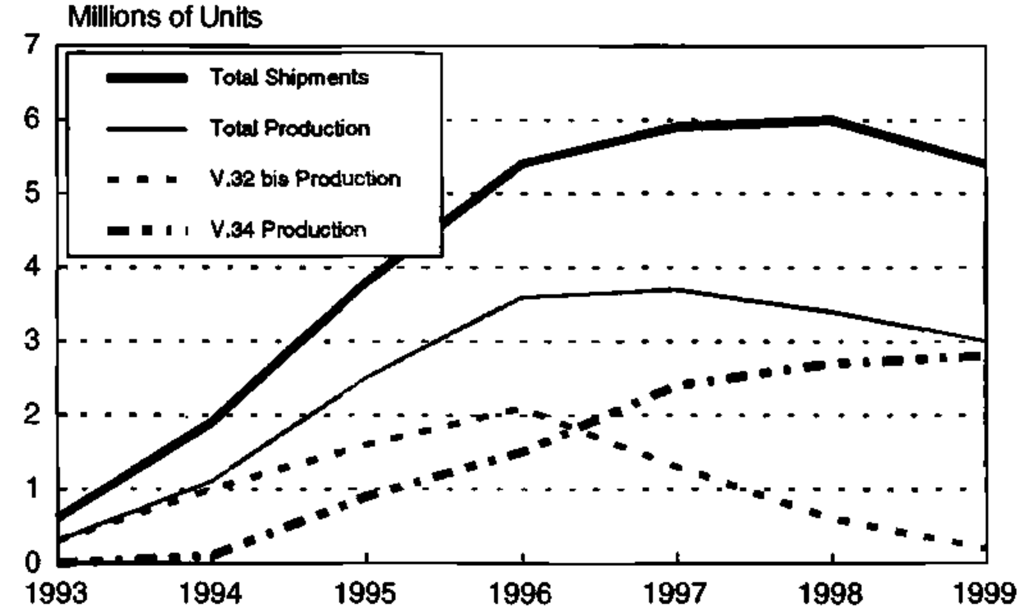
Figure 2-1 shows production of V.32 bis/V.34 modems in Europe from 1993 to 1999. The forecast for total production starts to fall from 1998 onwards; this is due to two factors: the emergence of a data transfer protocol faster than V.34, and the increase in ISDN links (in preference to modem links).

Table 2-1
V.32 bis/V.34 Modem Production in Europe—History and Forecast (Thousands of Units)

	1993	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Total Production	295	1,114	2,505	3,624	3,731	3,359	2,998	22%
V.32 bis Production	273	983	1,636	2,083	1,341	609	199	-27%
V.34 Production	22	131	869	1,541	2,390	2,750	2,799	84%

Source: Dataquest (November 1995 Estimates)

Figure 2-1
V.32 bis/V.34 Modem Shipments and Production in Europe



Source: Dataquest (November 1995 Estimates)

Chapter 3
V.32 bis/V.34 Modem Technology

Technology Overview

The purpose of a modem is to convert digital signals from a computer into an analog signal for transmission via a voiceband network. Figure 3-1 shows a block diagram of a generic V.32 bis/V.34 modem, and how it interfaces with a PC.

The telephone line interface has two main functions: driving a voiceband network line with the correct power levels and loading characteristics; and connecting the modem to the network (when necessary), while maintaining suitable electrical isolation.

The "data pump," which is a digital signal processing (DSP) IC, codes (to the V.32 bis standard, for example) the outgoing digital data, prior to the digital-to-analog conversion for voiceband transmission. It also performs the reverse operation (of analog-to-digital conversion followed by decoding) on incoming data. The device also negotiates connection protocols (such as speed and error correction standards) with the modem it is communicating with over a voiceband network.

The microcontroller provides overall control of the modem functions. It runs error correction algorithms (such as V.42), controls fax modem features, controls the PC interface, and controls the data fed to and from the DSP IC.

The nonvolatile memory (usually EEPROM or flash) stores the control software (firmware) for the microcontroller, and in some cases also stores the software for the DSP IC as well. This enables upgrades to the operating software to be loaded into nonvolatile memory. The volatile memory (usually SRAM) stores basic session information, such as the telephone number dialled and the connection speed settings.

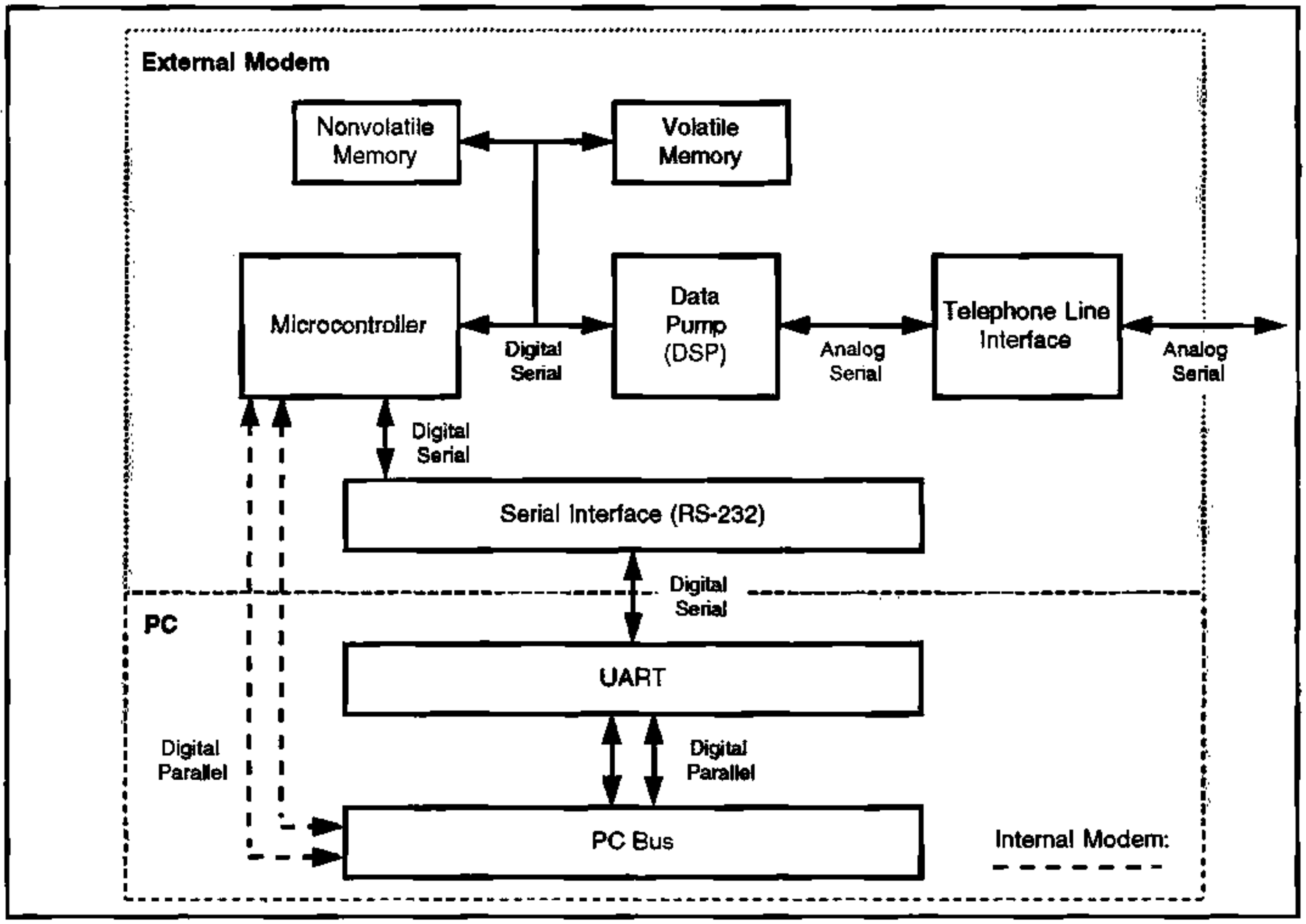
External and Internal Modems, and UARTs

The microcontroller feeds the DSP IC with a serial stream of digital data (for coding and then conversion to an analog signal). The microcontroller can accept digital information in serial or parallel. An external modem uses a serial (RS-232) interface in order for the microcontroller to connect to the serial port of a PC.

The PC serial port is connected to a universal asynchronous receiver transmitter (UART), which converts the data stream from serial to parallel in order to interface with the PC bus. Most current PCs are typically fitted with a 16550 UART device, which has a 16-character first-in first-out (FIFO) buffer. Older UART devices (with smaller buffers) may suffer from incoming data overwriting data waiting in the buffer, before the system software can fetch it.

Internal PC modems can interface directly with the PC bus. Internal modems either have a 16550 UART device on the add-in card, or emulate the functionality of a 16550 UART within the microcontroller. In Figure 3-1, the parallel link from the PC bus to the microcontroller is shown by two dashed lines.

Figure 3-1
Internal/External PC Modem



Source: Dataquest (November 1995)

V-Series Standards

The V-Series recommendations (effectively standards) define communication protocols for the transfer of data using public telephone networks. The standards are ratified and administered by group-14 of the International Telecommunications Union (ITU), the ITU-T (formerly the CCITT).

The V-Series covers a range of technical standards and protocols, including: error detection and correction, transmission quality, voiceband modem protocols, coding and signalling rates, as well as specifications covering power levels over networks.

The V.32 bis (*bis* refers to the second edition of the V.32 standard) standard relates to voiceband modems with a modem-to-modem data rate of up to 14,400 bit/s. The V.34 standard relates to voiceband modems with a modem-to-modem data rate of up to 28,800 bit/s. V.42 deals with error detection and correction, and V.42 bis relates to data compression.

Modem Chipsets

The modem chipset market is very competitive, offering common standards and features at low cost. It has been dominated for almost 10 years by Rockwell, which has tended to invest in emerging technologies in order to bring new products to market before the competition.

Recent research by Dataquest shows that in 1994, Rockwell had 64 percent of the V.32 bis chipset market (by shipments), followed by Cirrus Logic with 11 percent, and Texas Instruments with 10 percent. Rockwell's share of the V.34 market was 85 percent (of shipments), followed by AT&T with 9 percent, and Texas Instruments with 3 percent.

Emerging Technology

Modem technology is primarily driven by price/performance, as each manufacturer competes to offer faster transfer rates at lower cost. The most recent example of this is the increase from 14,400 bit/s to 28,800 bit/s. Many of the data transfer standards (such as V.32 bis and V.34) have emerged as manufacturers' proprietary standards (such as V.Fast and V.FC), before being ratified by the ITU-T.

Because modems have become commodity products, manufacturers are constantly offering more functionality in order to differentiate their products. This means that current state-of-the-art modem technology may well be mainstream within a year. The most significant technologies that will be offered over the next year are data transfer at 33,600 bit/s, and digital simultaneous voice and data (DSVD).

A faster data transfer rate of 33,600 bit/s has emerged, and is currently offered as a proprietary standard by several chipset and modem manufacturers. These proprietary standards will form the basis for a V.34 bis standard, which is currently being studied by the ITU-T. A transfer rate of 33,600 bit/s is likely to be one of the fastest rates achieved using analog (modem) technology, and in many cases the 33,600 bit/s rate will not be achieved due to poor voiceband network conditions. To transfer data over voiceband networks at significantly faster rates, it is necessary to use a digital technology such as ISDN.

DSVD has been developed by chipset, modem and PC manufacturers, to use one voiceband network line to transmit digitized voice and data simultaneously (to the same destination). This technology is based on efficient coding algorithms, and intelligent time-divisioned transmission (and reception) of digitized voice and data packets. It can be used to support collaborative working, and situations where it is necessary to discuss data or information held on a computer, using shared applications.

ISDN

Modems have to convert digital information (from computers) into a modulated analog waveform in order to be transmitted over a voiceband network. ISDN offers digital transmission from end to end, which is a far more efficient way of transferring data. Basic rate ISDN typically offers two 64,000 bit/s digitized voice/data channels. The 64,000 bit/s rate is almost twice as fast as current state-of-the-art modems, and modems are unlikely to transfer data much faster than 33,600 bit/s.

Chapter 4
Major Manufacturers

Market Leaders in Europe

Creatix Dominates

Table 4-1 shows how the 1.1 million V.32 bis/V.34 modems produced during 1994 were split by manufacturer. Creatix has achieved its dominance of the market by selling low-cost V.32 bis/V.34 modem models in high volume, predominantly in its home market of Germany. It has a similar low-cost/basic-features strategy to U.S. Robotics (which also dominates shipments to this market segment across Europe, but does not manufacture in Europe).

Table 4-1
1994 V.32 bis/V.34 Modem Production by Manufacturer (Thousands of Units)

Company	Unit Production	Production Share (%)	Cumulative Share (%)
Creatix	425.2	38.2%	38.2%
SAT	61.6	5.5%	43.7%
Philips	45.1	4.1%	47.7%
Psion Dacom	44.2	4.0%	51.7%
Motorola ISG	38.5	3.5%	55.2%
Racal	35.4	3.2%	58.4%
Pace Micro Communications	33.5	3.0%	61.4%
Hotline Export	30.9	2.8%	64.1%
Dataflex Design	26.1	2.3%	66.5%
Elsa	22.4	2.0%	68.5%
Olitec	18.8	1.7%	70.2%
Telindus	18.4	1.7%	71.8%
3X	18.0	1.6%	73.4%
Cray Communications	15.0	1.3%	74.8%
Others	280.9	25.2%	100.0%
Total Production	1,114.0		

Source: Dataquest (November 1995 Estimates)

Other Manufacturers

Many of the other OEMs produce higher-value modems (than Creatix, for example), and therefore tend to ship fewer units, mainly into corporate customers. Like Creatix, they can be dependent on a major market; for example SAT, Philips and 3X in France, and Racal in the United Kingdom.

Production in Europe

Most companies which ship modems in Europe also manufacture in Europe, and because of the need for PTO approval, modems are not generally exported to non-European markets.

In the past, there have been significant imports of "grey market" modems (which have not been approved by PTO approvals boards). These modems were shipped in from Asia/Pacific or the United States, and were significantly cheaper than many of the corporate-targeted modems manufactured in Europe. However, as European OEMs have focused on lower-cost modems (targeted at the home user), the price differential has been removed, and consumers are buying locally manufactured and approved modems (rather than unapproved imported modems).

European Locations

Table 4-2 shows the manufacturing and design locations of Europe's major V.32 bis/V.34 producers. Most of the companies use their own manufacturing facilities, but some modem OEMs use contract electronic manufacturers. Pace Micro Communications uses three CEMs based in England, Hotline Export subcontracts 100 percent of its production to a Swedish CEM, and Elsa subcontracts about 10 percent of its production (to smooth fluctuations in demand) to a German CEM.

Table 4-2
V.32 bis/V.34 Modem Manufacturing and Design Locations in Europe

Company	Location	Country	R&D	Production
Creatix	Saarbrücken	Germany	✓	✓
SAT	Hamburg	Germany	✓	✓
Philips	Rouen	France		✓
	Paris	France	✓	
Psion Dacom	Milton Keynes	England	✓	✓
Motorola ISG	Crawley	England		✓
Racal	Warrington	England	✓	✓
Pace Micro Communications	Shipley	England	✓	
	CEMs	England		✓
Hotline Export	Stockholm	Sweden	✓	
	CEM	Sweden		✓
Dataflex Design	London	England	✓	✓
Elsa	Aachen	Germany	✓	90%
	CEM	Germany		10%
Olitec	Nancy	France	✓	✓
Telindus	Heverlee	Belgium	✓	✓
3X	Paris	France	✓	✓
Cray Communications	Swindon	England	✓	
	Watford	England		✓

Source: Dataquest (November 1995)

Investment in Production

Along with Creatix, U.S. Robotics dominates the low-cost V.32 bis/V.34 modem market (shipping 285,000 V.32 bis/V.34 units in Europe during 1994). However, U.S. Robotics does not currently manufacture any products in Europe. The company has stated that it wishes to have some manufacturing presence in Europe, but has not yet announced specific plans. Obviously, any announcement by U.S. Robotics about European production has significant implications for component consumption.

Chapter 5

Teardown and Component Spend Analysis of the Creatix SG 2834 Data/Fax Modem

The modem chosen for teardown is the Creatix SG 2834 data/fax modem. It supports modem-to-modem data transfer rates up to V.34 standard, error correction and compression using V.42 and V.42 bis, and fax transmission and reception. The teardown includes all electronic components on the modem PCB. It does not include the external power supply, the telephone cable and the PC serial interface cable.

Teardown Summary

- Product availability:
  - February 1995
- Design and manufacturing aspects:
  - Mix of surface-mount (mainly digital) and through-hole (mainly analog) components
  - Four-layer PCB design, ground plane under digital components
  - Very compact and cost-reduced design—that is, no power switch, no rework wiring, and full use of PCB top-side real estate

Component Spend Analysis

Component spend analysis uses the component pricing (from the bill of materials), and the market forecasts for V.32 bis/V.34 modem production, to calculate the size of the market for each type of component. The BOM is in appendix A. Table 5-1 shows V.32 bis/V.34 modem production in Europe from 1993 to 1999.

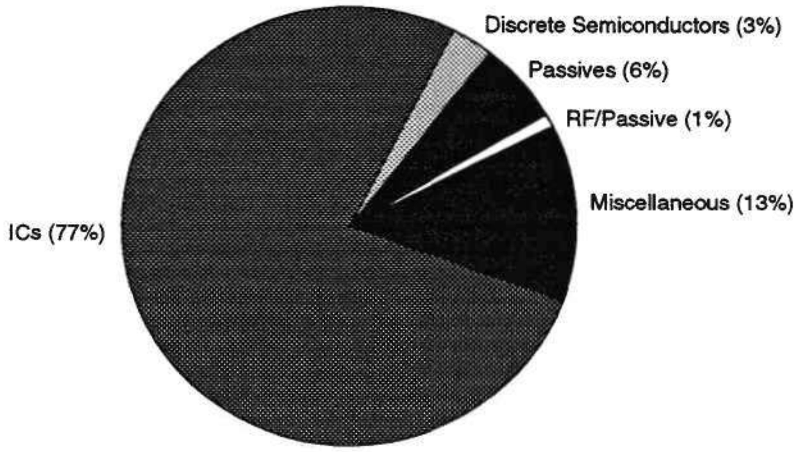
Figure 5-1 shows the cost distribution between semiconductors, discrete semiconductors, passive components, RF/passive components and miscellaneous components (based on component volumes of 100,000 units).

Table 5-1
V.32 bis/V.34 Modem Production in Europe, Factory ASP and Factory Revenue—History and Forecast

	1993	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Production (thousands of units)	295	1,114	2,505	3,624	3,731	3,359	2,998	22%
Factory ASP ($)	$357	$201	$152	$114	$95	$78	$64	-20%
Factory Revenue ($K)	$105,289	$223,996	$381,017	$412,740	$353,254	$261,283	$192,048	-3%

Source: Dataquest (November 1995 Estimates)

Figure 5-1
Component Cost Distribution—Creatix SG 2834 Teardown
(Based on Component Volumes of 100,000 Units)



Source: Dataquest (November 1995 Estimates)

Component Sector Analysis

The bill of materials is divided into component sectors. For the modem, 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 1995 and 1996 (and percent cost change 1995 to 1996)
- Total cost of the parts in a modem (device cost × quantity) for 1995 and 1996
- The total volume of parts required by the market, for 1995 and 1996
- The total value of the market for a specific part (and the component sector), for 1995 and 1996

Integrated Circuits (ICs)

ICs account for 77 percent of the teardown cost, and are dominated by the value of the Rockwell chipset. Most of the remaining value is in the volatile and nonvolatile memory devices. The spend analysis is in Table 5-2.

Discrete Semiconductors

These make up 3 percent of the teardown cost, and include a voltage regulator, a high-voltage transistor and a bridge rectifier. Table 5-3 shows the discrete semiconductor spend analysis.

Passive Components

The passive components make up 6 percent of the teardown. Table 5-4 shows the passive component spend analysis.

RF/Passive Components

The RF/passive components make up 1 percent of the teardown cost; the two components are both crystal oscillators. Table 5-5 shows the RF/passive component spend analysis.

Miscellaneous Components

The miscellaneous components make up 13 percent of the teardown cost; these include two modem specific relays and a line transformer. Table 5-6 shows the miscellaneous component spend analysis.

Table 5-2
Creatix SG 2834—IC Spend Analysis

Device Reference	Device Type	Manufacturer	Quantity	Unit Cost ($) 1995 (Q4)	Unit Cost ($) 1996 (Q4)	Total Cost ($) 1995 (Q4)	Total Cost ($) 1996 (Q4)	Cost Change 1995-1996	Market Volume (M) 1995	Market Volume (M) 1996	Market Value ($M) 1995	Market Value ($M) 1996
RC288DPi	Data pump	Rockwell	1	36.669	29.335	36.669	29.335	-20%	2.5	3.6	91.673	105.606
L3902-53	DSP	Rockwell	1	17.655	14.124	17.655	14.124	-20%	2.5	3.6	44.138	50.846
M27C1001-70XF1	EPROM, 128K×8, 70nS	SGS-Thomson	1	3.202	3.010	3.202	3.010	-6%	2.5	3.6	8.005	10.836
KM62256CLG-5L	SRAM, 32K×8, 70nS	Samsung	1	3.082	2.959	3.082	2.959	-4%	2.5	3.6	7.705	10.652
TLP627-2	Dual opto-isolator, Darlington output	Toshiba	1	0.513	0.498	0.513	0.498	-3%	2.5	3.6	1.283	1.793
TLP624	Opto-isolator, transistor output	Toshiba	1	0.358	0.347	0.358	0.347	-3%	2.5	3.6	0.895	1.249
SN75188	Quad RS-232C/ ITU-T V.24 line driver	Texas Instruments	1	0.313	0.304	0.313	0.304	-3%	2.5	3.6	0.783	1.094
SN75189A	Quad RS-232C line receiver	Texas Instruments	2	0.332	0.322	0.664	0.644	-3%	5.0	7.2	1.660	2.318
TL7705AC	Voltage supervisor	Texas Instruments	1	0.651	0.631	0.651	0.631	-3%	2.5	3.6	1.628	2.272
24C16J	EEPROM, 2K×8	Catalyst Semi.	1	1.650	1.650	1.650	1.650	0%	2.5	3.6	4.125	5.940
LM386	Audio power amplifier	National Semi.	1	0.347	0.337	0.347	0.337	-3%	2.5	3.6	0.868	1.213
Total						**$65.104**	**$53.839**				**$162.760**	**$193.820**

Source: Dataquest (November 1995 Estimates)

Table 5-3
Creatix SG 2834—Discrete Semiconductor Spend Analysis

Device Reference	Device Type	Manufacturer	Quantity	Unit Cost ($) 1995 (Q4)	Unit Cost ($) 1996 (Q4)	Total Cost ($) 1995 (Q4)	Total Cost ($) 1996 (Q4)	Cost Change 1995-1996	Market Volume (M) 1995	Market Volume (M) 1996	Market Value ($M) 1995	Market Value ($M) 1996
Diode	Small signal		7	0.040	0.039	0.280	0.273	-2%	17.5	25.2	0.700	0.983
Diode	Rectifier		2	0.092	0.090	0.184	0.180	-2%	5.0	7.2	0.460	0.648
LED	3 mm		7	0.037	0.036	0.259	0.252	-3%	17.5	25.2	0.648	0.907
Transistor	Transistor		2	0.048	0.047	0.096	0.094	-2%	5.0	7.2	0.240	0.338
MPSA42	Transistor	Motorola	1	0.105	0.103	0.105	0.103	-2%	2.5	3.6	0.263	0.371
LM2940T-5	Voltage regulator, 5V 1A	National Semi.	1	1.250	1.213	1.250	1.213	-3%	2.5	3.6	3.125	4.367
KSE340	High-voltage transistor	Samsung	1	0.322	0.312	0.322	0.312	-3%	2.5	3.6	0.805	1.123
DF04S	Bridge rectifier, 400V 1A	General Instruments	1	0.257	0.249	0.257	0.249	-3%	2.5	3.6	0.643	0.896
Total						**$2.753**	**$2.676**				**$6.883**	**$9.634**

Source: Dataquest (November 1995 Estimates)

Table 5-4
Creatix SG 2834—Passive Component Spend Analysis

				Unit Cost ($)		Total Cost ($)		Cost Change	Market Volume (M)		Market Value (M)	
Device Reference	Device Type	Manufacturer	Quantity	1995 (Q4)	1996 (Q4)	1995 (Q4)	1996 (Q4)	1995-1996	1995	1996	1995	1996
Capacitor	Electrolytic 2200uF, 16V	Nichicon	2	0.057	0.056	0.114	0.112	-2%	5.0	7.2	0.285	0.403
Capacitor	Electrolytic 470uF, 16V		1	0.057	0.056	0.057	0.056	-2%	2.5	3.6	0.143	0.202
Capacitor	Electrolytic 4.7uF, 100V	Samhwa	1	0.057	0.056	0.057	0.056	-2%	2.5	3.6	0.143	0.202
Capacitor	Electrolytic 100uF, 16V		2	0.143	0.140	0.286	0.280	-2%	5.0	7.2	0.715	1.008
Capacitor	Electrolytic 47uF, 16V		1	0.143	0.140	0.143	0.140	-2%	2.5	3.6	0.358	0.504
Capacitor	Electrolytic 22uF, 35V		6	0.143	0.140	0.858	0.840	-2%	15.0	21.6	2.145	3.024
Capacitor	Electrolytic 10uF, 35V		3	0.130	0.127	0.390	0.381	-2%	7.5	10.8	0.975	1.372
Capacitor	680nF, 250V	Philips	1	0.24	0.235	0.240	0.235	-2%	2.5	3.6	0.600	0.846
Capacitor	33nF, 250V		2	0.062	0.061	0.124	0.122	-2%	5.0	7.2	0.310	0.439
Capacitor	Various		31	0.031	0.030	0.961	0.930	-2%	77.5	111.6	2.403	3.348
Thermister	0.7mA 175V		1	0.251	0.243	0.251	0.243	-3%	2.5	3.6	0.628	0.875
Resistor	10R, 10%, 0.3W		1	0.005	0.005	0.005	0.005	-2%	2.5	3.6	0.013	0.018
Resistors	Various		50	0.005	0.005	0.250	0.250	-2%	125.0	180.0	0.625	0.900
Inductor	Balun, 10 × 5 mm		4	0.046	0.045	0.184	0.180	-3%	10.0	14.4	0.460	0.648
Connector	DS-25, female		1	0.683	0.669	0.683	0.669	-2%	2.5	3.6	1.708	2.408
Connector	US RJ-11/FCC-68, female		1	0.342	0.335	0.342	0.335	-2%	2.5	3.6	0.855	1.206
Connector	5 mm power, socket		1	0.122	0.120	0.122	0.120	-2%	2.5	3.6	0.305	0.432
Total						$5.067	$4.954				$12.668	$17.834

Source: Dataquest (November 1995 Estimates)

Table 5-5
Creatix SG 2834—RF/Passive Component Spend Analysis

Device Reference	Device Type	Manufacturer	Quantity	Unit Cost ($) 1995 (Q4)	Unit Cost ($) 1996 (Q4)	Total Cost ($) 1995 (Q4)	Total Cost ($) 1996 (Q4)	Cost Change 1995-1996	Market Volume (M) 1995	Market Volume (M) 1996	Market Value ($M) 1995	Market Value ($M) 1996
Crystal	40.320 MHz		1	0.372	0.361	0.372	0.361	-3%	2.5	3.6	0.9	1.3
Crystal	14.74 MHz		1	0.336	0.326	0.336	0.326	-3%	2.5	3.6	0.8	1.2
Total						$0.708	$0.687				$1.770	$2.473

Source: Dataquest (November 1995 Estimates)

Table 5-6
Creatix SG 2834—Miscellaneous Component Spend Analysis

Device Reference	Device Type	Manufacturer	Quantity	Unit Cost ($) 1995 (Q4)	Unit Cost ($) 1996 (Q4)	Total Cost ($) 1995 (Q4)	Total Cost ($) 1996 (Q4)	Cost Change 1995-1996	Market Volume (M) 1995	Market Volume (M) 1996	Market Value (M) 1995	Market Value (M) 1996
Piezo buzzer	12 mm		1	0.168	0.163	0.168	0.163	-3%	2.5	3.6	0.420	0.587
Transformer			1	0.747	0.732	0.747	0.732	-2%	2.5	3.6	1.868	2.635
Transformer	P1200	Etal	1	1.240	1.203	1.240	1.203	-3%	2.5	3.6	3.100	4.331
DIL-CL-1A81-9-13M	Relay	Meder	1	1.963	1.904	1.963	1.904	-3%	2.5	3.6	4.908	6.854
BA5W-K	Relay	Takamisawa	1	2.760	2.677	2.760	2.677	-3%	2.5	3.6	6.900	9.637
PCB	Four-layer, 13 8 × 75 mm		1	4.389	4.257	4.389	4.257	-3%	2.5	3.6	10.973	15.325
Total						$11.267	$10.936				$28.168	$39.370

Source: Dataquest (November 1995 Estimates)

High-Volume Pricing

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

Table 5-7 shows 1995 component pricing, based on quantities of 100,000 and 1 million units.

Table 5-7
1995 High-Volume Component Pricing for V.32 bis/V.34 Modems

				1995 (Q4) Total Cost ($)	
Device Reference	Device Type	Manufacturer	Quantity	Vol. = 100,000	Vol. = 1 Million
ICs					
RC288DPi	Data pump	Rockwell	1	36.669	29.464
L3902-53	DSP	Rockwell	1	17.655	14.186
M27C1001-70XF1	EPROM, 128K×8, 70nS	SGS-Thomson	1	3.202	3.013
KM62256CLG-5L	SRAM, 32K×8, 70nS	Samsung	1	3.082	2.961
TLP627-2	Dual opto-isolator, Darlington output	Toshiba	1	0.513	0.498
TLP624	Opto-isolator, transistor output	Toshiba	1	0.358	0.347
SN75188	Quad RS-232C/ITU-T V.24 line driver	Texas Instruments	1	0.313	0.304
SN75189A	Quad RS-232C line receiver	Texas Instruments	2	0.664	0.644
TL7705AC	Voltage supervisor	Texas Instruments	1	0.651	0.632
24C16J	EEPROM, 2K×8	Catalyst Semi	1	1.650	1.650
LM386	Audio power amplifier	National Semi.	1	0.347	0.337
Subtotal				**$65.104**	**$54.036**
Discrete Semiconductors					
Diode	Small signal		7	0.280	0.239
Diode	Rectifier		2	0.184	0.157
LED	3mm		7	0.259	0.203
Transistor	Transistor		2	0.096	0.082
MPSA42	Transistor	Motorola	1	0.105	0.090
LM2940T-5	Voltage regulator, 5V 1A	National Semi.	1	1.250	0.978
KSE340	High-voltage transistor	Samsung	1	0.322	0.252
DF04S	Bridge rectifier, 400V 1A	General Instruments	1	0.257	0.201
Subtotal				**$2.753**	**$2.202**

(continued)

Table 5-7 (Continued)
1995 High-Volume Component Pricing for V.32 bis/V.34 Modems

				1995 (Q4) Total Cost ($)	
Device Reference	**Device Type**	**Manufacturer**	**Quantity**	**Vol. = 100,000**	**Vol. = 1 Million**
Passives					
Capacitor	Electrolytic 2200uF, 16V	Nichicon	2	0.114	0.095
Capacitor	Electrolytic 470uF, 16V		1	0.057	0.048
Capacitor	Electrolytic 4.7uF, 100V	Samhwa	1	0.057	0.048
Capacitor	Electrolytic 100uF, 16V		2	0.286	0.239
Capacitor	Electrolytic 47uF, 16V		1	0.143	0.120
Capacitor	Electrolytic 22uF, 35V		6	0.858	0.718
Capacitor	Electrolytic 10uF, 35V		3	0.390	0.326
Capacitor	680nF, 250V	Philips	1	0.240	0.201
Capacitor	33nF, 250V		2	0.124	0.104
Capacitor	Various		31	0.961	0.804
Thermister	0.7mA 175V		1	0.251	0.190
Resistor	10R, 10%, 0.3W		1	0.005	0.004
Resistors	Various		50	0.250	0.209
Inductor	Balun, 10 × 5 mm		4	0.184	0.139
Connector	DS-25, female		1	0.683	0.572
Connector	US RJ-11/FCC-68, female		1	0.342	0.286
Connector	5 mm power, socket		1	0.122	0.102
Subtotal				**$5.067**	**$4.206**
RF/Passive					
Crystal	40.320 MHz		1	0.372	0.320
Crystal	14.74 MHz		1	0.336	0.289
Subtotal				**$0.708**	**$0.609**
Miscellaneous					
Piezo buzzer	12 mm		1	0.168	0.14
Transformer			1	0.747	0.68
Transformer	P1200	Etal	1	1.240	1.06
DIL-CL-1A81-9-13M	Relay	Meder	1	1.963	1.68
BA5W-K	Relay	Takamisawa	1	2.760	2.36
PCB	Four-layer, 138 × 75 mm		1	4.389	3.76
Subtotal				**$11.267**	**$9.690**
Total				**$84.899**	**$70.743**

Source: Dataquest (November 1995 Estimates)

Market Value in 1999

The 1999 forecasts for modem production, and component-sector values (in dollars), are used to predict the size of the European market for each component-sector. By 1999, V.32 bis modem production will have declined to almost nothing, and V.34 modem production is likely to have reached its peak. Production facilities will be increasing capacity for manufacturing V.34 bis modems (including DSVD technology), and ISDN combination modems.

A 1999 market value could be based on a V.34 modem, designed around a single IC chipset. However, a single IC implementation is unlikely to use significantly fewer components than the low-cost Creatix 2834 modem in 1995. Instead, the 1999 component forecast is based on a combination of mature V.34 technology, and newer V.34 bis technology.

The forecasts in Table 5-8 are based on component quantities of 1 million units. These forecasts are based on annual price reductions, component integration, efficiency improvements in component manufacturing, and overall market conditions.

Table 5-8
1999 High-Volume Component Pricing for V.34/V.34 bis Modems

Component Type	V.32 bis/V.34 Modem Content ($)		No. of V.32 bis/V.34 Modems (M)		Component Market Value ($M)	
	1995	1999	1995	1999	1995	1999
ICs	54.036	43.229	2.5	3.0	135.1	129.7
Discrete Semiconductors	2.202	2.026	2.5	3.0	5.5	6.1
Passives	4.206	3.659	2.5	3.0	10.5	11.0
RF/Passive	0.609	0.566	2.5	3.0	1.5	1.7
Miscellaneous	9.690	9.206	2.5	3.0	24.2	27.6
Total	$70.743	$58.686			176.9	176.1

Source: Dataquest (November 1995 Estimates)

Appendix A
Bill of Materials

Device Reference	Device Type	Manufacturer	Quantity	1995 (Q4) Unit Cost ($)	Package	1995 (Q4) Total Cost ($)
ICs						
RC288DPi	Data pump/DSP	Rockwell	1	36.669	PLCC-68	36.669
L3902-53	Microcontroller	Rockwell	1	17.655	PLCC-84	17.655
M27C1001-70XF1	EPROM, 128K×8, 70nS	SGS-Thomson	1	3.202	DIL-32	3.202
KM62256CLG-5L	SRAM, 32K×8, 70nS	Samsung	1	3.082	SOP-28	3.082
TLP627-2	Dual opto-isolator, Darlington output	Toshiba	1	0.513	DIL-8	0.513
TLP624	Opto-isolator, transistor output	Toshiba	1	0.358	DIL-4	0.358
SN75188	Quad RS-232C/ITU-T V.24 line driver	Texas Instruments	1	0.313	SOP-14	0.313
SN75189A	Quad RS-232C line receiver	Texas Instruments	2	0.332	SOP-14	0.664
TL7705AC	Voltage supervisor	Texas Instruments	1	0.651	SOP-8	0.651
24C16J	EEPROM, 2K×8	Catalyst Semi.	1	1.650	SOP-8	1.650
LM386	Audio power amplifier	National Semi.	1	0.347	SOP-8	0.347
Discrete Semiconductors						
Diode	Small signal		7	0.040	SMT	0.280
Diode	Rectifier		2	0.092	SMT	0.184
LED	3 mm		7	0.037	PIH	0.259
Transistor	Transistor		2	0.048	SOT-23	0.096
MPSA42	Transistor	Motorola	1	0.105	TO92	0.105
LM2940T-5	Voltage regulator, 5V 1A	National Semi.	1	1.250	TO220	1.250
KSE340	High-voltage transistor	Samsung	1	0.322	SOT82	0.322
DF04S	Bridge rectifier, 400V 1A	General Instruments	1	0.257	SMT-4	0.257
Passive Components						
Capacitor	Electrolytic 2200uF, 16V	Nichicon	2	0.057	PIH-Radial	0.114
Capacitor	Electrolytic 470uF, 16V		1	0.057	PIH-Radial	0.057
Capacitor	Electrolytic 4.7uF, 100V	Samhwa	1	0.057	PIH-Radial	0.057
Capacitor	Electrolytic 100uF, 16V		2	0.143	SMT	0.286
Capacitor	Electrolytic 22uF, 35V		6	0.143	SMT	0.858

(continued)

(Continued)

Device Reference	Device Type	Manufacturer	Quantity	1995 (Q4) Unit Cost ($)	Package	1995 (Q4) Total Cost ($)
Capacitor	Electrolytic 47uF, 16V		1	0.143	SMT	0.143
Capacitor	Electrolytic 10uF, 35V		3	0.130	SMT	0.390
Capacitor	680nF, 250V	Philips	1	0.240	PIH	0.240
Capacitor	33nF, 250V		2	0.062	PIH	0.124
Capacitor	Various		31	0.031	SMT-1206	0.961
S07K175GS2	Varistor	Siemens-Matsushita	1	0.251	PIH	0.251
Resistor	10R, 10%, 0.3W		1	0.005	PIH-Axial	0.005
Resistors	Various		50	0.005	SMT-1206	0.250
Inductor	Balun, 10 × 5 mm		4	0.046	PIH	0.184
Connector	DS-25, female		1	0.683	PIH	0.683
Connector	US RJ-11/FCC-68, female		1	0.342	PIH	0.342
Connector	5 mm power, socket		1	0.122	PIH	0.122
RF/Passive Components						
Crystal	40.320 MHz		1	0.372	Can-PIH	0.372
Crystal	14.7 4 MHz		1	0.336	Can-PIH	0.336
Miscellaneous Components						
Piezo buzzer	12 mm		1	0.168	PIH	0.168
Transformer			1	0.747	PIH	0.747
Transformer	P1200	Etal	1	1.240	PIH	1.240
DIL-CL-1A81-9-13M	Relay	Meder	1	1.963	PIH	1.963
BA5W-K	Relay	Takamisawa	1	2.760	PIH	2.760
PCB	4 layer, 138 × 75 mm		1	4.389		4.389
Total						**$84.899**

Source: Dataquest (November 1995 Estimates)

Dataquest

a company of
The Dun & Bradstreet Corporation

DATAQUEST WORLDWIDE OFFICES

EUROPE

European Headquarters
Dataquest Europe Limited
Holmers Farm Way
High Wycombe, Bucks HP12 4XH
United Kingdom
Phone: +44 1494 422 722
Facsimile: +44 1494 422 742

Dataquest Europe SA
Immeuble Défense Bergères
345, avenue Georges Clémenceau
TSA 40002
92882 - Nanterre CTC Cedex 9
France
Phone: +33 1 41 35 13 00
Facsimile: +33 1 41 35 13 13

Dataquest GmbH
Kronstadter Strasse 9
81677 München
Germany
Phone: +49 89 93 09 09 0
Facsimile: +49 89 93 03 27 7

Sales Offices:
Brussels, Belgium
Kfar Saba, Israel
Milan, Italy
Randburg, South Africa
Madrid, Spain

LATIN AMERICA

Research Affiliates and Sales Offices:
Buenos Aires, Argentina
Sao Paulo, Brazil
Santiago, Chile
Mexico City, Mexico

NORTH AMERICA

Worldwide Headquarters
Dataquest Incorporated
251 River Oaks Parkway
San Jose, California 95134-1913
United States
Phone: 1-408-468-8000
Facsimile: 1-408-954-1780

Dataquest Incorporated
Nine Technology Drive
P.O. Box 5093
Westborough, Massachusetts
01581-5093
United States
Phone: 1-508-871-5555
Facsimile: 1-508-871-6262

Dataquest Global Events
3990 Westerly Place, Suite 100
Newport Beach, California 92660
United States
Phone: 1-714-476-9117
Facsimile: 1-714-476-9969

Sales Offices:
Washington, DC (Federal)
New York, NY (Financial)
Dallas, TX

JAPAN

Japan Headquarters
Dataquest Japan K.K.
Shinkawa Sanko Building
6th Floor
1-3-17, Shinkawa
Chuo-ku, Tokyo 104
Japan
Phone: 81-3-5566-0411
Facsimile: 81-3-5566-0425

ASIA/PACIFIC

Asia/Pacific Headquarters
7/F China Underwriters Centre
88 Gloucester Road
Wan Chai
Hong Kong
Phone: 852-2824-6168
Facsimile: 852-2824-6138

Dataquest Korea
Suite 2407, Trade Tower
159 Samsung-dong, Kangnam-gu
Seoul 135-729
Korea
Phone: 822-551-1331
Facsimile: 822-551-1330

Dataquest Taiwan
11F-2, No. 188, Section 5
Nan King East Road
Taipei
Taiwan, R.O.C.
Phone: 8862-756-0389
Facsimile: 8862-756-2663

Dataquest Singapore
105 Cecil Street
#06-01/02 The Octagon
Singapore 0106
Phone: 65-227-1213
Facsimile: 65-227-4607

Dataquest Thailand
12/F, Vanissa Building
29 Soi Chidlom
Ploenchit Road
Patumwan, Bangkok 10330
Thailand
Phone: 662-655-0577
Facsimile: 662-655-0576

Research Affiliates and Sales Offic
Melbourne, Australia
Beijing, China

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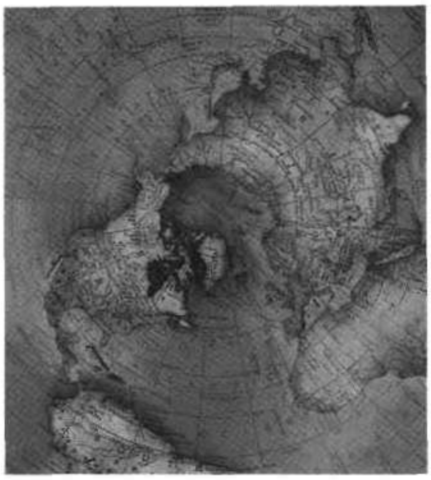

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Analog Set-Top Box Production in Europe: Implications for Component Consumption

Focus Report

1995

Program: Electronic Equipment Production Monitor
Product Code: SAPM-EU-FR-9504
Publication Date: October 16, 1995
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For More Information...

Robin Daines .... +44 1494 422 725
Internet address .... rdaines@dqeurope.com
Via fax .... +44 1494 422 742

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Chapter 1

Executive Summary and Introduction

This report evaluates component consumption in European production of analog satellite integrated receivers/decoders (IRDs), often referred to as a set-top boxes (STBs).

Analog Satellite IRDs: Market Overview

- In 1994, 4.6 million analog IRDs were shipped in Europe.
- Currently, 12 percent of European television households have satellite IRDs.
- The three largest installed bases of satellite IRDs are Germany, the United Kingdom and Poland.

Analog Satellite IRDs: Production Overview

- The forecast for analog IRD production within Europe is 4.4 million units in 1995, falling to 1.3 million units in 1999. This represents a compound annual growth rate (CAGR) of minus 22 percent.
- In 1994, the leading analog IRD producers (by units) were :
  - Sagem: 24 percent
  - Pace: 18 percent
  - Thomson Multimedia: 11 percent
- The average factory selling price of an analog IRD is estimated to be:
  - 1995: $150
  - 1999: $120

Analog Satellite IRDs: Component Market Overview

- The 1995 average component-sector costs (component volume of 100,000 for pricing purposes) are estimated as follows:
  - ICs: $31.74
  - Discretes: $11.16
  - Passives: $23.06
  - RF/Passive: $3.32
  - Miscellaneous: $28.04
- The 1995 average component-sector costs (component volume of 1 million for pricing purposes) are estimated as follows:
  - ICs: $27.61
  - Discretes: $10.27
  - Passives: $20.76
  - RF/Passive: $2.82
  - Miscellaneous: $24.68
- The 1999 average component-sector costs (component volume of 1 million for pricing purposes) are estimated as follows
  - ICs $22.09
  - Discretes: $8.21
  - Passives: $16.60

- RF/Passive: $2.26
- Miscellaneous: $19.74

- The 1995 market values (component volume of 100,000 for pricing purposes) are estimated as follows:
  - ICs: $128.0 million
  - Discretes: $49.1 million
  - Passives: $101.5 million
  - RF/Passive: $14.6 million
  - Miscellaneous: $123.4 million
- The 1999 market values (component volume of 1 million for pricing purposes) are estimated as follows:
  - ICs: $28.7 million
  - Discretes: $10.7 million
  - Passives: $21.6 million
  - RF/Passive: $2.9 million
  - Miscellaneous: $25.7 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 reports list the 10 largest producers (OEMs, the brand owners), or those who 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 (BOM) and typical high-volume component pricing.

Evaluation Methodology

Representative, leading-edge, typically configured models are acquired monthly 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 Procurement Service
- Dataquest's Mass Storage Service
- Cost models
- Press releases
- Industry quotes and surveys
- Catalogues and distributor information
- Industry sources

Component prices are based on 100,000-component quantities (not product quantities). These prices are usually (though not always) based on prices supported by the component vendor, obtained via component distributors. In addition, component prices based on 1 million–component quantities (not product quantities) are provided. These prices are partly based on prices supported by the component vendor, and partly based 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 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 Analog Satellite IRD Market in Europe

Introduction

Since it emerged in the late 1980s, direct-to-home (DTH) satellite television has revolutionized European TV viewing habits. DTH transmissions can cut across national borders, and allow broadcasters to offer programming (for example sport, feature films, pop music and home-shopping) targeted at specific interest groups.

The lower cost of DTH transmission equipment (when compared with building a terrestrial broadcast or cable network) has enabled many new and predominantly commercially funded broadcasters to transmit a wide variety of entertainment and information channels across Europe.

Analog DTH has brought concepts such as conditional access (CA) and subscription payment for channels into the mainstream. The acceptance of analog DTH will help with the introduction of newer services such as pay-per-view, video-on-demand and interactive services, via emerging digital transmission standards.

Product Definition

This report covers analog satellite integrated receivers/decoders. In Europe, Dataquest defines analog as PAL* or SECAM* video transmission standards; and not hybrid analog/digital standards based on D2-MAC* technology.

An IRD incorporates the functionality of a television tuner with the ability to decode (or "unscramble") conditional access transmissions. The IRD may be contained in a standalone unit, often referred to as a set-top box, or the IRD is itself integrated into a color television (CTV).

Background

Analog television delivered by earth-based transmitters was designed to provide the limited number of channels which were thought sufficient more than 30 years ago. Limited bandwidth (for analog terrestrial television transmission) means that an ever-increasing quantity of program material competes for only four or five delivery channels. Another factor restricting the proliferation of terrestrial broadcasting is the large capital cost of installing a comprehensive transmitter network.

DTH satellite television is a market created, quite literally, out of nowhere; using new technology to transmit many new channels. The prime reason for the proliferation of satellite television channels is the consumer demand for more programming—a demand that is not being met (for various reasons) by conventional terrestrial broadcasters. DTH is also more cost-effective, by providing instant transmission coverage to millions of homes across Europe.

Market Opportunity

Approximately 12 percent of European households with television also have DTH reception equipment; and in 1994, 4.6 million analog IRDs were shipped in Europe. Penetration levels of satellite receivers vary significantly

* PAL = Phase Alternating Line; SECAM = Sequential Couleur Avec Mémoire (sequential color with memory); D2-MAC = Duobinary-Multiplexed Analog Component

between European countries. Much of this variation depends upon the amount of cable TV infrastructure in place. The three largest installed bases for DTH in 1994 were Germany, the United Kingdom and Poland.

The success of DTH has demonstrated that consumers will purchase an extra piece of equipment (in addition to a CTV) in order to receive additional channels, and that they will also pay for some or all of these additional channels. Although the level of disposable income affects the buying decision, one of the main reasons for consumers purchasing DTH receiving equipment is the program material available. With Europe moving out of recession, and an increase in the quantity of material delivered by satellite, both shipments and production of DTH receiving equipment will increase.

Digital DTH Transmission

There is another major factor in the development of the DTH market over the next five years—the introduction of digital transmission. Digital transmission, using MPEG compression techniques, promises even more channels than those currently available. Although digital technology is being introduced in other parts of the world, it has not been implemented in Europe yet.

It is the media service operators (MSOs), such as Canal Plus, Filmnet and BSkyB, which will control the introduction and widespread deployment of digital DTH in Europe. Digital DTH is one of the marketing weapons that the MSOs have over the cable companies. Currently, satellites have the capability to move to digital transmission much more quickly than cable networks. However, although the additional services which digital transmission offers will tempt new customers to invest in an IRD, it will still be a costly exercise (for MSOs or consumers) to replace the installed base of analog IRDs.

Although it is expected that European digital satellite transmissions will be introduced during late 1995 and 1996, it is unclear exactly how fast they will be deployed. It is likely that MSOs (which control both content and transmission, compared with cable operators which generally control transmission only) will use digitally delivered services as both a marketing weapon, and a way of increasing subscription revenue.

European Production

Because IRDs are both a consumer product, and dependent on regional broadcasting technologies and standards, there is ample justification for local production. To help reduce cost, and be more responsive to consumer demands, companies are manufacturing close to markets. And knowledge about local transmission technologies also tends to favor European manufacturers.

Production of Digital IRDs

Digital DTH has not been introduced in Europe yet, but European manufacturers are now producing digital IRDs for export. Production of the higher-value digital IRDs is displacing production of lower-value analog IRDs to the Asia/Pacific region.

Unit Production

The CAGR for analog IRD production in Europe from 1994 to 1999 is minus 26 percent. Although the decline in analog reflects the shift in European production to manufacturing digital IRDs, many of the analog units currently manufactured are higher-value "replacement" units. Production of analog "replacement" IRDs will continue, as broadcasters have a legal obligation to continue broadcasting in analog for the next decade or so. The total number of IRDs (analog and digital) is forecast to rise by 5 percent over the same period.

Table 2-1 shows production of analog and digital IRDs in Europe from 1993 to 1999. Figure 2-1 shows production of analog and digital IRDs in Europe from 1993 to 1999.

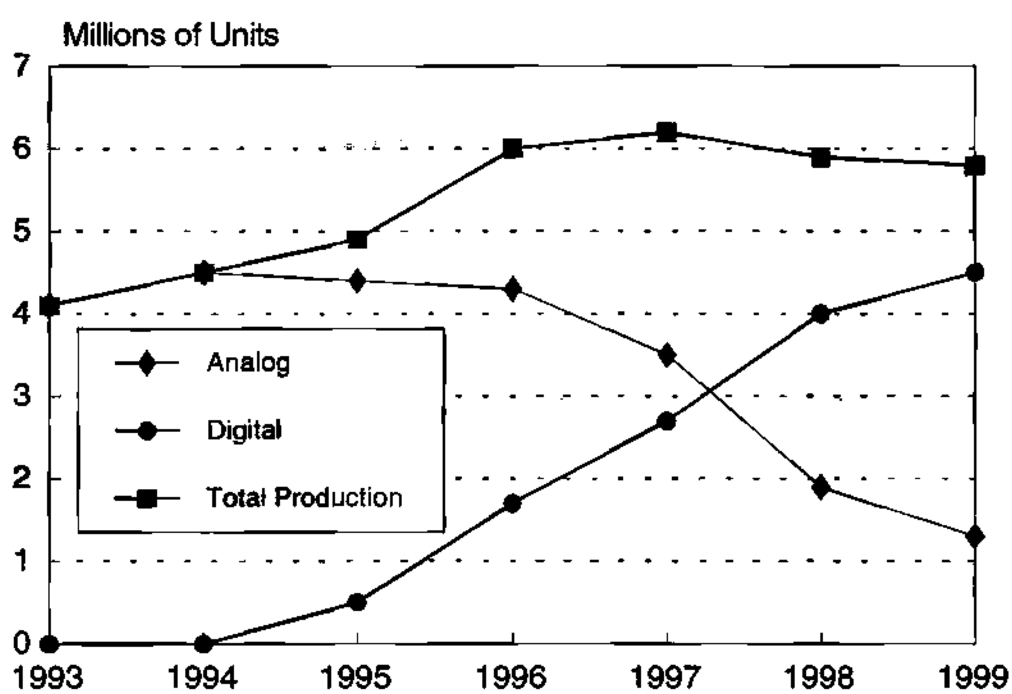
Since European production of digital IRDs will reach a significant level from late 1995 onwards, Dataquest will be publishing a teardown focus report covering digital IRDs (including DVB and MPEG technologies), during 1996.

Table 2-1
Analog and Digital IRD Production in Europe—History and Forecast (Millions of Units)

	1993	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Analog Units	4.1	4.5	4.4	4.3	3.5	1.9	1.3	-22%
Digital Units	0.0	0.0	0.5	1.7	2.7	4.0	4.5	NA
Total Production	4.1	4.5	4.9	6.0	6.2	5.9	5.8	5%

NA = not applicable
Source: Dataquest (October 1995 Estimates)

Figure 2-1
Analog and Digital IRD Production in Europe—History and Forecast



Source: Dataquest (October 1995 Estimates)

Chapter 3
Analog DTH and IRD Technology

Overview

The television signal is first processed (to reduce noise, and to add audio channels and text, and encryption where necessary) before being transmitted up to the satellite, where it is broadcast back to earth from a transponder. This signal is received by a satellite dish, and the weak signal is then focused onto a low noise block (LNB) amplifier (powered by the IRD).

The LNB amplifies the signal like a terrestrial mast-head amplifier would, and also shifts the received frequency from a 10- to 14-GHz range, to a 1- to 2-GHz intermediate frequency (IF), prior to tuning and decoding by the IRD. The frequency shifting at the LNB is so that the received signal (in the form of an IF) can be carried to the IRD via conventional coax, instead of via wave guides (which are needed for 10- to 14-GHz frequencies).

Transmission Standards

D2-MAC/D-MAC* is a hybrid analog/digital transmission standard, which is not compatible with the analog IRDs discussed in this report. It was the failure of D2-MAC/D-MAC as the European DTH standard, which has led to the current domination of conventional analog transmission.

D2-MAC/D-MAC

D2-MAC/D-MAC was an attempt by the European Union to impose a new Europe-wide standard for satellite broadcasting. The system uses a three-level digital coding system, together with time-division multiplexing, to alternate between analog time-compressed color information, analog time-compressed luminance information, and a burst of digital data containing sound, text and encryption information. The system has several benefits over analog PAL and SECAM:

- Wide-screen (16:9) pictures can be transmitted and handled as easily as conventional 4:3 ratio pictures.
- The CA scrambling/descrambling is effectively performed as part of the digital transmission, requiring no additional CA circuitry.
- Because the sound is transmitted digitally, there is no sound-on-vision interference pattern inherent with the use of a subcarriers for sound transmission.

Several problems with the introduction of D2-MAC/D-MAC mean that it is not the dominant DTH transmission system in Europe. Major delays in the development and manufacture of D2-MAC/D-MAC ICs (from the single source, ITT Intermettal in Germany) caused shortages of receiving equipment to severely effect the launch of D2-MAC/D-MAC services.

While D2-MAC/D-MAC services were delayed, systems based on PAL and SECAM were successfully launched. A second benefit of using the PAL system was that patents (and therefore any licensing fees) for PAL had expired, which allowed companies to manufacture PAL-compatible receivers anywhere in the world, including the lower-cost Asia/Pacific region. However, the D2-MAC/D-MAC patents were licensed in such a way that the lowest royalties were charged on higher-value models, with the majority of value added in Europe. This increased the price differential between D2-MAC/D-MAC and PAL systems.

* The difference between D2-MAC and D-MAC, is that D2-MAC transmits the digital part of the signal at half the rate of D-MAC. This does not affect picture quality, but reduces the capacity to carry sound and data channels. D2-MAC is more compatible with older cable TV distribution systems in continental Europe.

PAL/SECAM

The PAL/SECAM systems used for DTH transmission are very similar to those used for terrestrial television, although there are some differences from the PAL/SECAM standards used for terrestrial broadcast.

One of the problems with frequency modulation (FM) of the video signal, is that the higher-frequency components (including the color subcarrier) are particularly susceptible to noise, especially at the higher carrier frequencies used for satellite transmission. To help counter this effect, the higher-frequency components are emphasized (amplified) prior to transmission, and then de-emphasized (attenuated) after reception.

Each video carrier offers multiple audio subcarriers. The number of audio channels depends upon whether the audio is companded (*companding* is compression prior to transmission, followed by expansion after reception). It is not frequency-selective like emphasis/de-emphasis. However, pre-emphasis/de-emphasis is used to reduce the noise level of the audio channels, in a similar way to DOLBY noise reduction. Most satellite transmissions and reception equipment use the PANDA noise reduction system.

There are typically between six and eight audio channels per video channel. These may be used for different language tracks in synchronization with the picture, stereo sound, or for other audio broadcasts such as radio.

Conditional Access

Conditional access is the process of scrambling television channels, in order to charge subscribers for the right to decode and subsequently view them. CA is also used to protect purchased program rights, which may only cover specific geographical regions. Customers who have paid to watch scrambled broadcasts receive a smart card that must be inserted into the IRD in order to view the programs. The two main CA systems used for analog DTH in Europe are Videocrypt and Nagravision (Syster).

They make use of two techniques: Videocrypt uses cut-and-rotate, while Nagravision uses line-shuffle. With cut-and-rotate, each line of the picture is cut in two random places, and rotated. Line shuffling, is where the horizontal lines making up the picture are transmitted in a different (random) order. In fact, the random order is based on a pseudo random number sequence, which is controlled by an encrypted keyword transmitted by the satellite. A combination of ICs in the smart card and the IRD decode the keyword, which in turn allows the picture to be reconstituted.

DTH Satellites

Most analog DTH satellites broadcast in the Ku-Band, at approximately 10 to 14 GHz. Because Ku-band uses relatively high frequencies, and hence short-wavelengths, dishes as small as 60 cm can be used.

In terms of the number of dishes focused on them, the major analog DTH satellites for Europe are (in order of importance):

- Astra (four satellites, co-located at 19.2° East), operated by Société Européenne des Satellites (SES)
- Eutelsat II-F1/Hot Bird 1 (two satellites, co-located at 13° East)
- France Telecom satellites located at 5° West and 3° West

Astra 1D

The launch of the Astra 1D satellite has caused some compatibility issues with older DTH reception equipment. Because Astra 1D broadcasts at lower frequencies (10.7 to 10.95 GHz) than 1A-1C (10.95 to 11.70 GHz), some LNBs generate an IF outside the tuning range of older IRDs.

Table 3-1 details the specifications for LNBs and receivers necessary to receive Astra 1D. In some cases, an additional frequency shifter can be used with a 10-GHz LNB and an older IRD.

Table 3-1
LNB/Receiver Specifications for Astra 1D Compatibility

	Required for Astra 1D	Incompatible with Astra 1D
LNB: Oscillator Frequency	9.75 GHz	10 GHz
Receiver: Tuning Range	950-2050 MHz	950-1750 MHz

Source: Astra

Chapter 4
Major Manufacturers

European Manufacturers

Pace and Sagem Dominate

Two manufacturers, Pace and Sagem, between them share almost 40 percent of analog IRD production. Due to their early involvement in satellite reception equipment, and a decision to support PAL and SECAM rather than D2-MAC/D-MAC, they now dominate European production. Technistat and Thomson each have about 10 percent share of production, and the top four manufacturers have a combined share of 60 percent of European production.

Pace and Sagem manufacture IRDs for several other consumer electronics companies that then badge the products as their own, and distribute and market them.

Table 4-1 shows how the 5 million analog IRDs produced during 1994 were split by manufacturer.

Table 4-1
Analog IRD Production by Manufacturer
(Thousands of Units)

Company	Unit Production	Production Share (%)	Cumulative Share (%)
Sagem	1,200	24	24
Pace	900	18	42
Thomson Multimedia	550	11	53
Technistat	500	10	63
Nokia	300	6	69
Grundig	295	6	75
Others	1,255	25	100
Total Production	5,000		

Source: Dataquest (October 1995 Estimates)

Other Manufacturers

Nokia and Grundig are the other two significant European OEMs which are manufacturing (rather than simply badging) IRDs. The introduction of digital DTH has already led to announcements from other manufacturers about their entry into European IRD production.

Production in Europe

Export Opportunities

The majority of IRDs shipped in Europe are relatively high-value, and have historically been manufactured within Europe. High-value IRDs have also been exported to surrounding markets. Lower-value IRDs have been imported from outside Europe, mainly from Asia/Pacific and China. However, imported receivers make up only 10 percent of European IRD shipments.

European Locations

Most companies manufacture IRDs alongside other consumer or video-based equipment. Some, such as Pace in the United Kingdom, also use contract electronics manufacturers (CEMs) to provide additional production capacity, or to reduce risk in a potentially volatile consumer market.

Table 4-2 shows the manufacturing and design locations of Europe's major analog IRD producers. Grundig has moved IRD production from Germany to a UK plant, in a bid to reduce production costs and manufacture at a single location.

Table 4-2
Analog IRD OEM Locations in Europe

Company	Location	Country	R&D	Production
Grundig	Llantrisant	Wales	✓	✓
Nokia	Salo	Finland	✓	✓
Pace	Poznan	Poland		✓
	Shipley	England	✓	✓
Philips	Le Mans	France		✓
	Suresne	France	✓	
Sagem	Pontois	France	✓	
	Rouen	France		✓
Technistat	Dresden	Germany	✓	
	Eisenach	Germany		✓
	Vogtland	Germany		✓
Thomson Multimedia	Angers	France	✓	✓

Source: Dataquest (October 1995)

Investment in Production

Many of the recent announcements about increased production capacity relate to digital IRD production. These include Grundig, Mitsubishi and Sony allocating production capacity to IRDs. They previously used CEMs, or badged other manufacturers' equipment.

Chapter 5

Teardown and Component Spend Analysis of the Pace PRD800 Plus

The IRD chosen for teardown is the Pace PRD800 Plus. The PRD800 Plus is identical, in most respects, to the PRD900 Plus. The main difference is that the PRD900 Plus accepts two LNB inputs (which allows the viewer to watch one satellite channel, while recording another).

The teardown includes all electronic components within the IRD. It does not include the CA smart card, low-noise block (LNB) amplifier, or receiving dish; although the production and shipment figures can be used to forecast production and shipments of these items.

Teardown Summary

- Product availability:
  - PRD800 Plus/PRD900 Plus: April 1993.
- Design and manufacturing aspects:
  - Using a significant number of through-hole components will increase assembly time, but is likely to be cheaper, particularly when space is not a constraint.
  - Double-sided PCB is cheaper, though larger, than a multilayer design.
  - Only one custom ASIC is used.
  - Modulator is implemented using discrete components, rather than an integrated module.

Component Spend Analysis

Component spend analysis uses the component pricing (from the BOM), and the market forecast for analog IRD production, to calculate the size of the market for each type of component. The BOM is in appendix A. Table 5-1 shows analog IRD production in Europe from 1993 to 1999.

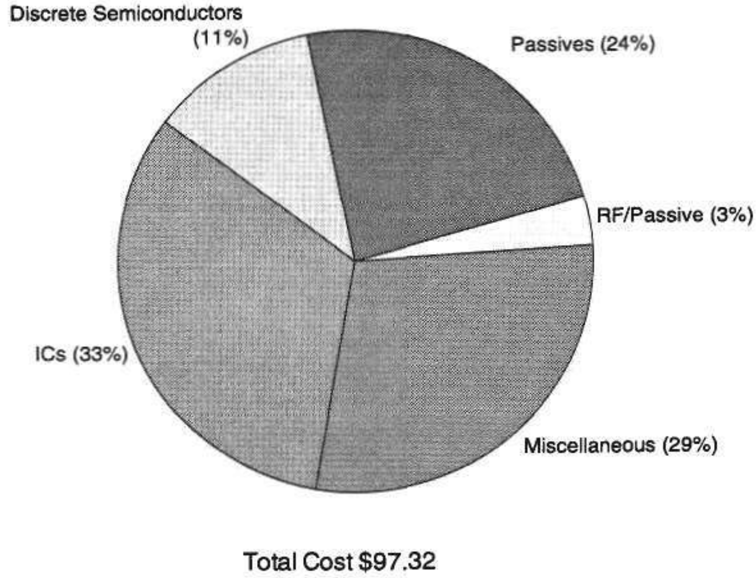
Figure 5-1 shows the cost distribution between semiconductors, discrete semiconductors, passive components, RF/passive components and miscellaneous components.

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

	1993	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Production (millions of units)	4.1	4.5	4.4	4.3	3.5	1.9	1.3	-22%
Factory ASP ($)	$163	$157	$150	$140	$134	$127	$120	-5%
Factory Revenue ($M)	$668	$707	$660	$602	$469	$241	$156	-26%

Source: Dataquest (October 1995 Estimates)

Figure 5-1
Component Cost Distribution—Pace PRD800 Plus Teardown (Based on Component Volumes of 100,000 Units)



Source: Dataquest (October 1995 Estimates)

Component Sector Analysis

The bill of materials is divided into component sectors. For the 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 1995 and 1996 (and percent cost change 1995 to 1996)
- Total cost of the parts in an IRD (device cost × quantity) for 1995 and 1996
- The total volume of parts required by the market, for 1995 and 1996
- The total value of the market for a specific part (and the component sector), for 1995 and 1996

Integrated Circuits (ICs)

ICs account for 33 percent of the teardown cost. The higher-value ICs include those which implement the UHF modulator and the Videocrypt functionality, as well as the graphic and sound ICs. The spend analysis is in Table 5-2.

Discrete Semiconductors

The discrete semiconductors in the IRD include various transistors and diodes (both through-hole and SMT), light-emitting diodes (LEDs) and a voltage regulator. These make up 11 percent of the teardown cost. Table 5-3 shows the discrete semiconductor spend analysis.

Passive Components

The passive components make up 24 percent of the teardown cost. This product contains various specialized inductors and resistors, as well as specific connectors. Table 5-4 shows the passive component spend analysis.

RF/Passive Components

The RF/passive components make up 3 percent of the teardown cost. These include the crystals and filters. Table 5-5 shows the RF/passive component spend analysis.

Miscellaneous Components

The miscellaneous components make up 29 percent of the teardown cost. Both the infrared receiver module and the fixed frequency tuner (both integrated devices, containing both semiconductor and non-semiconductor components), have been included here. Table 5-6 shows the miscellaneous component spend analysis.

Table 5-2
Pace PRD800 Plus—IC Spend Analysis

				Unit Cost ($)		Total Cost ($)		Cost Change	Market Volume (M)		Market Value ($M)	
Device Reference	Device Type	Manufacturer	Quantity	1995 (Q4)	1996 (Q4)	1995 (Q4)	1996 (Q4)	1995-1996	1995	1996	1995	1996
8661	Processor		1	1.892	1.798	1.892	1.798	-5%	4.4	4.3	8.3	7.7
Nicky ASIC 3	Video amps	Dialog	1	2.624	2.362	2.624	2.362	-10%	4.4	4.3	11.5	10.2
Videocrypt × 4			1	3.673	3.306	3.673	3.306	-10%	4.4	4.3	16.2	14.2
74HC139	Dual two- to four-line decoder		1	0.204	0.198	0.204	0.198	-3%	4.4	4.3	0.9	0.9
74HC04			1	0.204	0.198	0.204	0.198	-3%	4.4	4.3	0.9	0.9
74LS03			1	0.204	0.198	0.204	0.198	-3%	4.4	4.3	0.9	0.9
74LS74			2	0.204	0.198	0.408	0.396	-3%	8.8	8.6	1.8	1.7
SN74ALS541N	Octal buffer/line driver	Texas Instruments	1	0.351	0.333	0.351	0.333	-5%	4.4	4.3	1.5	1.4
NE572	Prog. analog compandor	Philips	1	2.32	2.088	2.320	2.088	-10%	4.4	4.3	10.2	9.0
LM324	Quad op. amp.		2	0.249	0.244	0.498	0.488	-2%	8.8	8.6	2.2	2.1
TL084	Quad Bi-FET op. amp. low noise	Thomson	2	0.372	0.361	0.744	0.722	-3%	8.8	8.6	3.3	3.1
HEF4052	Dual four-channel multiplexer		1	0.323	0.307	0.323	0.307	-5%	4.4	4.3	1.4	1.3
HEF4053	Triple two-channel multiplexer		2	0.307	0.292	0.614	0.584	-5%	8.8	8.6	2.7	2.5
ULN2003	Transistor Darlingtons	Thomson	2	0.366	0.355	0.732	0.710	-3%	8.8	8.6	3.2	3.1
UPD41101C-1/2/3	Graphics chips	NEC	2	1.594	1.466	3.188	2.932	-8%	8.8	8.6	14.0	12.6
M50555	Display controller (color graphics)	Mitsubishi	1	1.526	1.404	1.526	1.404	-8%	4.4	4.3	6.7	6.0
MV95308	8-bit DAC	Plessey	1	1.432	1.289	1.432	1.289	-10%	4.4	4.3	6.3	5.5
24C16	8K EEPROM	Catalyst	1	1.473	1.399	1.473	1.399	-5%	4.4	4.3	6.5	6.0
SL5066	Video modulator	Plessey	1	1.193	1.133	1.193	1.133	-5%	4.4	4.3	5.2	4.9
SP4633	Prescaler	Plessey	1	0.525	0.499	0.525	0.499	-5%	4.4	4.3	2.3	2.1
SP973T8	8-bit ADC	Plessey	1	1.049	0.997	1.049	0.997	-5%	4.4	4.3	4.6	4.3
TDA6160	SAT sound (IF)	Siemens	1	2.624	2.493	2.624	2.493	-5%	4.4	4.3	11.5	10.7
TEA2018	Switch mode PSU	Thomson	1	1.286	1.183	1.286	1.183	-8%	4.4	4.3	5.7	5.1
TEA2130	Sync. sep. (DS173019)	Thomson	1	2.649	2.437	2.649	2.437	-8%	4.4	4.3	0.0	10.5
Total						**$31.736**	**$29.454**				**128.0**	**126.7**

Source: Dataquest (October 1995 Estimates)

Table 5-3
Pace PRD800 Plus—Discrete Semiconductor Spend Analysis

				Unit Cost ($)		Total Cost ($)		Cost Change	Market Volume (M)		Market Value ($M)	
Device Reference	Device Type	Manufacturer	Quantity	1995 (Q4)	1996 (Q4)	1995 (Q4)	1996 (Q4)	1995 to 1996	1995	1996	1995	1996
Diode	1N series		13	0.040	0.039	0.520	0.507	-2%	57.2	55.9	2.3	2.2
Diode	BYV95/96	Philips	4	0.146	0.143	0.584	0.572	-2%	17.6	17.2	2.6	2.5
Diode	Various		25	0.048	0.047	1.200	1.175	-2%	110.0	107.5	5.3	5.1
Diode	BAT43		4	0.089	0.087	0.356	0.348	-2%	17.6	17.2	1.6	1.5
Diode	Zener		14	0.053	0.052	0.742	0.728	-2%	61.6	60.2	3.3	3.1
Diode	EGP30		2	0.378	0.359	0.756	0.718	-5%	8.8	8.6	3.3	3.1
LED	Indicator		8	0.037	0.036	0.296	0.288	-3%	35.2	34.4	1.3	1.2
LED	7-seg. display × 3		1	0.89	0.863	0.890	0.863	-3%	4.4	4.3	3.9	3.7
Transistor	Various		36	0.048	0.047	1.728	1.692	-2%	158.4	154.8	7.6	7.3
Transistor	Various		6	0.173	0.170	1.038	1.020	-2%	26.4	25.8	4.6	4.4
Transistor	FXT749	Zetex	5	0.183	0.178	0.915	0.890	-3%	22.0	21.5	4.0	3.8
Transistor	Various		4	0.128	0.125	0.512	0.500	-2%	17.6	17.2	2.3	2.2
Transistor	BD139		2	0.259	0.254	0.518	0.508	-2%	8.8	8.6	2.3	2.2
Transistor	MJE18004	Motorola	1	0.616	0.598	0.616	0.598	-3%	4.4	4.3	2.7	2.6
LM7812	Voltage regulator		1	0.488	0.473	0.488	0.473	-3%	4.4	4.3	2.1	2.0
Total						**$11.159**	**$10.880**				**49.1**	**46.8**

Source: Dataquest (October 1995 Estimates)

Table 5-4
Pace PRD800 Plus—Passive Component Spend Analysis

				Unit Cost ($)		Total Cost ($)		Cost Change	Market Volume (M)		Market Value ($M)	
Device Reference	Device Type	Manufacturer	Quantity	1995 (Q4)	1996 (Q4)	1995 (Q4)	1996 (Q4)	1995 to 1996	1995	1996	1995	1996
Capacitor	Electrolytic 2200 uF radial		2	0.052	0.051	0.104	0.102	-2%	8.8	8.6	0.5	0.4
Capacitor	Electrolytic 5 mm radial		95	0.026	0.025	2.470	2.375	-2%	418.0	408.5	10.9	10.2
Capacitor	Electrolytic 10 mm radial		2	0.096	0.094	0.192	0.188	-2%	8.8	8.6	0.8	0.8
Capacitor	MLCC		172	0.039	0.038	6.708	6.536	-2%	756.8	739.6	29.5	28.1
Capacitor	Class X/Y		2	0.178	0.174	0.356	0.348	-2%	8.8	8.6	1.6	1.5
Resistor	Thick film		408	0.005	0.005	2.040	2.040	-2%	1,795.2	1,754.4	9.0	8.8
Resistor	Carbon film		9	0.005	0.005	0.045	0.045	-2%	39.6	38.7	0.2	0.2
Resistor	Metal film		6	0.032	0.031	0.192	0.186	-2%	26.4	25.8	0.8	0.8
Resistor	Flame retardant		2	0.388	0.380	0.776	0.760	-2%	8.8	8.6	3.4	3.3
Resistor	Metox non-spiral		2	0.135	0.132	0.270	0.264	-2%	8.8	8.6	1.2	1.1
Resistor	Zero ohm links		46	0.008	0.008	0.368	0.368	-2%	202.4	197.8	1.6	1.6
Inductor	Axial inductor		17	0.16	0.157	2.720	2.669	-2%	74.8	73.1	12.0	11.5
Inductor	Balun	Pedoka	1	0.058	0.056	0.058	0.056	-3%	4.4	4.3	0.3	0.2
Inductor	Air wound coil	Pedoka	7	0.031	0.030	0.217	0.210	-3%	30.8	30.1	1.0	0.9
Inductor	Sound coil	Sumida	1	0.212	0.206	0.212	0.206	-3%	4.4	4.3	0.9	0.9
Inductor	Coil		2	0.132	0.128	0.264	0.256	-3%	8.8	8.6	1.2	1.1
Inductor	Ferrite bead	Pedoka	2	0.109	0.106	0.218	0.212	-3%	8.8	8.6	1.0	0.9
Inductor	Inductor	TDK	2	0.623	0.604	1.246	1.208	-3%	8.8	8.6	5.5	5.2
Fuse	20 × 5 mm Quick-blow		1	0.049	0.048	0.049	0.048	-2%	4.4	4.3	0.2	0.2
Connector	Smart card		1	1.069	1.037	1.069	1.037	-3%	4.4	4.3	4.7	4.5
Connector	RF/TV		2	0.325	0.319	0.650	0.638	-2%	8.8	8.6	2.9	2.7
Connector	21-pin SCART		3	0.203	0.199	0.609	0.597	-2%	13.2	12.9	2.7	2.6
Connector	Dual phono.		1	0.271	0.266	0.271	0.266	-2%	4.4	4.3	1.2	1.1
Connector	AC input socket		1	0.564	0.553	0.564	0.553	-2%	4.4	4.3	2.5	2.4
Switch	Push to make		7	0.199	0.195	1.393	1.365	-2%	30.8	30.1	6.1	5.9
Total						**$23.061**	**$22.533**				**101.5**	**96.9**

Source: Dataquest (October 1995 Estimates)

Table 5-5
Pace PRD800 Plus—RF/Passive Component Spend Analysis

Device Reference	Device Type	Manufacturer	Quantity	Unit Cost ($) 1995 (Q4)	Unit Cost ($) 1996 (Q4)	Total Cost ($) 1995 (Q4)	Total Cost ($) 1996 (Q4)	Cost Change 1995 to 1996	Market Volume (M) 1995	Market Volume (M) 1996	Market Value ($M) 1995	Market Value ($M) 1996
HC18U Series	Crystal 4 MHz		1	0.509	0.494	0.509	0.494	-3%	4.4	4.3	2.2	2.1
HC49U	Crystal 17.734 MHz		1	0.413	0.401	0.413	0.401	-3%	4.4	4.3	1.8	1.7
HC18U Series	Crystal 28 MHz		1	0.312	0.303	0.312	0.303	-3%	4.4	4.3	1.4	1.3
10.52MJA	Filter	Murata	2	0.306	0.297	0.612	0.594	-3%	8.8	8.6	2.7	2.6
10.7MJA	Filter	Murata	2	0.258	0.250	0.516	0.500	-3%	8.8	8.6	2.3	2.2
UF2327S-253-YOR5	Mains filter	TDK	1	0.668	0.648	0.668	0.648	-3%	4.4	4.3	2.9	2.8
CSB503F21	503 kHz resonator		1	0.292	0.283	0.292	0.283	-3%	4.4	4.3	1.3	1.2
Total						$3.322	$3.223				14.6	13.9

Source: Dataquest (October 1995 Estimates)

Table 5-6
Pace PRD800 Plus—Miscellaneous Component Spend Analysis

				Unit Cost ($)		Total Cost ($)		Cost Change	Market Volume (M)		Market Value ($M)	
Device Reference	Device Type	Manufacturer	Quantity	1995 (Q4)	1996 (Q4)	1995 (Q4)	1996 (Q4)	1995 to 1996	1995	1996	1995	199
SBX1620-E2	Infrared receive module	Sony	1	1.113	1.057	1.113	1.057	-5%	4.4	4.3	4.9	4.5
PC77G01	2 GHz fixed frequency tuner		1	12.593	11.334	12.593	11.334	-10%	4.4	4.3	55.4	48.7
PCB	Double-sided		1	12.164	11.921	12.164	11.921	-2%	4.4	4.3	53.5	51.3
SM800 Series	Transformer		1	2.172	2.107	2.172	2.107	-3%	4.4	4.3	9.6	9.1
Total						$28.042	$26.419				123.4	113.6

Source: Dataquest (October 1995 Estimates)

High-Volume Pricing

The bill of materials pricing is based on component volumes of 100,000. However, producers such as Sagem and Pace 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 1995 component pricing, based on quantities of 100,000 and 1 million units.

Table 5-7
1995 High-Volume Component Pricing for Analog IRDs

				1995 (Q4) Total Cost ($)	
Device Reference	**Device Type**	**Manufacturer**	**Quantity**	**Vol. = 100,000**	**Vol. = 1 Million**
ICs					
8661	Processor		1	1.892	1.721
Nicky ASIC 3	Video amps	Dialog	1	2.624	2.150
Videocrypt × 4			1	3.673	3.009
74HC139	Dual two- to four-line decoder		1	0.204	0.193
74HC04			1	0.204	0.193
74LS03			1	0.204	0.193
74LS74			2	0.408	0.386
SN74ALS541N	Octal buffer/line driver	Texas Instruments	1	0.351	0.319
NE572	Prog. analog compandor	Philips	1	2.32	1.901
LM324	Quad op. amp.		2	0.498	0.480
TL084	Quad Bi-FET op. amp. low noise	Thomson	2	0.744	0.704
HEF4052	Dual four-channel multiplexer		1	0.323	0.294
HEF4053	Triple two-channel multiplexer		2	0.614	0.559
ULN2003	Transistor Darlingtons	Thomson	2	0.732	0.692
UPD41101C-1/2/3	Graphics chips	NEC	2	3.188	2.727
M50555	Display controller (color graphics)	Mitsubishi	1	1.526	1.305
MV95308	8-bit DAC	Plessey	1	1.432	1.173
24C16	8K EEPROM	Catalyst	1	1.473	1.340
SL5066	Video modulator	Plessey	1	1.193	1.085
SP4633	Prescaler	Plessey	1	0.525	0.478
SP973T8	8-bit ADC	Plessey	1	1.049	0.954
TDA6160	SAT sound (IF)	Siemens	1	2.624	2.387
TEA2018	Switch mode PSU	Thomson	1	1.286	1.100
TEA2130	Sync. sep. (DS173019)	Thomson	1	2.649	2.266
			Subtotal	**$31.736**	**$27.610**

(continued)

Table 5-7 (Continued)
1995 High-Volume Component Pricing for Analog IRDs

				1995 (Q4) Total Cost ($)	
Device Reference	Device Type	Manufacturer	Quantity	Vol. = 100,000	Vol. = 1 Million
Discrete Semiconductors					
Diode	1N series		13	0.520	0.487
Diode	BYV95/96	Philips	4	0.584	0.546
Diode	Various		25	1.200	1.123
Diode	BAT43		4	0.356	0.333
Diode	Zener		14	0.742	0.694
Diode	EGP30		2	0.756	0.635
LED			8	0.296	0.267
LED	7-seg display × 3		1	0.89	0.804
Transistor	Various		36	1.728	1.617
Transistor	Various		6	1.038	0.971
Transistor	FXT749	Zetex	5	0.915	0.827
Transistor	Various		4	0.512	0.479
Transistor	BD139		2	0.518	0.485
Transistor	MJE18004	Motorola	1	0.616	0.557
LM7812	Voltage regulator		1	0.488	0.441
			Subtotal	**$11.159**	**$10.266**
Passives					
Capacitor	Electrolytic 2200 uF radial		2	0.104	0.09
Capacitor	Electrolytic 5 mm radial		95	2.470	2.24
Capacitor	Electrolytic 10 mm radial		2	0.192	0.17
Capacitor	MLCC		172	6.708	6.08
Capacitor	Class X/Y		2	0.356	0.32
Resistor	Thick film		408	2.040	1.85
Resistor	Carbon film		9	0.045	0.04
Resistor	Metal film		6	0.192	0.17
Resistor	Flame retardant		2	0.776	0.70
Resistor	Metox non-spiral		2	0.270	0.24
Resistor	Zero ohm links		46	0.368	0.33
Inductor	Axial inductor		17	2.720	2.47
Inductor	Balun	Pedoka	1	0.058	0.05
Inductor	Air wound coil	Pedoka	7	0.217	0.19
Inductor	Sound coil	Sumida	1	0.212	0.18
Inductor	Coil		2	0.264	0.23
Inductor	Ferrite bead	Pedoka	2	0.218	0.19
Inductor	Inductor	TDK	2	1.246	1.07
Fuse	20 × 5 mm Quickblow		1	0.049	0.04
Connector	Smart card		1	1.069	0.92
Connector	RF/TV		2	0.65	0.59
Connector	21-pin SCART		3	0.609	0.55
Connector	Dual phono.		1	0.271	0.25
Connector	AC input socket		1	0.564	0.51
Switch	Push to make		7	1.393	1.26
			Subtotal	**$23.061**	**$20.755**

(continued)

Table 5-7 (Continued)
1995 High-Volume Component Pricing for Analog IRDs

				1995 (Q4) Total Cost ($)	
Device Reference	**Device Type**	**Manufacturer**	**Quantity**	**Vol. = 100,000**	**Vol. = 1 Million**
RF/Passive					
HC18U Series	Crystal 4 MHz		1	0.509	0.43
HC49U	Crystal 17.734 MHz		1	0.413	0.35
HC18U Series	Crystal 28 MHz		1	0.312	0.27
10.52MJA	Filter	Murata	2	0.612	0.52
10.7MJA	Filter	Murata	2	0.516	0.44
UF2327S-253-YOR5	Mains filter	TDK	1	0.668	0.568
CSB503F21	503 kHz resonator		1	0.292	0.25
			Subtotal	**$3.322**	**$2.824**
Miscellaneous					
SBX1620-E2	Infrared receive module	Sony	1	1.113	0.998
PC77G01	2 GHz fixed frequency tuner		1	12.593	9.983
PCB	Double-sided		1	12.164	11.660
SM800 Series	Transformer		1	2.172	2.037
			Subtotal	**$28.042**	**$24.677**
			Total	**$97.320**	**$86.132**

Source: Dataquest (October 1995 Estimates)

Market Value in 1999

The 1999 forecasts for analog IRD production and component sector values (in dollars) are used to predict the size of the European market for each component sector. Forecasts for 1999, in Table 5-8, are based on component quantities of 1 million. These forecasts are based on annual price reductions, component integration, efficiency improvements in component manufacturing, and overall market conditions.

The value of the components is unlikely to fall significantly over the next few years. There is little incentive for further cost reduction or redesign of the mature analog equipment, when development is focused on higher-value digital technology.

Analog reception equipment will become the entry level for DTH, with digital IRDs commanding a premium. Because of the services digital DTH will offer, it is likely that IRDs will remain as separate units initially, in order to connect to CTVs, VCRs, PCs and so on. The cheaper analog IRD, repositioned as a wideband television tuner, could be integrated into other products, such as CTVs.

Table 5-8
1999 High-Volume Component Pricing for IRDs

	IRD Content ($)		No. of IRDs (M)		Component Market Value ($M)	
Component Type	1995	1999	1995	1999	1995	1999
ICs	27.610	22.088	4.4	1.3	121.5	28.7
Discrete Semiconductors	10.266	8.213	4.4	1.3	45.2	10.7
Passives	20.755	16.604	4.4	1.3	91.3	21.6
RF/Passive	2.824	2.259	4.4	1.3	12.4	2.9
Miscellaneous	24.677	19.742	4.4	1.3	108.6	25.7
Total	**$86.132**	**$68.906**			**379.0**	**89.6**

Source: Dataquest (October 1995 Estimates)

Bill of Materials

				1995 (Q4)		1995 (Q4)
Device Reference	Device Type	Manufacturer	Quantity	Unit Cost ($)	Package	Total Cost ($)
ICs						
8661	Processor		1	1.892	DIL-40	1.892
Nicky ASIC 3	Video amps	Dialog	1	2.624	DIL-24	2.624
Videocrypt × 4			1	3.673	DIL-40/ DIL-20	3.673
74HC139	Dual two- to four-line decoder		1	0.204	DIL-16	0.204
74HC04			1	0.204	SMD-14	0.204
74LS03			1	0.204	SMD-14	0.204
74LS74			2	0.204	SMD-14	0.408
SN74ALS541N	Octal buffer/line driver	Texas Instruments	1	0.351	DIL-20	0.351
NE572	Prog. analog compandor	Philips	1	2.320	DIL-16	2.320
LM324	Quad op. amp.		2	0.249	DIL-14	0.498
TL084	Quad Bi-FET op. amp. low noise	Thomson	2	0.372	DIL-14	0.744
HEF4052	Dual four-channel multiplexer		1	0.323	DIL-16	0.323
HEF4053	Triple two-channel multiplexer		2	0.307	DIL-16	0.614
ULN2003	Transistor Darlingtons	Thomson	2	0.366	DIL-16	0.732
UPD41101C-1/2/3	Graphics chips	NEC	2	1.594	DIL-24	3.188
M50555	Display controller (color graphics)	Mitsubishi	1	1.526	DIL-32	1.526
MV95308	8-bit DAC	Plessey	1	1.432	DIL-20	1.432
24C16	8K EEPROM	Catalyst	1	1.473	DIL-8	1.473
SL5066	Video modulator	Plessey	1	1.193	DIL-20	1.193
SP4633	Prescaler	Plessey	1	0.525	DIL-8	0.525
SP973T8	8-bit ADC	Plessey	1	1.049	DIL-18	1.049
TDA6160	SAT sound (IF)	Siemens	1	2.624	SMD-29	2.624
TEA2018	Switch mode PSU	Thomson	1	1.286	DIL-8	1.286
TEA2130	Sync. sep. (DS173019)	Thomson	1	2.649	DIL-20	2.649
Discrete Semiconductors						
Diode	1N Series		13	0.040	PIH	0.520
Diode	BYV95/96	Philips	4	0.146	PIH	0.584
Diode	Various		25	0.048	SOT23	1.200
Diode	BAT43		4	0.089	PIH	0.356
Diode	Zener		14	0.053	PIH	0.742
Diode	EGP30		2	0.378	PIH	0.756
LED	Indicator		8	0.037	PIH	0.296

(continued)

(Continued)

Device Reference	Device Type	Manufacturer	Quantity	1995 (Q4) Unit Cost ($)	Package	1995 (Q4) Total Cost ($)
LED	7-Seg display x 3		1	0.890	PIH	0.890
Transistor	Various		36	0.048	SOT23	1.728
Transistor	Various		6	0.173	SOT23	1.038
Transistor	FXT749	Zetex	5	0.183	PIH	0.915
Transistor	Various		4	0.128	TO92	0.512
Transistor	BD139		2	0.259	TO126	0.518
Transistor	MJE18004	Motorola	1	0.616	PIH	0.616
LM7812	Voltage regulator		1	0.488	TO220	0.488
Passive Components						
Capacitor	Electrolytic 2200 uF radial		2	0.052	PIH	0.104
Capacitor	Electrolytic 5 mm radial		95	0.026	PIH	2.470
Capacitor	Electrolytic 10 mm radial		2	0.096	PIH	0.192
Capacitor	MLCC		172	0.039	0805	6.708
Capacitor	Class X/Y		2	0.178	PIH	0.356
Resistor	Thick film		408	0.005	0805	2.040
Resistor	Carbon film		9	0.005	PIH	0.045
Resistor	Metal film		6	0.032	PIH	0.192
Resistor	Flame retardant		2	0.388	PIH	0.776
Resistor	Metox non-spiral		2	0.135	PIH	0.270
Resistor	Zero ohm links		46	0.008	0805	0.368
Inductor	Axial inductor		17	0.160	PIH	2.720
Inductor	Balun	Pedoka	1	0.058	PIH	0.058
Inductor	Air wound coil	Pedoka	7	0.031	PIH	0.217
Inductor	Sound coil	Sumida	1	0.212	PIH	0.212
Inductor	Coil		2	0.132	PIH	0.264
Inductor	Ferrite bead	Murata	2	0.109	PIH	0.218
Inductor	Inductor	TDK	2	0.623	PIH	1.246
Fuse	20 x 5 mm Quickblow		1	0.049	Holder	0.049
Connector	Smart card		1	1.069	PIH	1.069
Connector	RF/TV		2	0.325	PIH	0.650
Connector	21-pin SCART		3	0.203	PIH	0.609
Connector	Dual phono.		1	0.271	PIH	0.271
Connector	AC input socket		1	0.564	PIH	0.564
Switch	Push to make		7	0.199	PIH	1.393

(continued)

(Continued)

Device Reference	Device Type	Manufacturer	Quantity	1995 (Q4) Unit Cost ($)	Package	1995 (Q4) Total Cost ($)
RF/Passive Components						
HC18U Series	Crystal 4 MHz		1	0.509	PIH	0.509
HC49U	Crystal 17.734 MHz		1	0.413	PIH	0.413
HC18U Series	Crystal 28 MHz		1	0.312	PIH	0.312
10.52MJA	Filter	Murata	2	0.306	PIH	0.612
10.7MJA	Filter	Murata	2	0.258	PIH	0.516
UF2327S-253-YOR5	Mains filter	TDK	1	0.668	PIH	0.668
CSB503F21	503 kHz resonator		1	0.292	PIH	0.292
Miscellaneous Components						
SBX1620-E2	Infrared receive module	Sony	1	1.113	PIH	1.113
PC77G01	2 GHz fixed frequency tuner		1	12.593	PIH	12.593
PCB	Double-sided		1	12.164		12.164
SM800 Series	Transformer		1	2.172		2.172
					Total	**$97.320**

Source: Dataquest (October 1995 Estimates)

Dataquest

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The Dun & Bradstreet Corporation

DATAQUEST WORLDWIDE OFFICES

EUROPE

European Headquarters
Dataquest Europe Limited
Holmers Farm Way
High Wycombe, Bucks HP12 4XH
United Kingdom
Phone: +44 1494 422 722
Facsimile: +44 1494 422 742

Dataquest Europe SA
Immeuble Défense Bergères
345, avenue Georges Clémenceau
TSA 40002
92882 - Nanterre CTC Cedex 9
France
Phone: +33 1 41 35 13 00
Facsimile: +33 1 41 35 13 13

Dataquest GmbH
Kronstadter Strasse 9
81677 München
Germany
Phone: +49 89 93 09 09 0
Facsimile: +49 89 93 03 27 7

Sales Offices:
Brussels, Belgium
Kfar Saba, Israel
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LATIN AMERICA

Research Affiliates and Sales Offices:
Buenos Aires, Argentina
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NORTH AMERICA

Worldwide Headquarters
Dataquest Incorporated
251 River Oaks Parkway
San Jose, California 95134-1913
United States
Phone: 1-408-468-8000
Facsimile: 1-408-954-1780

Dataquest Incorporated
Nine Technology Drive
P.O. Box 5093
Westborough, Massachusetts
01581-5093
United States
Phone: 1-508-871-5555
Facsimile: 1-508-871-6262

Dataquest Global Events
3990 Westerly Place, Suite 100
Newport Beach, California 92660
United States
Phone: 1-714-476-9117
Facsimile: 1-714-476-9969

Sales Offices:
Washington, DC (Federal)
New York, NY (Financial)
Dallas, TX

JAPAN

Japan Headquarters
Dataquest Japan K.K.
Shinkawa Sanko Building
6th Floor
1-3-17, Shinkawa
Chuo-ku, Tokyo 104
Japan
Phone: 81-3-5566-0411
Facsimile: 81-3-5566-0425

ASIA/PACIFIC

Asia/Pacific Headquarters
7/F China Underwriters Centre
88 Gloucester Road
Wan Chai
Hong Kong
Phone: 852-2824-6168
Facsimile: 852-2824-6138

Dataquest Korea
Suite 2407, Trade Tower
159 Samsung-dong, Kangnam-gu
Seoul 135-729
Korea
Phone: 822-551-1331
Facsimile: 822-551-1330

Dataquest Taiwan
11F-2, No. 188, Section 5
Nan King East Road
Taipei
Taiwan, R.O.C.
Phone: 8862-756-0389
Facsimile: 8862-756-2663

Dataquest Singapore
105 Cecil Street
#06-01/02 The Octagon
Singapore 0106
Phone: 65-227-1213
Facsimile: 65-227-4607

Dataquest Thailand
12/F, Vanissa Building
29 Soi Chidlom
Ploenchit Road
Patumwan, Bangkok 10330
Thailand
Phone: 662-655-0577
Facsimile: 662-655-0576

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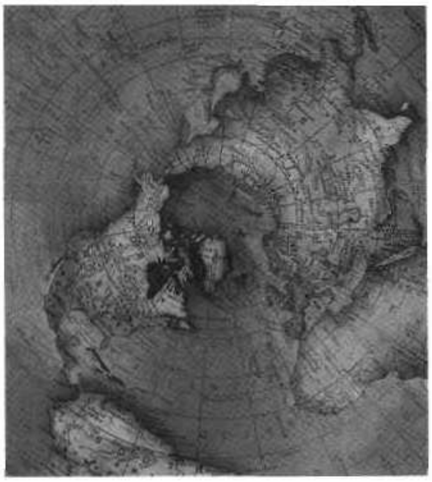

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Analog Set-Top Box Production in Europe: Implications for Component Consumption

Focus Report

1995

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Analog Set-Top Box Production in Europe: Implications for Component Consumption

Focus Report

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For More Information...

Robin Daines .... +44 1494 422 725
Internet address .... rdaines@dqeurope.com
Via fax .... +44 1494 422 742

Dataquest
a company of The Dun & Bradstreet Corporation

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Executive Summary and Introduction

This report evaluates component consumption in European production of analog satellite integrated receivers/decoders (IRDs), often referred to as a set-top boxes (STBs).

Analog Satellite IRDs: Market Overview

- In 1994, 4.6 million analog IRDs were shipped in Europe.
- Currently, 12 percent of European television households have satellite IRDs.
- The three largest installed bases of satellite IRDs are Germany, the United Kingdom and Poland.

Analog Satellite IRDs: Production Overview

- The forecast for analog IRD production within Europe is 4.4 million units in 1995, falling to 1.3 million units in 1999. This represents a compound annual growth rate (CAGR) of minus 22 percent.
- In 1994, the leading analog IRD producers (by units) were :
  - Sagem: 24 percent
  - Pace: 18 percent
  - Thomson Multimedia: 11 percent
- The average factory selling price of an analog IRD is estimated to be:
  - 1995: $150
  - 1999: $120

Analog Satellite IRDs: Component Market Overview

- The 1995 average component-sector costs (component volume of 100,000 for pricing purposes) are estimated as follows:
  - ICs: $31.74
  - Discretes: $11.16
  - Passives: $23.06
  - RF/Passive: $3.32
  - Miscellaneous: $28.04
- The 1995 average component-sector costs (component volume of 1 million for pricing purposes) are estimated as follows:
  - ICs: $27.61
  - Discretes: $10.27
  - Passives: $20.76
  - RF/Passive: $2.82
  - Miscellaneous: $24.68
- The 1999 average component-sector costs (component volume of 1 million for pricing purposes) are estimated as follows
  - ICs $22.09
  - Discretes: $8.21
  - Passives: $16.60

- RF/Passive: $2.26
- Miscellaneous: $19.74

- The 1995 market values (component volume of 100,000 for pricing purposes) are estimated as follows:
  - ICs: $128.0 million
  - Discretes: $49.1 million
  - Passives: $101.5 million
  - RF/Passive: $14.6 million
  - Miscellaneous: $123.4 million
- The 1999 market values (component volume of 1 million for pricing purposes) are estimated as follows:
  - ICs: $28.7 million
  - Discretes: $10.7 million
  - Passives: $21.6 million
  - RF/Passive: $2.9 million
  - Miscellaneous: $25.7 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 reports list the 10 largest producers (OEMs, the brand owners), or those who 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 (BOM) and typical high-volume component pricing.

Evaluation Methodology

Representative, leading-edge, typically configured models are acquired monthly 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 Procurement Service
- Dataquest's Mass Storage Service
- Cost models
- Press releases
- Industry quotes and surveys
- Catalogues and distributor information
- Industry sources

Component prices are based on 100,000-component quantities (not product quantities). These prices are usually (though not always) based on prices supported by the component vendor, obtained via component distributors. In addition, component prices based on 1 million–component quantities (not product quantities) are provided. These prices are partly based on prices supported by the component vendor, and partly based 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 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 Analog Satellite IRD Market in Europe

Introduction

Since it emerged in the late 1980s, direct-to-home (DTH) satellite television has revolutionized European TV viewing habits. DTH transmissions can cut across national borders, and allow broadcasters to offer programming (for example sport, feature films, pop music and home-shopping) targeted at specific interest groups.

The lower cost of DTH transmission equipment (when compared with building a terrestrial broadcast or cable network) has enabled many new and predominantly commercially funded broadcasters to transmit a wide variety of entertainment and information channels across Europe.

Analog DTH has brought concepts such as conditional access (CA) and subscription payment for channels into the mainstream. The acceptance of analog DTH will help with the introduction of newer services such as pay-per-view, video-on-demand and interactive services, via emerging digital transmission standards.

Product Definition

This report covers analog satellite integrated receivers/decoders. In Europe, Dataquest defines analog as PAL* or SECAM* video transmission standards; and not hybrid analog/digital standards based on D2-MAC* technology.

An IRD incorporates the functionality of a television tuner with the ability to decode (or "unscramble") conditional access transmissions. The IRD may be contained in a standalone unit, often referred to as a set-top box, or the IRD is itself integrated into a color television (CTV).

Background

Analog television delivered by earth-based transmitters was designed to provide the limited number of channels which were thought sufficient more than 30 years ago. Limited bandwidth (for analog terrestrial television transmission) means that an ever-increasing quantity of program material competes for only four or five delivery channels. Another factor restricting the proliferation of terrestrial broadcasting is the large capital cost of installing a comprehensive transmitter network.

DTH satellite television is a market created, quite literally, out of nowhere; using new technology to transmit many new channels. The prime reason for the proliferation of satellite television channels is the consumer demand for more programming—a demand that is not being met (for various reasons) by conventional terrestrial broadcasters. DTH is also more cost-effective, by providing instant transmission coverage to millions of homes across Europe.

Market Opportunity

Approximately 12 percent of European households with television also have DTH reception equipment; and in 1994, 4.6 million analog IRDs were shipped in Europe. Penetration levels of satellite receivers vary significantly

* PAL = Phase Alternating Line; SECAM = Sequential Couleur Avec Mémoire (sequential color with memory); D2-MAC = Duobinary-Multiplexed Analog Component

between European countries. Much of this variation depends upon the amount of cable TV infrastructure in place. The three largest installed bases for DTH in 1994 were Germany, the United Kingdom and Poland.

The success of DTH has demonstrated that consumers will purchase an extra piece of equipment (in addition to a CTV) in order to receive additional channels, and that they will also pay for some or all of these additional channels. Although the level of disposable income affects the buying decision, one of the main reasons for consumers purchasing DTH receiving equipment is the program material available. With Europe moving out of recession, and an increase in the quantity of material delivered by satellite, both shipments and production of DTH receiving equipment will increase.

Digital DTH Transmission

There is another major factor in the development of the DTH market over the next five years—the introduction of digital transmission. Digital transmission, using MPEG compression techniques, promises even more channels than those currently available. Although digital technology is being introduced in other parts of the world, it has not been implemented in Europe yet.

It is the media service operators (MSOs), such as Canal Plus, Filmnet and BSkyB, which will control the introduction and widespread deployment of digital DTH in Europe. Digital DTH is one of the marketing weapons that the MSOs have over the cable companies. Currently, satellites have the capability to move to digital transmission much more quickly than cable networks. However, although the additional services which digital transmission offers will tempt new customers to invest in an IRD, it will still be a costly exercise (for MSOs or consumers) to replace the installed base of analog IRDs.

Although it is expected that European digital satellite transmissions will be introduced during late 1995 and 1996, it is unclear exactly how fast they will be deployed. It is likely that MSOs (which control both content and transmission, compared with cable operators which generally control transmission only) will use digitally delivered services as both a marketing weapon, and a way of increasing subscription revenue.

European Production

Because IRDs are both a consumer product, and dependent on regional broadcasting technologies and standards, there is ample justification for local production. To help reduce cost, and be more responsive to consumer demands, companies are manufacturing close to markets. And knowledge about local transmission technologies also tends to favor European manufacturers.

Production of Digital IRDs

Digital DTH has not been introduced in Europe yet, but European manufacturers are now producing digital IRDs for export. Production of the higher-value digital IRDs is displacing production of lower-value analog IRDs to the Asia/Pacific region.

Unit Production

The CAGR for analog IRD production in Europe from 1994 to 1999 is minus 26 percent. Although the decline in analog reflects the shift in European production to manufacturing digital IRDs, many of the analog units currently manufactured are higher-value "replacement" units. Production of analog "replacement" IRDs will continue, as broadcasters have a legal obligation to continue broadcasting in analog for the next decade or so. The total number of IRDs (analog and digital) is forecast to rise by 5 percent over the same period.

Table 2-1 shows production of analog and digital IRDs in Europe from 1993 to 1999. Figure 2-1 shows production of analog and digital IRDs in Europe from 1993 to 1999.

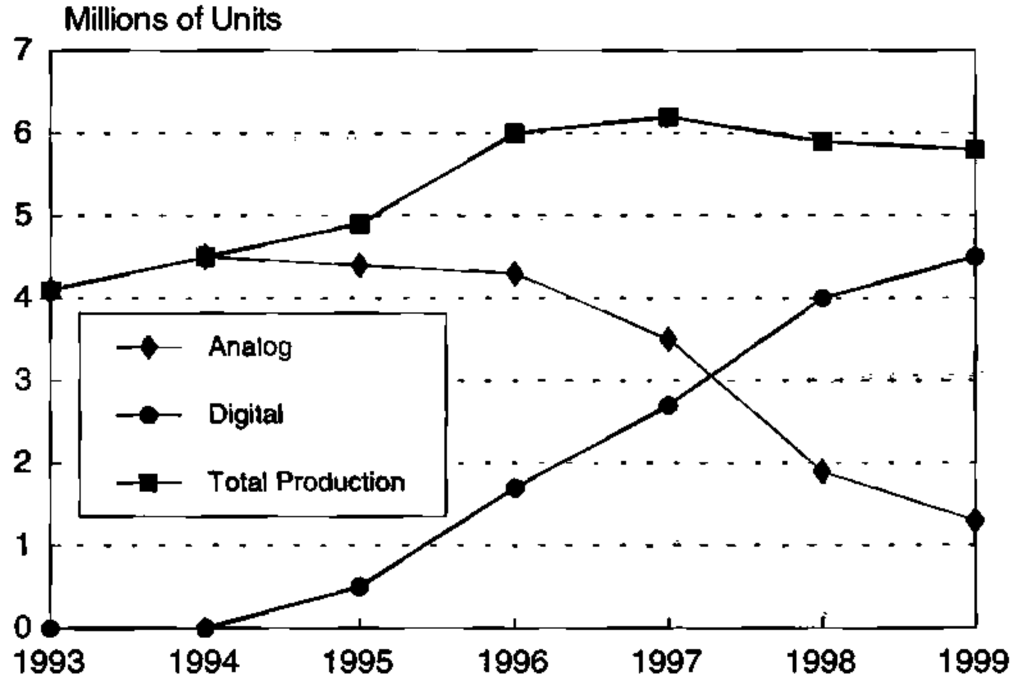
Since European production of digital IRDs will reach a significant level from late 1995 onwards, Dataquest will be publishing a teardown focus report covering digital IRDs (including DVB and MPEG technologies), during 1996.

Table 2-1
Analog and Digital IRD Production in Europe—History and Forecast (Millions of Units)

	1993	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Analog Units	4.1	4.5	4.4	4.3	3.5	1.9	1.3	-22%
Digital Units	0.0	0.0	0.5	1.7	2.7	4.0	4.5	NA
Total Production	4.1	4.5	4.9	6.0	6.2	5.9	5.8	5%

NA = not applicable
Source: Dataquest (October 1995 Estimates)

Figure 2-1
Analog and Digital IRD Production in Europe—History and Forecast



Source: Dataquest (October 1995 Estimates)

Chapter 3

Analog DTH and IRD Technology

Overview

The television signal is first processed (to reduce noise, and to add audio channels and text, and encryption where necessary) before being transmitted up to the satellite, where it is broadcast back to earth from a transponder. This signal is received by a satellite dish, and the weak signal is then focused onto a low noise block (LNB) amplifier (powered by the IRD).

The LNB amplifies the signal like a terrestrial mast-head amplifier would, and also shifts the received frequency from a 10- to 14-GHz range, to a 1- to 2-GHz intermediate frequency (IF), prior to tuning and decoding by the IRD. The frequency shifting at the LNB is so that the received signal (in the form of an IF) can be carried to the IRD via conventional coax, instead of via wave guides (which are needed for 10- to 14-GHz frequencies).

Transmission Standards

D2-MAC/D-MAC* is a hybrid analog/digital transmission standard, which is not compatible with the analog IRDs discussed in this report. It was the failure of D2-MAC/D-MAC as the European DTH standard, which has led to the current domination of conventional analog transmission.

D2-MAC/D-MAC

D2-MAC/D-MAC was an attempt by the European Union to impose a new Europe-wide standard for satellite broadcasting. The system uses a three-level digital coding system, together with time-division multiplexing, to alternate between analog time-compressed color information, analog time-compressed luminance information, and a burst of digital data containing sound, text and encryption information. The system has several benefits over analog PAL and SECAM:

- Wide-screen (16:9) pictures can be transmitted and handled as easily as conventional 4:3 ratio pictures.
- The CA scrambling/descrambling is effectively performed as part of the digital transmission, requiring no additional CA circuitry.
- Because the sound is transmitted digitally, there is no sound-on-vision interference pattern inherent with the use of a subcarriers for sound transmission.

Several problems with the introduction of D2-MAC/D-MAC mean that it is not the dominant DTH transmission system in Europe. Major delays in the development and manufacture of D2-MAC/D-MAC ICs (from the single source, ITT Intermettal in Germany) caused shortages of receiving equipment to severely effect the launch of D2-MAC/D-MAC services.

While D2-MAC/D-MAC services were delayed, systems based on PAL and SECAM were successfully launched. A second benefit of using the PAL system was that patents (and therefore any licensing fees) for PAL had expired, which allowed companies to manufacture PAL-compatible receivers anywhere in the world, including the lower-cost Asia/Pacific region. However, the D2-MAC/D-MAC patents were licensed in such a way that the lowest royalties were charged on higher-value models, with the majority of value added in Europe. This increased the price differential between D2-MAC/D-MAC and PAL systems.

* The difference between D2-MAC and D-MAC, is that D2-MAC transmits the digital part of the signal at half the rate of D-MAC. This does not affect picture quality, but reduces the capacity to carry sound and data channels. D2-MAC is more compatible with older cable TV distribution systems in continental Europe.

PAL/SECAM

The PAL/SECAM systems used for DTH transmission are very similar to those used for terrestrial television, although there are some differences from the PAL/SECAM standards used for terrestrial broadcast.

One of the problems with frequency modulation (FM) of the video signal, is that the higher-frequency components (including the color subcarrier) are particularly susceptible to noise, especially at the higher carrier frequencies used for satellite transmission. To help counter this effect, the higher-frequency components are emphasized (amplified) prior to transmission, and then de-emphasized (attenuated) after reception.

Each video carrier offers multiple audio subcarriers. The number of audio channels depends upon whether the audio is companded (*companding* is compression prior to transmission, followed by expansion after reception). It is not frequency-selective like emphasis/de-emphasis. However, pre-emphasis/de-emphasis is used to reduce the noise level of the audio channels, in a similar way to DOLBY noise reduction. Most satellite transmissions and reception equipment use the PANDA noise reduction system.

There are typically between six and eight audio channels per video channel. These may be used for different language tracks in synchronization with the picture, stereo sound, or for other audio broadcasts such as radio.

Conditional Access

Conditional access is the process of scrambling television channels, in order to charge subscribers for the right to decode and subsequently view them. CA is also used to protect purchased program rights, which may only cover specific geographical regions. Customers who have paid to watch scrambled broadcasts receive a smart card that must be inserted into the IRD in order to view the programs. The two main CA systems used for analog DTH in Europe are Videocrypt and Nagravision (Syster).

They make use of two techniques: Videocrypt uses cut-and-rotate, while Nagravision uses line-shuffle. With cut-and-rotate, each line of the picture is cut in two random places, and rotated. Line shuffling, is where the horizontal lines making up the picture are transmitted in a different (random) order. In fact, the random order is based on a pseudo random number sequence, which is controlled by an encrypted keyword transmitted by the satellite. A combination of ICs in the smart card and the IRD decode the keyword, which in turn allows the picture to be reconstituted.

DTH Satellites

Most analog DTH satellites broadcast in the Ku-Band, at approximately 10 to 14 GHz. Because Ku-band uses relatively high frequencies, and hence short-wavelengths, dishes as small as 60 cm can be used.

In terms of the number of dishes focused on them, the major analog DTH satellites for Europe are (in order of importance):

- Astra (four satellites, co-located at 19.2° East), operated by Société Européenne des Satellites (SES)
- Eutelsat II-F1/Hot Bird 1 (two satellites, co-located at 13° East)
- France Telecom satellites located at 5° West and 3° West

Astra 1D

The launch of the Astra 1D satellite has caused some compatibility issues with older DTH reception equipment. Because Astra 1D broadcasts at lower frequencies (10.7 to 10.95 GHz) than 1A-1C (10.95 to 11.70 GHz), some LNBs generate an IF outside the tuning range of older IRDs.

Table 3-1 details the specifications for LNBs and receivers necessary to receive Astra 1D. In some cases, an additional frequency shifter can be used with a 10-GHz LNB and an older IRD.

Table 3-1
LNB/Receiver Specifications for Astra 1D Compatibility

	Required for Astra 1D	Incompatible with Astra 1D
LNB: Oscillator Frequency	9.75 GHz	10 GHz
Receiver: Tuning Range	950-2050 MHz	950-1750 MHz

Source: Astra

Chapter 4
Major Manufacturers

European Manufacturers

Pace and Sagem Dominate

Two manufacturers, Pace and Sagem, between them share almost 40 percent of analog IRD production. Due to their early involvement in satellite reception equipment, and a decision to support PAL and SECAM rather than D2-MAC/D-MAC, they now dominate European production. Technistat and Thomson each have about 10 percent share of production, and the top four manufacturers have a combined share of 60 percent of European production.

Pace and Sagem manufacture IRDs for several other consumer electronics companies that then badge the products as their own, and distribute and market them.

Table 4-1 shows how the 5 million analog IRDs produced during 1994 were split by manufacturer.

Table 4-1
Analog IRD Production by Manufacturer
(Thousands of Units)

Company	Unit Production	Production Share (%)	Cumulative Share (%)
Sagem	1,200	24	24
Pace	900	18	42
Thomson Multimedia	550	11	53
Technistat	500	10	63
Nokia	300	6	69
Grundig	295	6	75
Others	1,255	25	100
Total Production	5,000		

Source: Dataquest (October 1995 Estimates)

Other Manufacturers

Nokia and Grundig are the other two significant European OEMs which are manufacturing (rather than simply badging) IRDs. The introduction of digital DTH has already led to announcements from other manufacturers about their entry into European IRD production.

Production in Europe

Export Opportunities

The majority of IRDs shipped in Europe are relatively high-value, and have historically been manufactured within Europe. High-value IRDs have also been exported to surrounding markets. Lower-value IRDs have been imported from outside Europe, mainly from Asia/Pacific and China. However, imported receivers make up only 10 percent of European IRD shipments.

European Locations

Most companies manufacture IRDs alongside other consumer or video-based equipment. Some, such as Pace in the United Kingdom, also use contract electronics manufacturers (CEMs) to provide additional production capacity, or to reduce risk in a potentially volatile consumer market.

Table 4-2 shows the manufacturing and design locations of Europe's major analog IRD producers. Grundig has moved IRD production from Germany to a UK plant, in a bid to reduce production costs and manufacture at a single location.

Table 4-2
Analog IRD OEM Locations in Europe

Company	Location	Country	R&D	Production
Grundig	Llantrisant	Wales	✓	✓
Nokia	Salo	Finland	✓	✓
Pace	Poznan	Poland		✓
	Shipley	England	✓	✓
Philips	Le Mans	France		✓
	Suresne	France	✓	
Sagem	Pontois	France	✓	
	Rouen	France		✓
Technistat	Dresden	Germany	✓	
	Eisenach	Germany		✓
	Vogtland	Germany		✓
Thomson Multimedia	Angers	France	✓	✓

Source: Dataquest (October 1995)

Investment in Production

Many of the recent announcements about increased production capacity relate to digital IRD production. These include Grundig, Mitsubishi and Sony allocating production capacity to IRDs. They previously used CEMs, or badged other manufacturers' equipment.

Chapter 5

Teardown and Component Spend Analysis of the Pace PRD800 Plus

The IRD chosen for teardown is the Pace PRD800 Plus. The PRD800 Plus is identical, in most respects, to the PRD900 Plus. The main difference is that the PRD900 Plus accepts two LNB inputs (which allows the viewer to watch one satellite channel, while recording another).

The teardown includes all electronic components within the IRD. It does not include the CA smart card, low-noise block (LNB) amplifier, or receiving dish; although the production and shipment figures can be used to forecast production and shipments of these items.

Teardown Summary

- Product availability:
  - PRD800 Plus/PRD900 Plus: April 1993.
- Design and manufacturing aspects:
  - Using a significant number of through-hole components will increase assembly time, but is likely to be cheaper, particularly when space is not a constraint.
  - Double-sided PCB is cheaper, though larger, than a multilayer design.
  - Only one custom ASIC is used.
  - Modulator is implemented using discrete components, rather than an integrated module.

Component Spend Analysis

Component spend analysis uses the component pricing (from the BOM), and the market forecast for analog IRD production, to calculate the size of the market for each type of component. The BOM is in appendix A. Table 5-1 shows analog IRD production in Europe from 1993 to 1999.

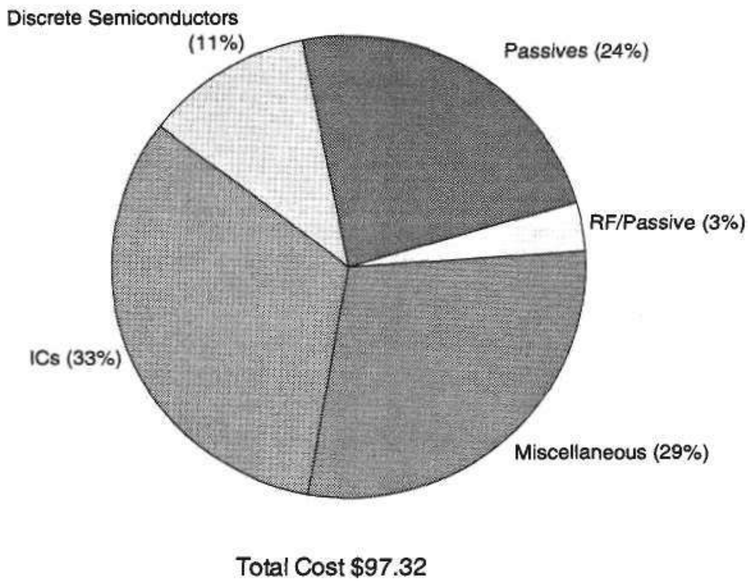
Figure 5-1 shows the cost distribution between semiconductors, discrete semiconductors, passive components, RF/passive components and miscellaneous components.

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

	1993	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Production (millions of units)	4.1	4.5	4.4	4.3	3.5	1.9	1.3	-22%
Factory ASP ($)	$163	$157	$150	$140	$134	$127	$120	-5%
Factory Revenue ($M)	$668	$707	$660	$602	$469	$241	$156	-26%

Source: Dataquest (October 1995 Estimates)

Figure 5-1
Component Cost Distribution—Pace PRD800 Plus Teardown (Based on Component Volumes of 100,000 Units)



Source: Dataquest (October 1995 Estimates)

Component Sector Analysis

The bill of materials is divided into component sectors. For the 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 1995 and 1996 (and percent cost change 1995 to 1996)
- Total cost of the parts in an IRD (device cost × quantity) for 1995 and 1996
- The total volume of parts required by the market, for 1995 and 1996
- The total value of the market for a specific part (and the component sector), for 1995 and 1996

Integrated Circuits (ICs)

ICs account for 33 percent of the teardown cost. The higher-value ICs include those which implement the UHF modulator and the Videocrypt functionality, as well as the graphic and sound ICs. The spend analysis is in Table 5-2.

Discrete Semiconductors

The discrete semiconductors in the IRD include various transistors and diodes (both through-hole and SMT), light-emitting diodes (LEDs) and a voltage regulator. These make up 11 percent of the teardown cost. Table 5-3 shows the discrete semiconductor spend analysis.

Passive Components

The passive components make up 24 percent of the teardown cost. This product contains various specialized inductors and resistors, as well as specific connectors. Table 5-4 shows the passive component spend analysis.

RF/Passive Components

The RF/passive components make up 3 percent of the teardown cost. These include the crystals and filters. Table 5-5 shows the RF/passive component spend analysis.

Miscellaneous Components

The miscellaneous components make up 29 percent of the teardown cost. Both the infrared receiver module and the fixed frequency tuner (both integrated devices, containing both semiconductor and non-semiconductor components), have been included here. Table 5-6 shows the miscellaneous component spend analysis.

Table 5-2
Pace PRD800 Plus—IC Spend Analysis

Device Reference	Device Type	Manufacturer	Quantity	Unit Cost ($) 1995 (Q4)	Unit Cost ($) 1996 (Q4)	Total Cost ($) 1995 (Q4)	Total Cost ($) 1996 (Q4)	Cost Change 1995-1996	Market Volume (M) 1995	Market Volume (M) 1996	Market Value ($M) 1995	Market Value ($M) 1996
8661	Processor		1	1.892	1.798	1.892	1.798	-5%	4.4	4.3	8.3	7.7
Nicky ASIC 3	Video amps	Dialog	1	2.624	2.362	2.624	2.362	-10%	4.4	4.3	11.5	10.2
Videocrypt × 4			1	3.673	3.306	3.673	3.306	-10%	4.4	4.3	16.2	14.2
74HC139	Dual two- to four-line decoder		1	0.204	0.198	0.204	0.198	-3%	4.4	4.3	0.9	0.9
74HC04			1	0.204	0.198	0.204	0.198	-3%	4.4	4.3	0.9	0.9
74LS03			1	0.204	0.198	0.204	0.198	-3%	4.4	4.3	0.9	0.9
74LS74			2	0.204	0.198	0.408	0.396	-3%	8.8	8.6	1.8	1.7
SN74ALS541N	Octal buffer/line driver	Texas Instruments	1	0.351	0.333	0.351	0.333	-5%	4.4	4.3	1.5	1.4
NE572	Prog. analog compandor	Philips	1	2.32	2.088	2.320	2.088	-10%	4.4	4.3	10.2	9.0
LM324	Quad op. amp.		2	0.249	0.244	0.498	0.488	-2%	8.8	8.6	2.2	2.1
TL084	Quad Bi-FET op. amp. low noise	Thomson	2	0.372	0.361	0.744	0.722	-3%	8.8	8.6	3.3	3.1
HEF4052	Dual four-channel multiplexer		1	0.323	0.307	0.323	0.307	-5%	4.4	4.3	1.4	1.3
HEF4053	Triple two-channel multiplexer		2	0.307	0.292	0.614	0.584	-5%	8.8	8.6	2.7	2.5
ULN2003	Transistor Darlingtons	Thomson	2	0.366	0.355	0.732	0.710	-3%	8.8	8.6	3.2	3.1
UPD41101C-1/2/3	Graphics chips	NEC	2	1.594	1.466	3.188	2.932	-8%	8.8	8.6	14.0	12.6
M50555	Display controller (color graphics)	Mitsubishi	1	1.526	1.404	1.526	1.404	-8%	4.4	4.3	6.7	6.0
MV95308	8-bit DAC	Plessey	1	1.432	1.289	1.432	1.289	-10%	4.4	4.3	6.3	5.5
24C16	8K EEPROM	Catalyst	1	1.473	1.399	1.473	1.399	-5%	4.4	4.3	6.5	6.0
SL5066	Video modulator	Plessey	1	1.193	1.133	1.193	1.133	-5%	4.4	4.3	5.2	4.9
SP4633	Prescaler	Plessey	1	0.525	0.499	0.525	0.499	-5%	4.4	4.3	2.3	2.1
SP973T8	8-bit ADC	Plessey	1	1.049	0.997	1.049	0.997	-5%	4.4	4.3	4.6	4.3
TDA6160	SAT sound (IF)	Siemens	1	2.624	2.493	2.624	2.493	-5%	4.4	4.3	11.5	10.7
TEA2018	Switch mode PSU	Thomson	1	1.286	1.183	1.286	1.183	-8%	4.4	4.3	5.7	5.1
TEA2130	Sync. sep. (DS173019)	Thomson	1	2.649	2.437	2.649	2.437	-8%	4.4	4.3	0.0	10.5
Total						$31.736	$29.454				128.0	126.7

Source: Dataquest (October 1995 Estimates)

Table 5-3
Pace PRD800 Plus—Discrete Semiconductor Spend Analysis

				Unit Cost ($)		Total Cost ($)		Cost Change	Market Volume (M)		Market Value ($M)	
Device Reference	Device Type	Manufacturer	Quantity	1995 (Q4)	1996 (Q4)	1995 (Q4)	1996 (Q4)	1995 to 1996	1995	1996	1995	1996
Diode	1N series		13	0.040	0.039	0.520	0.507	-2%	57.2	55.9	2.3	2.2
Diode	BYV95/96	Philips	4	0.146	0.143	0.584	0.572	-2%	17.6	17.2	2.6	2.5
Diode	Various		25	0.048	0.047	1.200	1.175	-2%	110.0	107.5	5.3	5.1
Diode	BAT43		4	0.089	0.087	0.356	0.348	-2%	17.6	17.2	1.6	1.5
Diode	Zener		14	0.053	0.052	0.742	0.728	-2%	61.6	60.2	3.3	3.1
Diode	EGP30		2	0.378	0.359	0.756	0.718	-5%	8.8	8.6	3.3	3.1
LED	Indicator		8	0.037	0.036	0.296	0.288	-3%	35.2	34.4	1.3	1.2
LED	7-seg. display x 3		1	0.89	0.863	0.890	0.863	-3%	4.4	4.3	3.9	3.7
Transistor	Various		36	0.048	0.047	1.728	1.692	-2%	158.4	154.8	7.6	7.3
Transistor	Various		6	0.173	0.170	1.038	1.020	-2%	26.4	25.8	4.6	4.4
Transistor	FXT749	Zetex	5	0.183	0.178	0.915	0.890	-3%	22.0	21.5	4.0	3.8
Transistor	Various		4	0.128	0.125	0.512	0.500	-2%	17.6	17.2	2.3	2.2
Transistor	BD139		2	0.259	0.254	0.518	0.508	-2%	8.8	8.6	2.3	2.2
Transistor	MJE18004	Motorola	1	0.616	0.598	0.616	0.598	-3%	4.4	4.3	2.7	2.6
LM7812	Voltage regulator		1	0.488	0.473	0.488	0.473	-3%	4.4	4.3	2.1	2.0
Total						**$11.159**	**$10.880**				**49.1**	**46.8**

Source: Dataquest (October 1995 Estimates)

Table 5-4
Pace PRD800 Plus—Passive Component Spend Analysis

				Unit Cost ($)		Total Cost ($)		Cost Change	Market Volume (M)		Market Value ($M)	
Device Reference	Device Type	Manufacturer	Quantity	1995 (Q4)	1996 (Q4)	1995 (Q4)	1996 (Q4)	1995 to 1996	1995	1996	1995	1996
Capacitor	Electrolytic 2200 uF radial		2	0.052	0.051	0.104	0.102	-2%	8.8	8.6	0.5	0.4
Capacitor	Electrolytic 5 mm radial		95	0.026	0.025	2.470	2.375	-2%	418.0	408.5	10.9	10.2
Capacitor	Electrolytic 10 mm radial		2	0.096	0.094	0.192	0.188	-2%	8.8	8.6	0.8	0.8
Capacitor	MLCC		172	0.039	0.038	6.708	6.536	-2%	756.8	739.6	29.5	28.1
Capacitor	Class X/Y		2	0.178	0.174	0.356	0.348	-2%	8.8	8.6	1.6	1.5
Resistor	Thick film		408	0.005	0.005	2.040	2.040	-2%	1,795.2	1,754.4	9.0	8.8
Resistor	Carbon film		9	0.005	0.005	0.045	0.045	-2%	39.6	38.7	0.2	0.2
Resistor	Metal film		6	0.032	0.031	0.192	0.186	-2%	26.4	25.8	0.8	0.8
Resistor	Flame retardant		2	0.388	0.380	0.776	0.760	-2%	8.8	8.6	3.4	3.3
Resistor	Metox non-spiral		2	0.135	0.132	0.270	0.264	-2%	8.8	8.6	1.2	1.1
Resistor	Zero ohm links		46	0.008	0.008	0.368	0.368	-2%	202.4	197.8	1.6	1.6
Inductor	Axial inductor		17	0.16	0.157	2.720	2.669	-2%	74.8	73.1	12.0	11.5
Inductor	Balun	Pedoka	1	0.058	0.056	0.058	0.056	-3%	4.4	4.3	0.3	0.2
Inductor	Air wound coil	Pedoka	7	0.031	0.030	0.217	0.210	-3%	30.8	30.1	1.0	0.9
Inductor	Sound coil	Sumida	1	0.212	0.206	0.212	0.206	-3%	4.4	4.3	0.9	0.9
Inductor	Coil		2	0.132	0.128	0.264	0.256	-3%	8.8	8.6	1.2	1.1
Inductor	Ferrite bead	Pedoka	2	0.109	0.106	0.218	0.212	-3%	8.8	8.6	1.0	0.9
Inductor	Inductor	TDK	2	0.623	0.604	1.246	1.208	-3%	8.8	8.6	5.5	5.2
Fuse	20 × 5 mm Quick-blow		1	0.049	0.048	0.049	0.048	-2%	4.4	4.3	0.2	0.2
Connector	Smart card		1	1.069	1.037	1.069	1.037	-3%	4.4	4.3	4.7	4.5
Connector	RF/TV		2	0.325	0.319	0.650	0.638	-2%	8.8	8.6	2.9	2.7
Connector	21-pin SCART		3	0.203	0.199	0.609	0.597	-2%	13.2	12.9	2.7	2.6
Connector	Dual phono.		1	0.271	0.266	0.271	0.266	-2%	4.4	4.3	1.2	1.1
Connector	AC input socket		1	0.564	0.553	0.564	0.553	-2%	4.4	4.3	2.5	2.4
Switch	Push to make		7	0.199	0.195	1.393	1.365	-2%	30.8	30.1	6.1	5.9
Total						$23.061	$22.533				101.5	96.9

Source: Dataquest (October 1995 Estimates)

Table 5-5
Pace PRD800 Plus—RF/Passive Component Spend Analysis

				Unit Cost ($)		Total Cost ($)		Cost Change	Market Volume (M)		Market Value ($M)	
Device Reference	Device Type	Manufacturer	Quantity	1995 (Q4)	1996 (Q4)	1995 (Q4)	1996 (Q4)	1995 to 1996	1995	1996	1995	1996
HC18U Series	Crystal 4 MHz		1	0.509	0.494	0.509	0.494	-3%	4.4	4.3	2.2	2.1
HC49U	Crystal 17.734 MHz		1	0.413	0.401	0.413	0.401	-3%	4.4	4.3	1.8	1.7
HC18U Series	Crystal 28 MHz		1	0.312	0.303	0.312	0.303	-3%	4.4	4.3	1.4	1.3
10.52MJA	Filter	Murata	2	0.306	0.297	0.612	0.594	-3%	8.8	8.6	2.7	2.6
10.7MJA	Filter	Murata	2	0.258	0.250	0.516	0.500	-3%	8.8	8.6	2.3	2.2
UF2327S-253-YOR5	Mains filter	TDK	1	0.668	0.648	0.668	0.648	-3%	4.4	4.3	2.9	2.8
CSB503F21	503 kHz resonator		1	0.292	0.283	0.292	0.283	-3%	4.4	4.3	1.3	1.2
Total						**$3.322**	**$3.223**				**14.6**	**13.9**

Source: Dataquest (October 1995 Estimates)

Table 5-6
Pace PRD800 Plus—Miscellaneous Component Spend Analysis

				Unit Cost ($)		Total Cost ($)		Cost Change	Market Volume (M)		Market Value ($M)	
Device Reference	Device Type	Manufacturer	Quantity	1995 (Q4)	1996 (Q4)	1995 (Q4)	1996 (Q4)	1995 to 1996	1995	1996	1995	199
SBX1620-E2	Infrared receive module	Sony	1	1.113	1.057	1.113	1.057	-5%	4.4	4.3	4.9	4.5
PC77G01	2 GHz fixed frequency tuner		1	12.593	11.334	12.593	11.334	-10%	4.4	4.3	55.4	48.7
PCB	Double-sided		1	12.164	11.921	12.164	11.921	-2%	4.4	4.3	53.5	51.3
SM800 Series	Transformer		1	2.172	2.107	2.172	2.107	-3%	4.4	4.3	9.6	9.1
Total						$28.042	$26.419				123.4	113.6

Source: Dataquest (October 1995 Estimates)

High-Volume Pricing

The bill of materials pricing is based on component volumes of 100,000. However, producers such as Sagem and Pace 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 1995 component pricing, based on quantities of 100,000 and 1 million units.

Table 5-7
1995 High-Volume Component Pricing for Analog IRDs

				1995 (Q4) Total Cost ($)	
Device Reference	**Device Type**	**Manufacturer**	**Quantity**	**Vol. = 100,000**	**Vol. = 1 Million**
ICs					
8661	Processor		1	1.892	1.721
Nicky ASIC 3	Video amps	Dialog	1	2.624	2.150
Videocrypt × 4			1	3.673	3.009
74HC139	Dual two- to four-line decoder		1	0.204	0.193
74HC04			1	0.204	0.193
74LS03			1	0.204	0.193
74LS74			2	0.408	0.386
SN74ALS541N	Octal buffer/line driver	Texas Instruments	1	0.351	0.319
NE572	Prog. analog compandor	Philips	1	2.32	1.901
LM324	Quad op. amp.		2	0.498	0.480
TL084	Quad Bi-FET op. amp. low noise	Thomson	2	0.744	0.704
HEF4052	Dual four-channel multiplexer		1	0.323	0.294
HEF4053	Triple two-channel multiplexer		2	0.614	0.559
ULN2003	Transistor Darlingtons	Thomson	2	0.732	0.692
UPD41101C-1/2/3	Graphics chips	NEC	2	3.188	2.727
M50555	Display controller (color graphics)	Mitsubishi	1	1.526	1.305
MV95308	8-bit DAC	Plessey	1	1.432	1.173
24C16	8K EEPROM	Catalyst	1	1.473	1.340
SL5066	Video modulator	Plessey	1	1.193	1.085
SP4633	Prescaler	Plessey	1	0.525	0.478
SP973T8	8-bit ADC	Plessey	1	1.049	0.954
TDA6160	SAT sound (IF)	Siemens	1	2.624	2.387
TEA2018	Switch mode PSU	Thomson	1	1.286	1.100
TEA2130	Sync. sep. (DS173019)	Thomson	1	2.649	2.266
			Subtotal	**$31.736**	**$27.610**

(continued)

Table 5-7 (Continued)
1995 High-Volume Component Pricing for Analog IRDs

				1995 (Q4) Total Cost ($)	
Device Reference	Device Type	Manufacturer	Quantity	Vol. = 100,000	Vol. = 1 Million
Discrete Semiconductors					
Diode	1N series		13	0.520	0.487
Diode	BYV95/96	Philips	4	0.584	0.546
Diode	Various		25	1.200	1.123
Diode	BAT43		4	0.356	0.333
Diode	Zener		14	0.742	0.694
Diode	EGP30		2	0.756	0.635
LED			8	0.296	0.267
LED	7-seg display × 3		1	0.89	0.804
Transistor	Various		36	1.728	1.617
Transistor	Various		6	1.038	0.971
Transistor	FXT749	Zetex	5	0.915	0.827
Transistor	Various		4	0.512	0.479
Transistor	BD139		2	0.518	0.485
Transistor	MJE18004	Motorola	1	0.616	0.557
LM7812	Voltage regulator		1	0.488	0.441
			Subtotal	**$11.159**	**$10.266**
Passives					
Capacitor	Electrolytic 2200 uF radial		2	0.104	0.09
Capacitor	Electrolytic 5 mm radial		95	2.470	2.24
Capacitor	Electrolytic 10 mm radial		2	0.192	0.17
Capacitor	MLCC		172	6.708	6.08
Capacitor	Class X/Y		2	0.356	0.32
Resistor	Thick film		408	2.040	1.85
Resistor	Carbon film		9	0.045	0.04
Resistor	Metal film		6	0.192	0.17
Resistor	Flame retardant		2	0.776	0.70
Resistor	Metox non-spiral		2	0.270	0.24
Resistor	Zero ohm links		46	0.368	0.33
Inductor	Axial inductor		17	2.720	2.47
Inductor	Balun	Pedoka	1	0.058	0.05
Inductor	Air wound coil	Pedoka	7	0.217	0.19
Inductor	Sound coil	Sumida	1	0.212	0.18
Inductor	Coil		2	0.264	0.23
Inductor	Ferrite bead	Pedoka	2	0.218	0.19
Inductor	Inductor	TDK	2	1.246	1.07
Fuse	20 × 5 mm Quickblow		1	0.049	0.04
Connector	Smart card		1	1.069	0.92
Connector	RF/TV		2	0.65	0.59
Connector	21-pin SCART		3	0.609	0.55
Connector	Dual phono.		1	0.271	0.25
Connector	AC input socket		1	0.564	0.51
Switch	Push to make		7	1.393	1.26
			Subtotal	**$23.061**	**$20.755**

(continued)

Table 5-7 (Continued)
1995 High-Volume Component Pricing for Analog IRDs

				1995 (Q4) Total Cost ($)	
Device Reference	**Device Type**	**Manufacturer**	**Quantity**	**Vol. = 100,000**	**Vol. = 1 Million**
RF/Passive					
HC18U Series	Crystal 4 MHz		1	0.509	0.43
HC49U	Crystal 17.734 MHz		1	0.413	0.35
HC18U Series	Crystal 28 MHz		1	0.312	0.27
10.52MJA	Filter	Murata	2	0.612	0.52
10.7MJA	Filter	Murata	2	0.516	0.44
UF2327S-253-YOR5	Mains filter	TDK	1	0.668	0.568
CSB503F21	503 kHz resonator		1	0.292	0.25
			Subtotal	**$3.322**	**$2.824**
Miscellaneous					
SBX1620-E2	Infrared receive module	Sony	1	1.113	0.998
PC77G01	2 GHz fixed frequency tuner		1	12.593	9.983
PCB	Double-sided		1	12.164	11.660
SM800 Series	Transformer		1	2.172	2.037
			Subtotal	**$28.042**	**$24.677**
			Total	**$97.320**	**$86.132**

Source: Dataquest (October 1995 Estimates)

Market Value in 1999

The 1999 forecasts for analog IRD production and component sector values (in dollars) are used to predict the size of the European market for each component sector. Forecasts for 1999, in Table 5-8, are based on component quantities of 1 million. These forecasts are based on annual price reductions, component integration, efficiency improvements in component manufacturing, and overall market conditions.

The value of the components is unlikely to fall significantly over the next few years. There is little incentive for further cost reduction or redesign of the mature analog equipment, when development is focused on higher-value digital technology.

Analog reception equipment will become the entry level for DTH, with digital IRDs commanding a premium. Because of the services digital DTH will offer, it is likely that IRDs will remain as separate units initially, in order to connect to CTVs, VCRs, PCs and so on. The cheaper analog IRD, repositioned as a wideband television tuner, could be integrated into other products, such as CTVs.

Table 5-8
1999 High-Volume Component Pricing for IRDs

	IRD Content ($)		No. of IRDs (M)		Component Market Value ($M)	
Component Type	**1995**	**1999**	**1995**	**1999**	**1995**	**1999**
ICs	27.610	22.088	4.4	1.3	121.5	28.7
Discrete Semiconductors	10.266	8.213	4.4	1.3	45.2	10.7
Passives	20.755	16.604	4.4	1.3	91.3	21.6
RF/Passive	2.824	2.259	4.4	1.3	12.4	2.9
Miscellaneous	24.677	19.742	4.4	1.3	108.6	25.7
Total	**$86.132**	**$68.906**			**379.0**	**89.6**

Source: Dataquest (October 1995 Estimates)

Bill of Materials

Device Reference	Device Type	Manufacturer	Quantity	1995 (Q4) Unit Cost ($)	Package	1995 (Q4) Total Cost ($)
ICs						
8661	Processor		1	1.892	DIL-40	1.892
Nicky ASIC 3	Video amps	Dialog	1	2.624	DIL-24	2.624
Videocrypt × 4			1	3.673	DIL-40/ DIL-20	3.673
74HC139	Dual two- to four-line decoder		1	0.204	DIL-16	0.204
74HC04			1	0.204	SMD-14	0.204
74LS03			1	0.204	SMD-14	0.204
74LS74			2	0.204	SMD-14	0.408
SN74ALS541N	Octal buffer/line driver	Texas Instruments	1	0.351	DIL-20	0.351
NE572	Prog. analog compandor	Philips	1	2.320	DIL-16	2.320
LM324	Quad op. amp.		2	0.249	DIL-14	0.498
TL084	Quad Bi-FET op. amp. low noise	Thomson	2	0.372	DIL-14	0.744
HEF4052	Dual four-channel multiplexer		1	0.323	DIL-16	0.323
HEF4053	Triple two-channel multiplexer		2	0.307	DIL-16	0.614
ULN2003	Transistor Darlingtons	Thomson	2	0.366	DIL-16	0.732
UPD41101C-1/2/3	Graphics chips	NEC	2	1.594	DIL-24	3.188
M50555	Display controller (color graphics)	Mitsubishi	1	1.526	DIL-32	1.526
MV95308	8-bit DAC	Plessey	1	1.432	DIL-20	1.432
24C16	8K EEPROM	Catalyst	1	1.473	DIL-8	1.473
SL5066	Video modulator	Plessey	1	1.193	DIL-20	1.193
SP4633	Prescaler	Plessey	1	0.525	DIL-8	0.525
SP973T8	8-bit ADC	Plessey	1	1.049	DIL-18	1.049
TDA6160	SAT sound (IF)	Siemens	1	2.624	SMD-29	2.624
TEA2018	Switch mode PSU	Thomson	1	1.286	DIL-8	1.286
TEA2130	Sync. sep. (DS173019)	Thomson	1	2.649	DIL-20	2.649
Discrete Semiconductors						
Diode	1N Series		13	0.040	PIH	0.520
Diode	BYV95/96	Philips	4	0.146	PIH	0.584
Diode	Various		25	0.048	SOT23	1.200
Diode	BAT43		4	0.089	PIH	0.356
Diode	Zener		14	0.053	PIH	0.742
Diode	EGP30		2	0.378	PIH	0.756
LED	Indicator		8	0.037	PIH	0.296

(continued)

(Continued)

Device Reference	Device Type	Manufacturer	Quantity	1995 (Q4) Unit Cost ($)	Package	1995 (Q4) Total Cost ($)
LED	7-Seg display × 3		1	0.890	PIH	0.890
Transistor	Various		36	0.048	SOT23	1.728
Transistor	Various		6	0.173	SOT23	1.038
Transistor	FXT749	Zetex	5	0.183	PIH	0.915
Transistor	Various		4	0.128	TO92	0.512
Transistor	BD139		2	0.259	TO126	0.518
Transistor	MJE18004	Motorola	1	0.616	PIH	0.616
LM7812	Voltage regulator		1	0.488	TO220	0.488
Passive Components						
Capacitor	Electrolytic 2200 uF radial		2	0.052	PIH	0.104
Capacitor	Electrolytic 5 mm radial		95	0.026	PIH	2.470
Capacitor	Electrolytic 10 mm radial		2	0.096	PIH	0.192
Capacitor	MLCC		172	0.039	0805	6.708
Capacitor	Class X/Y		2	0.178	PIH	0.356
Resistor	Thick film		408	0.005	0805	2.040
Resistor	Carbon film		9	0.005	PIH	0.045
Resistor	Metal film		6	0.032	PIH	0.192
Resistor	Flame retardant		2	0.388	PIH	0.776
Resistor	Metox non-spiral		2	0.135	PIH	0.270
Resistor	Zero ohm links		46	0.008	0805	0.368
Inductor	Axial inductor		17	0.160	PIH	2.720
Inductor	Balun	Pedoka	1	0.058	PIH	0.058
Inductor	Air wound coil	Pedoka	7	0.031	PIH	0.217
Inductor	Sound coil	Sumida	1	0.212	PIH	0.212
Inductor	Coil		2	0.132	PIH	0.264
Inductor	Ferrite bead	Murata	2	0.109	PIH	0.218
Inductor	Inductor	TDK	2	0.623	PIH	1.246
Fuse	20 × 5 mm Quickblow		1	0.049	Holder	0.049
Connector	Smart card		1	1.069	PIH	1.069
Connector	RF/TV		2	0.325	PIH	0.650
Connector	21-pin SCART		3	0.203	PIH	0.609
Connector	Dual phono.		1	0.271	PIH	0.271
Connector	AC input socket		1	0.564	PIH	0.564
Switch	Push to make		7	0.199	PIH	1.393

(continued)

(Continued)

Device Reference	Device Type	Manufacturer	Quantity	1995 (Q4) Unit Cost ($)	Package	1995 (Q4) Total Cost ($)
RF/Passive Components						
HC18U Series	Crystal 4 MHz		1	0.509	PIH	0.509
HC49U	Crystal 17.734 MHz		1	0.413	PIH	0.413
HC18U Series	Crystal 28 MHz		1	0.312	PIH	0.312
10.52MJA	Filter	Murata	2	0.306	PIH	0.612
10.7MJA	Filter	Murata	2	0.258	PIH	0.516
UF2327S-253-YOR5	Mains filter	TDK	1	0.668	PIH	0.668
CSB503F21	503 kHz resonator		1	0.292	PIH	0.292
Miscellaneous Components						
SBX1620-E2	Infrared receive module	Sony	1	1.113	PIH	1.113
PC77G01	2 GHz fixed frequency tuner		1	12.593	PIH	12.593
PCB	Double-sided		1	12.164		12.164
SM800 Series	Transformer		1	2.172		2.172
					Total	**$97.320**

Source: Dataquest (October 1995 Estimates)

Dataquest

a company of
The Dun & Bradstreet Corporation

DATAQUEST WORLDWIDE OFFICES

EUROPE

European Headquarters

Dataquest Europe Limited
Holmers Farm Way
High Wycombe, Bucks HP12 4XH
United Kingdom
Phone: +44 1494 422 722
Facsimile: +44 1494 422 742

Dataquest Europe SA

Immeuble Défense Bergères
345, avenue Georges Clémenceau
TSA 40002
92882 - Nanterre CTC Cedex 9
France
Phone: +33 1 41 35 13 00
Facsimile: +33 1 41 35 13 13

Dataquest GmbH

Kronstadter Strasse 9
81677 München
Germany
Phone: +49 89 93 09 09 0
Facsimile: +49 89 93 03 27 7

Sales Offices:
Brussels, Belgium
Kfar Saba, Israel
Milan, Italy
Randburg, South Africa
Madrid, Spain

LATIN AMERICA

Research Affiliates and Sales Offices:
Buenos Aires, Argentina
Sao Paulo, Brazil
Santiago, Chile
Mexico City, Mexico

NORTH AMERICA

Worldwide Headquarters

Dataquest Incorporated
251 River Oaks Parkway
San Jose, California 95134-1913
United States
Phone: 1-408-468-8000
Facsimile: 1-408-954-1780

Dataquest Incorporated

Nine Technology Drive
P.O. Box 5093
Westborough, Massachusetts
01581-5093
United States
Phone: 1-508-871-5555
Facsimile: 1-508-871-6262

Dataquest Global Events

3990 Westerly Place, Suite 100
Newport Beach, California 92660
United States
Phone: 1-714-476-9117
Facsimile: 1-714-476-9969

Sales Offices:
Washington, DC (Federal)
New York, NY (Financial)
Dallas, TX

JAPAN

Japan Headquarters

Dataquest Japan K.K.
Shinkawa Sanko Building
6th Floor
1-3-17, Shinkawa
Chuo-ku, Tokyo 104
Japan
Phone: 81-3-5566-0411
Facsimile: 81-3-5566-0425

ASIA/PACIFIC

Asia/Pacific Headquarters

7/F China Underwriters Centre
88 Gloucester Road
Wan Chai
Hong Kong
Phone: 852-2824-6168
Facsimile: 852-2824-6138

Dataquest Korea

Suite 2407, Trade Tower
159 Samsung-dong, Kangnam-gu
Seoul 135-729
Korea
Phone: 822-551-1331
Facsimile: 822-551-1330

Dataquest Taiwan

11F-2, No. 188, Section 5
Nan King East Road
Taipei
Taiwan, R.O.C.
Phone: 8862-756-0389
Facsimile: 8862-756-2663

Dataquest Singapore

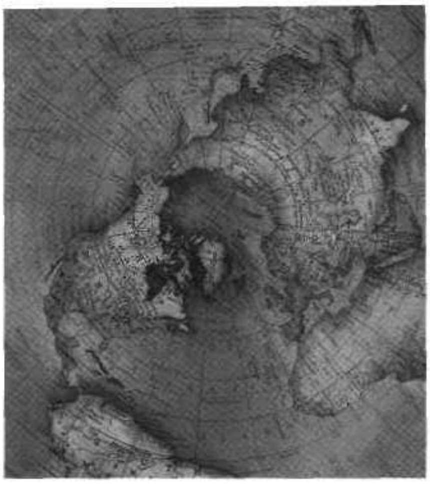
105 Cecil Street
#06-01/02 The Octagon
Singapore 0106
Phone: 65-227-1213
Facsimile: 65-227-4607

Dataquest Thailand

12/F, Vanissa Building
29 Soi Chidlom
Ploenchit Road
Patumwan, Bangkok 10330
Thailand
Phone: 662-655-0577
Facsimile: 662-655-0576

Research Affiliates and Sales Offices:
Melbourne, Australia
Beijing, China

50151



Dataquest

Wide Area Pager Production in Europe: Promise of Growth from a Mature Market

Focus Report

1995

Program: Electronic Equipment Production Monitor
Product Code: SAPM-EU-FR-9503
Publication Date: September 8, 1995
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For More Information...

Robin Daines .... +44 1494 422 725
Internet address .... rdaines@dqeurope.com
Via fax .... +44 1494 422 742

Dataquest
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- In 1994, 985,000 wide area pagers were shipped in Europe.

Wide Area Pagers: Production Overview

- The forecast for wide area pager production within Europe is 887,000 units in 1995, rising to just over 1.5 million units in 1999. This represents a compound annual growth rate (CAGR) of 16 percent.
- In 1994, the leading wide area pager producers (by units) were as follows:
  - Motorola: 50 percent
  - Philips: 36 percent
  - Swatch: 10 percent
- Factory average selling prices (ASPs) of a wide area pager are estimated to be:
  - 1995: $76
  - 1999: $80

Wide Area Pager: Component Market Overview

- The 1995 average component-sector costs (component volume of 100,000 for pricing purposes) are estimated as follows:
  - ICs: $12.63
  - Discretes: $1.03
  - Passives: $4.51
  - RF/Passive: $2.77
  - Miscellaneous: $5.98
- The 1995 average component-sector costs (component volume of 1 million for pricing purposes) are estimated as follows:
  - ICs: $11.37
  - Discretes: $0.93
  - Passives: $4.24
  - RF/Passive: $2.57
  - Miscellaneous: $5.56
- The 1999 average component-sector costs (component volume of 1 million for pricing purposes) are estimated as follows:
  - ICs: $10.01
  - Discretes: $0.56
  - Passives: $2.55
  - RF/Passive: $2.44
  - Miscellaneous: $5.00

- The 1995 market values (component volume of 100,000 for pricing purposes) are estimated as follows:
  - ICs: $11.2 million
  - Discretes: $915,000
  - Passives: $4.0 million
  - RF/Passive: $4.4 million
  - Miscellaneous: $5.3 million
- The 1999 market values (component volume of 1 million for pricing purposes) are estimated as follows:
  - ICs: $15.9 million
  - Discretes: $885,000
  - Passives: $4.0 million
  - RF/Passive: $3.9 million
  - Miscellaneous: $7.9 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 growth 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 (BOM) and average high-volume component pricing.

Evaluation Methodology

Representative, leading-edge, typically configured models are acquired monthly 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 Procurement Service
- Dataquest's Mass Storage service
- Cost models
- Press releases
- Industry quotes and surveys
- Catalogues and distributor information
- Industry sources

Component prices are based on 100,000-component quantities (not product quantities). These prices are usually (though not always) based on prices supported by the component vendor, obtained via component distributors. In addition, component prices based on 1 million–component quantities (not product quantities) are provided. These prices are partly based on prices supported by the component vendor, and partly based 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 manufacturers that 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 Wide Area Pager Market in Europe

Pagers are moving into the mainstream across Europe. Aided by "youth culture" marketing, simple purchase plans and brightly colored cases, shipments of wide area pagers are poised for a period of strong growth.

Although the total cost of ownership of cellular phones continues to fall, it remains higher (in most cases) than the total cost of ownership of a pager. Pagers are cheaper to manufacture, cheaper to operate (from the point of view of both the network operator and the user), and use standard disposable batteries. As well as reduced cost, pagers offer other advantages over mobile phones. They are physically discreet, and can alert the wearer in an unobtrusive manner (unlike most mobile phones). They are less prone to theft, and are the ideal vehicles for one-way, time-critical messages.

Product Definition

This report covers wide area pagers. These units allow the wearer to roam over a large geographical region, either nationally or internationally, and still receive messages. The report does not cover more specialized local, or on-site, paging.

Market Drivers

Pagers, like many other electronic applications, are moving from the realms of business into the consumer sector. Pager shipments to business customers have levelled off as demand from the business market has matured, and production is used mainly to supply the replacement market, rather than fuelling growth.

Many of those involved in the pager industry have been concerned in the past about the threat from analog cellular, and are now worried about the market positioning of digital cellular. It has been necessary to try to define a role for pagers which does not overlap with mobile telephony.

Calling Party Pays

The response to this issue is marketing-led. It has resulted in several initiatives, the most significant being "calling party pays" (CPP). Historically, most users of wide area pagers paid a monthly subscription, which covered both the pager unit and the message delivery service. With CPP pagers, the user makes a one-off payment to purchase the pager, which is linked to its own dedicated phone number. All subsequent payments are incurred by callers dialling the pager number (at a premium rate), in order to leave a message.

The other marketing drive is to target pagers at demographic groups that are put off by the cost, or perceived difficulty, of buying a cellular phone (predominantly the market sector comprising people between 15 and 24 years old). In order to achieve this, pager manufacturers have started to color and liven up the pager case, and both manufacturers and network operators are image building via advertising and sponsorship.

Market Opportunity

Current market penetration of wide area pagers is low. However, an estimated 985,000 units shipped in Europe during 1994. This is forecast to rise to more than 1.1 million units in 1995.

The market sector of 15 to 24 year-olds contains 71 million people across Europe; a penetration rate of 5 percent is equivalent to 3.6 million pagers. Pagers move from being a higher-margin, lower-volume product that is business oriented, to a high-volume, lower-margin, commodity-type product aimed at consumers.

European Production

Most pagers for the European market are manufactured in Europe. This is due to a number of factors:

- The historical development of transmission standards, and allocation of radio frequencies in Europe.
- The early involvement of European manufacturers.
- Pagers are relatively cheap to manufacture, which reduces the benefit of off-shore production.

Currently, just under 80 percent of European pager shipments are manufactured in Europe—a proportion that is likely to rise slightly over the next few years, as a Europe-wide paging standard is implemented. This is likely to attract European telecommunications manufacturers which have not previously produced wide area pagers. Additionally, if the Europe-based standard is adopted worldwide, it offers an opportunity for additional European production.

Unit Production

The CAGR for wide area pager production in Europe (from 1994 to 1999) is 16 percent. This grows slightly faster than shipment growth, due to the increase in European production. Table 2-1 shows wide area pager production in Europe from 1993 to 1999.

The production levels, prior to CPP, take into account historical subscription levels, and the number of pagers required to maintain (through replacements) and grow the subscription base. The CPP-influenced element of the forecast (predominantly from 1995 onwards) takes into account the increased marketing focus on CPP, together with technical development and price reductions.

However, there is a danger that the market will ignore pagers. For example, if CPP is not supported by the service providers, or cellular (both analog and digital) is priced very low, then wide area paging will remain a niche service.

The production forecast is based on current production levels of wide area pagers, as well as future production, linked to emerging pager standards. It also takes into account the number of pagers imported into Europe.

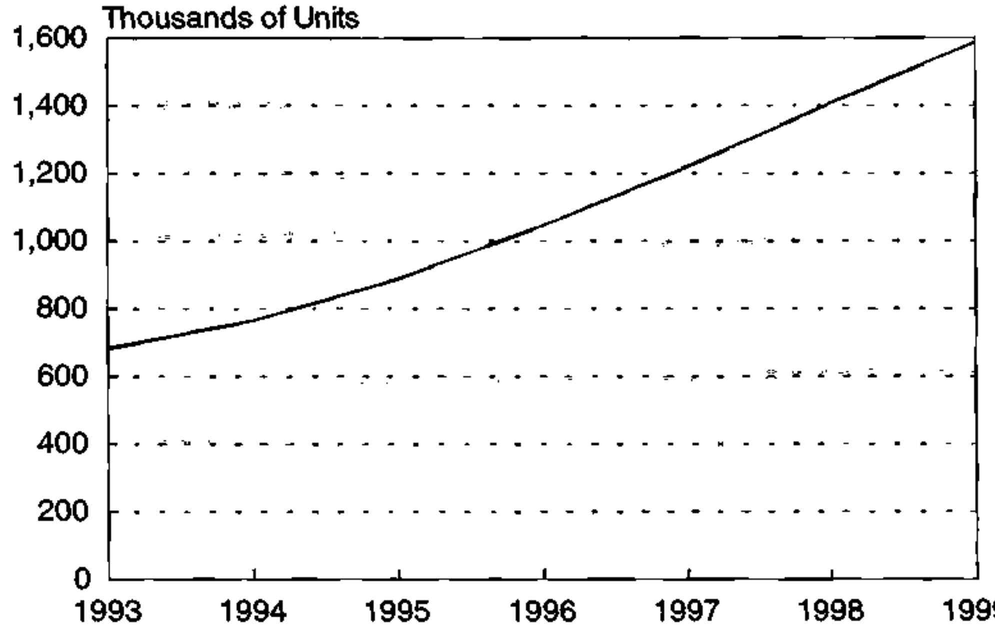
Figure 2-1 shows the growth in European pager production from 1993 to 1999.

Table 2-1
Wide Area Pager Production in Europe—History and Forecast (Thousands of Units)

Year	Unit Production
1993	683
1994	765
1995	887
1996	1,046
1997	1,218
1998	1,406
1999	1,588
CAGR 1994-1999	16%

Source: Dataquest (September 1995 Estimates)

Figure 2-1
Wide Area Pager Production in Europe



Source: Dataquest (September 1995 Estimates)

Chapter 3
Pager Standards and Technology

Historically, wide area paging in Europe has been limited to operation in a single country. Several transmission and coding formats are in use, with varying degrees of compatibility. Other formats have been proposed to allow Europe-wide "roaming" similar to that available with GSM cellular.

Standards

POCSAG

The post office code standardization advisory group (POCSAG) protocol is the nearest thing there is to a de facto European (and worldwide) pager standard. The POCSAG protocol includes information about the following:

- The coding format (including addressing, messaging and synchronization)
- How the coded message is modulated—usually by frequency shift keying (FSK)
- How fast the data is transmitted—up to 1200 bit/s

The POCSAG protocol is used with transmit and receive networks operating at a range of frequencies.

APOC

Advanced POCSAG (APOC) is a pager coding system proposed by Philips. This offers features such as longer text messages and roaming. It is intended to be cheap to implement, minimizing system upgrade costs, while offering compatibility with current POCSAG pagers. The coding has been designed to optimize channel capacity, and the system can dynamically vary bit rates (up to 6400 bit/s). The chosen coding structure leads to reduced power consumption and increased success with message reception. APOC claims to offer more efficient coding than any other paging system.

MBS-RDS

MBS encodes paging information onto an FM subcarrier, which is then transmitted with conventional FM radio broadcasts. MBS has evolved into a system based upon the radio data system (RDS) standard. Because RDS uses FM radio transmissions, it offers very good coverage (and high channel capacity), with reduced investment in infrastructure. The relatively low frequency used for RDS leads to reception problems using small receivers. This can be overcome by retransmitting the messages at periodic intervals. Nokia is most involved with the RDS and MBS protocols.

ERMES

The European radio message system (ERMES) is a Europe-sponsored standard. It has been developed, in a similar way to GSM, by representatives from paging and telecoms equipment manufacturers, network operators, and the European Telecommunications Standards Institute (ETSI).

ERMES makes use of a group of 16 channels, at 169 MHz, allocated across Europe. It is promoted as an "open" standard. It offers technical features similar to APOC, including high-speed, high-capacity transmission; more unique pager addresses than POCSAG; increased battery life; and European roaming.

Unlike APOC, it is the "official" European standard, and is already in use in several European countries, with other committed countries in Europe to follow. As well as Europe, markets in the Middle East and Asia/Pacific offer opportunities for high-volume production of a standard pager unit.

FLEX

Flex is a protocol developed by Motorola. It offers very similar features to those offered by both ERMES and APOC. It is a proprietary Motorola system, and is unlikely to gain the support of other pager manufacturers.

Technology Trends

Pagers are a mature and well-understood technology. Because they have predominantly been used in the business market (where the user was compelled to wear it), there has been no incentive for customer-driven technical development. Functionality has been related to business needs, rather than consumer behavior.

Until now, size, weight, battery life (and even color), while important, have not been critical. The emerging standards, such as ERMES, offer the opportunity to redesign pagers in order to address these issues.

Many of the large pager manufacturers are vertically integrated companies, which manufacture the ICs that are used in their pagers. Some also sell their devices (ICs) on the open market. This integration has advantages and drawbacks. The integration means that the IC designers can work very closely with the system-level designers to achieve all the design objectives. The disadvantage is that if the system designer is an "internal" customer, they may not be able to influence the level of device integration, low-power operation, or device size.

As pagers are integrated into different physical forms, the technology will evolve. The pager functionality is likely to be implemented using two ICs (receiver and decoder/controller), with much of the filtering incorporated into the ICs, rather than using discrete components. Most units already operate on a lowered voltage, but there remains scope for power conservation techniques such as a "sleep" mode. This in turn offers opportunities to use small button cells to power the units.

Enhanced features, and an improved man-machine interface (MMI), will require more IC functionality and a larger LCD display, as well as increasing power drain. The small electric motor currently used to vibrate the pager could be replaced by vibrating flat piezoelectric material (which could also act as an audible alert) on or in the pager.

Chapter 4
Major Manufacturers

Motorola and Philips Dominate

For various historical reasons, European wide area pager production is dominated by two large manufacturers. Between them, Motorola and Philips manufacture just over 85 percent of the pagers produced in Europe. However, because ERMES is being promoted as the pager equivalent of GSM, more European players are likely to enter the market.

Several factors have helped Motorola and Philips dominate European production. They are both vertically integrated companies, manufacturing components for pagers as well as the pager units. Motorola is a company that competes in all areas of mobile communications, on a worldwide basis. This allows it to design pagers for the world market, and manufacture locally. Philips is a company which also used to compete in each sector, although recently it has disposed of some parts of its communications empire.

Table 4-1 shows how the 765,000 wide area pagers produced during 1994 were split by manufacturer.

Table 4-1
Wide Area Pager Production by Manufacturer
(Thousands of Units)

Company	Unit Production	Production Share (%)	Cumulative Share (%)
Motorola	385	50%	50%
Philips	275	36%	86%
Swatch	75	10%	96%
Others	30	4%	100%
Total Production	765		

Source: Dataquest (September 1995 Estimates)

Other Manufacturers

Nokia currently manufactures a RDS/MBS wide area pager, and Ericsson does not produce wide area pagers at all. Companies such as these and other traditional suppliers to the European cellular handset market are likely to produce (or at least badge) some form of wide area pager in the future.

Swatch, a company more usually known for its watches, entered the pager market towards the end of 1995. Swatch manufactures a wide area pager in a wristwatch; and has used its understanding of the youth accessories market, and distribution channels, to market the new product.

Production in Europe

NEC is the only significant importer into the European market; all other units are manufactured locally. Most European production remains in Europe and is not exported. This situation may change if ERMES networks are installed in the Middle East and Africa.

Table 4-2 shows the manufacturing and design locations of Europe's major wide area pager OEMs.

Further investment in production capacity is unlikely in the short term. Pagers are relatively easy to assemble, and due to their small physical size, many PCBs can be assembled simultaneously, and then split up for system assembly. Any new entrants to the market are likely to make use of existing production capacity, or invest in additional surface mount production lines.

Table 4-2
Pager Production and R&D Locations in Europe
(Thousands of Units)

Company	Location	Country	R&D	Production
Motorola	Dublin	Ireland		✔
Nokia	Salo	Finland	✔	✔
Philips	Cambridge	England	✔	✔
	Eindhoven	Netherlands	✔	
Swatch	Grenchen	Switzerland	✔	✔
Swissphone	Samstagern	Switzerland	✔	✔

Source: Dataquest (September 1995)

Chapter 5

Teardown and Component Spend Analysis of the Motorola Bravo Express Numeric Pager

The Motorola Bravo Express is a wide area numeric pager. It is marketed, and resold by numerous service providers across Europe, either as a CPP pager, or as part of a subscription service. The pager is manufactured in several variants, depending on which radio frequency it uses, and whether it offers a vibrate option. The teardown includes the electronics, and excludes all housing materials, the main battery cell, mechanical buttons and battery contacts.

Teardown Summary

- Design and manufacturing advantages
  - All components mounted on the top side of the PCB; reduces cost
  - Modular design: RF PCB, and decoder/controller PCB
- Design and manufacturing disadvantages
  - Numerous through-hole components, possible manual insertion
  - Single-sided assembly, larger physical size

Component Spend Analysis

Component spend analysis uses the component pricing (from the BOM), and the market forecasts for pager production, to calculate the size of the market for each type of component. The BOM is in appendix A. Table 5-1 shows wide area pager production in Europe from 1993 to 1999.

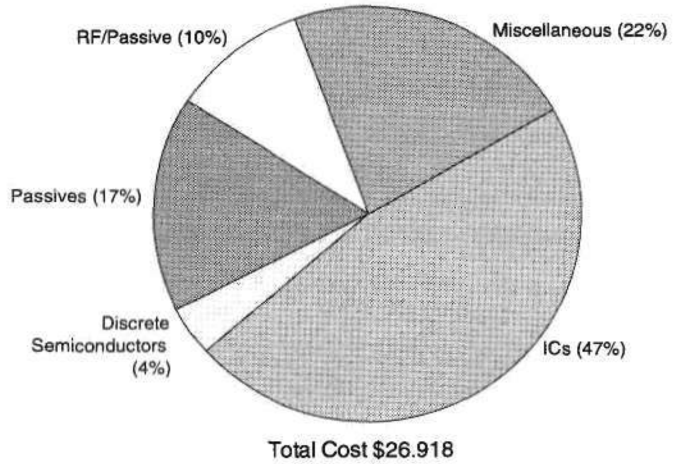
Figure 5-1 shows the cost distribution between semiconductors, discrete semiconductors, passive components, RF/passive components and miscellaneous components.

Table 5-1
Pager Production in Europe, Factory ASP and Factory Revenue—History and Forecast

	1993	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Pager Production (thousands of units)	683	765	887	1,046	1,218	1,406	1,588	16%
Factory ASP ($)	$74	$75	$76	$78	$79	$80	$80	1%
Factory Revenue ($M)	50.5	57.3	67.4	81.6	96.2	112.5	127.1	17%

Source: Dataquest (September 1995 Estimates)

Figure 5-1
Component Cost Distribution—Motorola Bravo Express Teardown



Source: Dataquest (September 1995 Estimates)

Component Sector Analysis

The bill of materials is divided into component sectors. For the pager, 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 1995 and 1996 (and percent cost change 1995 to 1996)
- Total cost of the parts in a PC (device cost × quantity) for 1995 and 1996
- The total volume of parts required by the market, for 1995 and 1996
- The total value of the market for a specific part (and the component sector), for 1995 and 1996

Integrated Circuits (ICs)

ICs account for 47 percent of the teardown cost. The four parts in the unit are all Motorola devices. The spend analysis is in Table 5-2. The value of the ICs is likely to remain stable, as renewed development effort should allow more functionality to be integrated into a two-chip set.

Discrete Semiconductors

The discrete semiconductors in the pager are various transistors, and a diode. These make up 4 percent of the teardown cost. Table 5-3 shows the discrete semiconductor spend analysis.

Passive Components

The passive components make up 17 percent of the teardown cost. Table 5-4 shows the passive component spend analysis.

RF/Passive Components

The RF/passive components make up 10 percent of the teardown cost. These include the crystals, and the bulk filters. Table 5-5 shows the RF/passive component spend analysis.

Miscellaneous Components

The miscellaneous components make up 22 percent of the teardown cost. The PCBs are cheap and basic technology, the RF PCB is double-sided with through hole components such as the aerial unit, and the board-to-board connector mounted on it. Table 5-6 shows the RF/passive component spend analysis.

Table 5-2
Motorola Bravo Express—IC Spend Analysis

				Unit Cost ($)		Total Cost ($)		Cost Change	Market Volume (K)		Market Value ($M)	
Device Reference	Device Type	Manufacturer	Quantity	1995 (Q3)	1996 (Q3)	1995 (Q3)	1996 (Q3)	1995-1996	1995	1996	1995	1996
SC410055FU	Controller/ decoder	Motorola	1	5.749	5.462	5.749	5.462	-5%	887	1,046	5.1	5.7
16SO2	RF	Motorola	1	2.233	2.121	2.233	2.121	-5%	887	1,046	2.0	2.2
LD Z23B	RF	Motorola	1	2.060	1.957	2.060	1.957	-5%	887	1,046	1.8	2.0
99Z32	RF	Motorola	1	2.590	2.461	2.590	2.461	-5%	887	1,046	2.3	2.6
Total =						**$12.632**	**$12.001**				**11.2**	**12.6**

Source: Dataquest (September 1995 Estimates)

Table 5-3
Motorola Bravo Express—Discrete Semiconductor Spend Analysis

				Unit Cost ($)		Total Cost ($)		Cost Change	Market Volume (K)		Market Value ($K)	
Device Reference	Device Type	Manufacturer	Quantity	1995 (Q3)	1996 (Q3)	1995 (Q3)	1996 (Q3)	1995-1996	1995	1996	1995	1996
Transistor	Various		9	0.056	0.053	0.504	0.477	-5%	7,983	9,414	447	499
Transistor			2	0.251	0.238	0.502	0.476	-5%	1,774	2,092	445	498
Diode			1	0.026	0.025	0.026	0.025	-5%	887	1,046	23	26
Total =						**$1.032**	**$0.978**				**915**	**1,023**

Source: Dataquest (September 1995 Estimates)

Table 5-4
Motorola Bravo Express—Passive Component Spend Analysis

Device Reference	Device Type	Manufacturer	Quantity	Unit Cost ($) 1995 (Q3)	Unit Cost ($) 1996 (Q3)	Total Cost ($) 1995 (Q3)	Total Cost ($) 1996 (Q3)	Cost Change 1995-1996	Market Volume (K) 1995	Market Volume (K) 1996	Market Value ($K) 1995	Market Value ($K) 1996
Capacitor	Tantalum		1	0.079	0.077	0.079	0.077	-2%	887	1,046	70	81
Capacitor	Tantalum		2	0.081	0.079	0.162	0.158	-2%	1,774	2,092	144	165
Capacitor	Tantalum		1	0.081	0.079	0.081	0.079	-2%	887	1,046	72	83
Capacitor	MLCC		31	0.029	0.028	0.899	0.868	-2%	27,497	32,426	797	908
Capacitor	MLCC		7	0.029	0.028	0.203	0.196	-2%	6,209	7,322	180	205
Capacitor	Variable/ trimmer		1	0.129	0.126	0.129	0.126	-2%	887	1,046	114	132
Inductor	Magnetic shielded		1	0.157	0.152	0.157	0.152	-3%	887	1,046	139	159
Inductor	Wound		1	0.294	0.285	0.294	0.285	-3%	887	1,046	261	298
Inductor	Variable		4	0.390	0.378	1.560	1.512	-3%	3,548	4,184	1,384	1,582
Resistor	Thick film		24	0.010	0.010	0.240	0.240	-2%	21,288	25,104	213	251
Connector	Female, 1×8		1	0.354	0.343	0.354	0.343	-3%	887	1,046	314	359
Connector	Male, 1×9		1	0.354	0.343	0.354	0.343	-3%	887	1,046	314	359
Total =						**$4.512**	**$4.379**				**4,002**	**4,580**

Source: Dataquest (September 1995 Estimates)

Table 5-5
Motorola Bravo Express—RF/Passive Component Spend Analysis

				Unit Cost ($)		Total Cost ($)		Cost Change	Market Volume (K)		Market Value ($K)	
Device Reference	Device Type	Manufacturer	Quantity	1995 (Q3)	1996 (Q3)	1995 (Q3)	1996 (Q3)	1995-1996	1995	1996	1995	1996
T9442	Crystal		1	0.457	0.434	0.457	0.434	-5%	887	1046	405	454
KST9418	Crystal		1	0.457	0.434	0.457	0.434	-5%	887	1046	405	454
9350S	Crystal		1	0.255	0.242	0.255	0.242	-5%	887	1046	226	253
B01 431	Crystal		1	0.629	0.598	0.629	0.598	-5%	887	1046	558	626
55D	Bulk filter	Murata	1	0.484	0.460	0.484	0.46	-5%	887	1046	429	481
55E	Bulk filter	Murata	1	0.484	0.460	0.484	0.46	-5%	887	1046	429	481
Total =						**$2.766**	**$2.628**				**4,448**	**4,745**

Source: Dataquest (September 1995 Estimates)

Table 5-6
Motorola Bravo Express—Miscellaneous Component Spend Analysis

			Unit Cost ($)		Total Cost ($)		Cost Change	Market Volume (K)		Market Value ($K)	
Device Reference	Device Type	Quantity	1995 (Q3)	1996 (Q3)	1995 (Q3)	1996 (Q3)	1995-1996	1995	1996	1995	1996
Aerial	Strip aerial unit	1	1.320	1.280	1.320	1.280	-3%	887	1,046	1,171	1,339
Battery		1	0.216	0.210	0.216	0.210	-3%	887	1,046	192	220
Buzzer		1	0.180	0.175	0.180	0.175	-3%	887	1,046	160	183
Motor	Mounted on SMT flex connector	1	2.270	2.157	2.270	2.157	-5%	887	1,046	2,013	2,256
LCD Display	Mounted on SMT flex connector	1	0.190	0.181	0.190	0.181	-5%	887	1,046	169	189
Bulb		1	0.220	0.213	0.220	0.213	-3%	887	1,046	195	223
Bare PWB (PCB)	Controller/display (four- layer)	1	0.830	0.813	0.830	0.813	-2%	887	1,046	736	850
Bare PWB (PCB)	RF (two-layer)	1	0.750	0.735	0.750	0.735	-2%	887	1,046	665	769
Total =					$5.976	$5.764				5,301	6,029

Source: Dataquest (September 1995 Estimates)

High-Volume Pricing

The bill of materials pricing is based on component volumes of 100,000. Unlike previous reports, where large OEMs produced more than 1 million units annually, the large pager manufacturers produce (at most) several hundred thousand units annually. The situation is complicated by companies such as Philips and Motorola using their own ICs within their pagers. And many companies will purchase commodity-type components, such as surface-mount resistors and capacitors, in large numbers for use in several different products.

However, it is still true that the large consumers of these components will buy in greater volume; in many cases direct from the manufacturer. Besides avoiding distribution, an equipment manufacturer can source many part types from a single vendor, and negotiate further discounts.

Table 5-7 shows 1995 component pricing, based on quantities of 100,000 and 1 million units.

Table 5-7
1995 High-Volume Component Pricing for Pagers

				1995 (Q3) Total Cost ($)	
Device Reference	**Device Type**	**Manufacturer**	**Quantity**	**Vol. = 100,000**	**Vol. = 1 Million**
ICs					
SC410055FU	Controller/decoder	Motorola	1	5.749	5.175
16SO2	RF	Motorola	1	2.233	2.010
LD Z23B	RF	Motorola	1	2.060	1.854
99Z32	RF	Motorola	1	2.590	2.331
			Subtotal	**$12.632**	**$11.370**
Discrete Semiconductors					
Transistor	Various		9	0.504	0.454
Transistor			2	0.502	0.452
Diode			1	0.026	0.023
			Subtotal	**$1.032**	**$0.929**
Passive					
Capacitor	Tantalum		1	0.079	0.08
Capacitor	Tantalum		2	0.162	0.15
Capacitor	Tantalum		1	0.081	0.08
Capacitor	MLCC		31	0.899	0.86
Capacitor	MLCC		7	0.203	0.19
Capacitor	Variable/trimmer		1	0.129	0.12
Inductor	Magnetic shielded		1	0.157	0.15
Inductor	Wound		1	0.294	0.27
Inductor	Variable		4	1.560	1.45
Resistor	Thick film		24	0.240	0.23
Connector	Female, 1×8		1	0.354	0.33
Connector	Male, 1×9		1	0.354	0.33
			Subtotal	**$4.512**	**$4.241**

(continued)

Table 5-7 (Continued)
1995 High-Volume Component Pricing for Pagers

Device Reference	Device Type	Manufacturer	Quantity	1995 (Q3) Total Cost ($) Vol. = 100,000	Vol. = 1 Million
RF/Passive					
T9442	Crystal		1	0.457	0.42
KST9418	Crystal		1	0.457	0.42
9350S	Crystal		1	0.255	0.24
B01 431	Crystal		1	0.629	0.58
55D	Bulk filter	Murata	1	0.484	0.45
55E	Bulk filter	Murata	1	0.484	0.45
			Subtotal	**$2.766**	**$2.572**
Miscellaneous					
Aerial	Strip aerial unit		1	1.320	1.242
Battery			1	0.216	0.203
Buzzer			1	0.180	0.169
Motor	Mounted on SMT flex connector		1	2.270	2.047
LCD Display	Mounted on SMT flex connector		1	0.190	0.171
Bulb			1	0.220	0.207
Bare PWB (PCB)	Controller/display (four-layer)		1	0.830	0.797
Bare PWB (PCB)	RF (two-layer)		1	0.750	0.721
			Subtotal	**$5.976**	**$5.558**
			Total	**$26.918**	**$24.670**

Source: Dataquest (September 1995 Estimates)

Market Value in 1999

The 1999 forecasts for wide area pager production and component-sector values (in dollars) are used to predict the size of the European market for each component sector. Forecasts for 1999, in Table 5-8, are based on component quantities of 1 million. These forecasts are based on annual price reductions, component integration, component manufacturing efficiency improvements, and overall market conditions.

The move towards pager systems such as ERMES during the forecast period will lead to increased functionality within the average pager unit. While numeric and alphanumeric pagers will service the consumer market, Dataquest expects ERMES pagers to be used primarily by business users to receive longer text messages, sent by electronic mail or other means. These pagers will have an increased semiconductor value, reflecting the increased functionality.

Integration of pager functionality on a two-chip set will reduce the number of ancillary components, especially resistors, capacitors and transistors.

Table 5-8
1999 High-Volume Component Pricing for Pagers

	Pager Content ($)		No. of Pagers (K)		Component Market Value ($K)	
Component Type	**1995**	**1999**	**1995**	**1999**	**1995**	**1999**
ICs	11.370	10.006	887	1,588	10,085	15,889
Discrete Semiconductors	0.929	0.557	887	1,588	824	885
Passives	4.241	2.545	887	1,588	3,762	4,041
RF/Passive	2.572	2.443	887	1,588	2,281	3,880
Miscellaneous	5.558	5.002	887	1,588	4,930	7,943
Total	**$24.670**	**$20.553**			**21,882**	32,638

Source: Dataquest (September 1995 Estimates)

Appendix A
Bill of Materials

Device Reference	Device Type	Manufacturer	Quantity	1995 (Q3) Unit Cost ($)	Package	1995 (Q3) Total Cost ($)
ICs						
SC410055FU	Controller/decoder	Motorola	1	5.749	PPQFP-80	5.749
16SO2	RF	Motorola	1	2.233	Ceramic-24	2.233
LD Z23B	RF	Motorola	1	2.060	Ceramic-10	2.060
99Z32	RF	Motorola	1	2.590	Ceramic-32	2.590
Discrete Semiconductors						
Transistor	Various		9	0.056	SOT23	0.504
Transistor			2	0.251	SOT23	0.502
Diode			1	0.026	SOT123	0.026
Passive						
Capacitor	Tantalum		1	0.079	EIA-D	0.079
Capacitor	Tantalum		2	0.081	3528	0.162
Capacitor	Tantalum		1	0.081	1206	0.081
Capacitor	MLCC		31	0.029	0805	0.899
Capacitor	MLCC		7	0.029	1206	0.203
Capacitor	Variable/trimmer		1	0.129	PIH	0.129
Inductor	Magnetic shielded		1	0.157	SMT	0.157
Inductor	Wound		1	0.294	SMT	0.294
Inductor	Variable		4	0.390	PIH	1.560
Resistor	Thick film		24	0.010	0805	0.240
Connector	Female, 1x8		1	0.354	PIH	0.354
Connector	Male, 1x9		1	0.354	PIH	0.354
RF/Passive						
X6300	Crystal		1	0.457	Can/PIH	0.457
KST17900/20J20	Crystal		1	0.457	Can/PIH	0.457
9350S	Watch Crystal		1	0.255	Can/PIH	0.255
B01 431	Crystal		1	0.629	SMT	0.629
55D	Miniature ceramic filter	Murata	1	0.484	PIH	0.484
55E	Miniature ceramic filter	Murata	1	0.484	PIH	0.484
Miscellaneous						
Aerial	Strip aerial unit		1	1.320	PIH	1.320
Battery			1	0.216	SMT	0.216
Buzzer			1	0.180	SMT	0.180
Motor	Mounted on SMT flex connector		1	2.270	SMT/PIH	2.270
LCD Display	Mounted on SMT flex connector		1	0.190	SMT	0.190
Bulb			1	0.220	SMT	0.220
Bare PWB (PCB)	Controller/display (four-layer)		1	0.830		0.830
Bare PWB (PCB)	RF (two-layer)		1	0.750		0.750
					Total	$26.918

Source: Dataquest (September 1995 Estimates)

Dataquest

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DATAQUEST WORLDWIDE OFFICES

EUROPE

European Headquarters
Dataquest Europe Limited
Holmers Farm Way
High Wycombe, Bucks HP12 4XH
United Kingdom
Phone: +44 1494 422 722
Facsimile: +44 1494 422 742

Dataquest Europe SA
Immeuble Défense Bergères
345, avenue Georges Clémenceau
TSA 40002
92882 - Nanterre CTC Cedex 9
France
Phone: +33 1 41 35 13 00
Facsimile: +33 1 41 35 13 13

Dataquest GmbH
Kronstadter Strasse 9
81677 München
Germany
Phone: +49 89 93 09 09 0
Facsimile: +49 89 93 03 27 7

Sales Offices:
Brussels, Belgium
Kfar Saba, Israel
Milan, Italy
Randburg, South Africa
Madrid, Spain

LATIN AMERICA

Research Affiliates and Sales Offices:
Buenos Aires, Argentina
Sao Paulo, Brazil
Santiago, Chile
Mexico City, Mexico

NORTH AMERICA

Worldwide Headquarters
Dataquest Incorporated
251 River Oaks Parkway
San Jose, California 95134-1913
United States
Phone: 1-408-468-8000
Facsimile: 1-408-954-1780

Dataquest Incorporated
Nine Technology Drive
P.O. Box 5093
Westborough, Massachusetts
01581-5093
United States
Phone: 1-508-871-5555
Facsimile: 1-508-871-6262

Dataquest Global Events
3990 Westerly Place, Suite 100
Newport Beach, California 92660
United States
Phone: 1-714-476-9117
Facsimile: 1-714-476-9969

Sales Offices:
Washington, DC (Federal)
New York, NY (Financial)
Dallas, TX

JAPAN

Japan Headquarters
Dataquest Japan K.K.
Shinkawa Sanko Building
6th Floor
1-3-17, Shinkawa
Chuo-ku, Tokyo 104
Japan
Phone: 81-3-5566-0411
Facsimile: 81-3-5566-0425

ASIA/PACIFIC

Asia/Pacific Headquarters
7/F China Underwriters Centre
88 Gloucester Road
Wan Chai
Hong Kong
Phone: 852-2824-6168
Facsimile: 852-2824-6138

Dataquest Korea
Suite 2407, Trade Tower
159 Samsung-dong, Kangnam-gu
Seoul 135-729
Korea
Phone: 822-551-1331
Facsimile: 822-551-1330

Dataquest Taiwan
11F-2, No. 188, Section 5
Nan King East Road
Taipei
Taiwan, R.O.C.
Phone: 8862-756-0389
Facsimile: 8862-756-2663

Dataquest Singapore
105 Cecil Street
#06-01/02 The Octagon
Singapore 0106
Phone: 65-227-1213
Facsimile: 65-227-4607

Dataquest Thailand
12/F, Vanissa Building
29 Soi Chidlom
Ploenchit Road
Patumwan, Bangkok 10330
Thailand
Phone: 662-655-0577
Facsimile: 662-655-0576

Research Affiliates and Sales Offices:
Melbourne, Australia
Beijing, China

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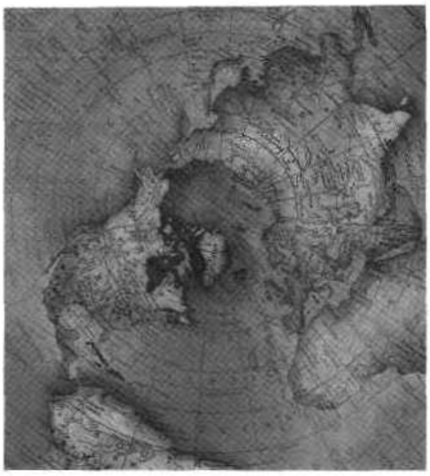

Dataquest

Growth in PC Production: Implications for Component Consumption Within the European Market

Focus Report

1995

Program: Electronic Equipment Production Monitor
Product Code: SAPM-EU-FR-9502
Publication Date: July 24, 1995
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For More Information...

Robin Daines .... +44 1494 422 725
Internet address .... rdaines@dqeurope.com
Via fax .... +44 1494 422 742

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Chapter 1

Executive Summary and Introduction

PC Market Overview

- The value of PCs shipped in Europe, during 1994, was $27 billion.
- Only 10 percent of the estimated 146 million homes in Europe have a PC.
- During 1995, sales of Pentium models will overtake sales of 486-based machines.

Production Overview

- The forecast for total PC production within Europe is 16.3 million units in 1995, rising to 28.3 million units in 1999. This represents a compound annual growth rate (CAGR) of 15 percent.
- The forecast for full-build PC production in Europe is 7.2 million units in 1995, rising to 15.6 million units in 1999. This represents a CAGR of 21 percent. (Full-build is where the motherboard is fully assembled, in addition to system assembly.)
- In 1994, the top 10 PC producers (by units) were as follows:
  - IBM: 11.5 percent
  - Compaq: 10.4 percent
  - Apple: 5.8 percent
  - Olivetti: 5.1 percent
  - Dell: 4.2 percent
  - Vobis: 4.2 percent
  - Hewlett-Packard: 3.8 percent
  - Escom: 3.3 percent
  - Siemens Nixdorf: 3.1 percent
  - Digital Equipment: 2.7 percent
- In 1994, the top three countries for PC production were:
  - United Kingdom, 34 percent
  - Germany, 19 percent
  - Ireland, 13 percent
- Factory average selling prices (ASPs) of a PC are estimated to be:
  - 1995: $1,133
  - 1999: $1,098

Component Market Overview

- The 1995 average component-sector costs (component volume of 100,000 units for pricing purposes) are estimated as:
  - ICs: $976
  - Discretes: $0.55
  - Passives: $38
  - RF/Passive: $0.90
  - Miscellaneous: $76

- The 1995 average component-sector costs (component volume of 1 million units for pricing purposes) are estimated as:
  - ICs: $831
  - Discretes: $0.50
  - Passives: $31
  - RF/Passive: $0.75
  - Miscellaneous: $58
- The 1999 average component-sector costs (component volume of 1 million units for pricing purposes) are forecast as:
  - ICs: $823
  - Discretes: $0.40
  - Passives: $25
  - RF/Passive: $0.61
  - Miscellaneous: $47
- The 1995 market values (component volume of 100,000 units for pricing purposes) are estimated as:
  - ICs: $7,025 million
  - Discretes: $4 million
  - Passives: $212 million
  - RF/Passive: $6.5 million
  - Miscellaneous: $123 million
- The 1999 market values (component volume of 1 million units for pricing purposes) are forecast as:
  - ICs: $12,839 million
  - Discretes: $6 million
  - Passives: $391 million
  - RF/Passive: $10 million
  - Miscellaneous: $739 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 growth within Europe. For each product type, the report lists the 10 largest producers (OEMs, the brand owners), or 75 percent of the market, within Europe. The report details manufacturing (including contract electronics manufacturing, CEM) and design (R&D) locations, unit production, equipment bill of materials (BOM) and average high-volume component pricing.

Evaluation Methodology

Representative, leading-edge, typically configured models are acquired monthly 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.

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 Procurement Service
- Dataquest's Mass Storage Service
- Cost models
- Press releases
- Industry quotes and surveys
- Catalogues and distributor information
- Industry sources

Component prices are based on 100,000-unit component quantities (not product quantities). In addition, component prices based on 1 million-unit component quantities (not product quantities) are provided. 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.

Chapter 2
The PC Marketplace: Demand and Supply Within Europe

Market Opportunity

The PC in Europe is big business, but it could be considerably bigger. Almost 12 million units were shipped in 1994, with a total value of $27 billion. And although the 14 percent increase over 1993 gives some indication of the growing demand in the home market, it cannot convey the potential size of the market. Of the estimated 146 million homes in Europe, only 10 percent currently have a PC. This represents a massive opportunity for PC manufacturers and their suppliers.

Europe is emerging from recession; average GDP growth for 1995 is forecast at 3 percent, with particularly strong growth in Denmark, France, Ireland, Italy and the United Kingdom. Economic growth will help stimulate both demand for PCs within Europe, and the need to manufacture locally.

Market Drivers

Traditionally, PCs were predominantly sold (in significant numbers) to large corporate businesses. As the corporate market matured, PC manufacturers targeted smaller businesses and the home office. And now the PC is being marketed as a multimedia information, entertainment and education tool for the home. Extensive and sophisticated marketing has shifted the perception of home PCs away from being work-oriented, to being fun-oriented. This has been supported by the availability of powerful CPUs and multimedia peripherals at (relatively) affordable prices, together with appropriate software.

Demanding consumers, used to seeing sophisticated special effects on television and at the cinema, and possibly unhappy with the performance of their aging PC at work, can now buy an affordable home PC which at least meets, if not exceeds, their expectations.

European Production

The increase in demand for PCs within Europe has coincided with the transition of the PC from technically differentiated product, to price-sensitive commodity, where the brand is everything. Therefore, PC production is influenced by the need to supply low-cost, high-quality products to the end user as quickly and cost-effectively as possible. This is why companies choose to produce in Europe, in order to sell in Europe.

PC brands are attempting to differentiate themselves via service metrics such as delivery. And so meeting delivery dates and volume requirements is essential when selling a commodity product, where the customer can easily buy elsewhere.

Production Definitions

Dataquest defines PC production as follows:

- **Full-Build**—Full motherboard assembly (by OEM or CEM), with or without system build.
- **Part Stuffing**—Where at least the memory and processor are added (to the motherboard).
- **Screwdriver**—System build only (with imported motherboard, which contains processor and memory).

Unit Production

The CAGR for total PC production within Europe (from 1994 to 1999) is 17 percent. The number of PCs fully built and assembled in Europe rises faster, at 23 percent. And by 1999, 55 percent of PCs produced in Europe will be full-build assembly. Table 2-1 shows PC production in Europe from 1993 to 1999.

Table 2-1
PC Production in Europe—History and Forecast

	1993	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Full-Build (millions of units)	3.9	5.6	7.2	8.3	10.0	12.3	15.6	23%
Total Production (millions of units)	10.9	13.0	16.3	18.4	21.5	24.7	28.3	17%
Full-Build (share of total production)	36%	43%	44%	45%	47%	50%	55%	5%

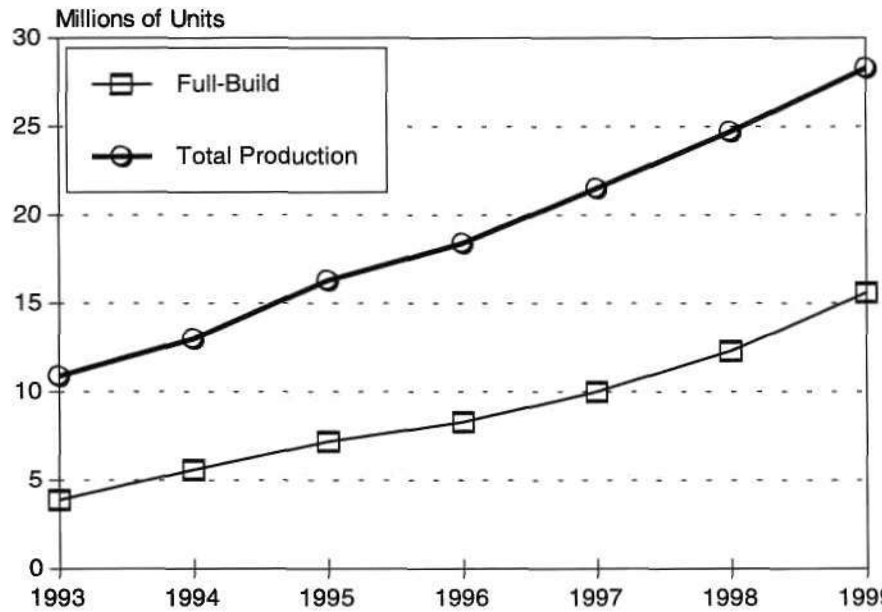
Source: Dataquest (July 1995 Estimates)

There will be a trend to more full-build production in Europe over the next five years, driven by the following factors:

- PC manufacturers investing in surface mount (SMT) production lines, or using CEMs to perform full-build, instead of importing motherboards. This effectively collapses the supply chain, and provides more local control over supply—the aim being to efficiently service the customer base.
- Increased full-build production in Central and Eastern Europe, utilizing lower labor costs, coupled with Western European expertise (in PC design and manufacturing technology).
- Most OEMs that produce PCs in Europe have some form of Europe-based R&D expertise to call upon. It will become more important to move full-build PC manufacturing closer to this R&D base, as the product becomes more complicated to design and manufacture.

Figure 2-1 shows the growth in European PC production, and the (relative) growth in full-build production.

Figure 2-1
PC Production in Europe



Source: Dataquest (July 1995 Estimates)

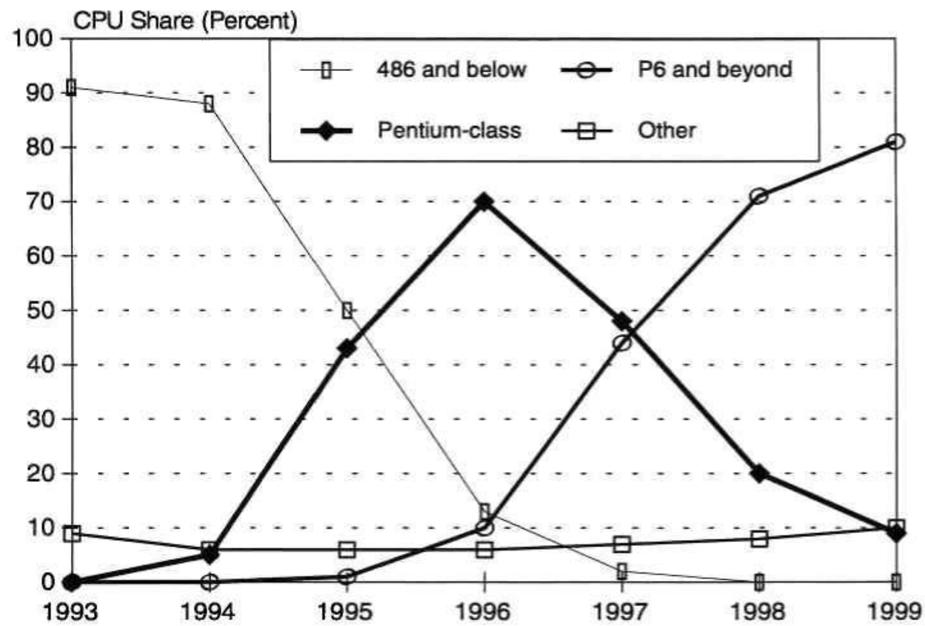
Chapter 3
CPU Technology

Pentium Growth

The year 1995 is when Pentium sales are expected to overtake those of the 486 family, which is why we have selected a Pentium-based PC for this report. In the longer term, the 486 in its DX4 and DX2 guises, as well as clone CPUs manufactured by (among others) AMD, Cyrix and Texas Instruments, will become a niche product, offering reasonable performance at a very low price. Figure 3-1 shows PC production in Europe by CPU.

The next 18 months represent the volume phase of Pentium processor shipments. Devices running at various clock speeds (including 120 MHz and upwards) will be introduced, and the earlier CPUs will be marketed as entry-level processors.

Figure 3-1
PC Production in Europe by CPU



Source: Dataquest (July 1995 Estimates)

CPU Definitions

For the purpose of this report we have segmented PC CPUs as follows:

- **486 and below** includes 80486DX4/DX2/DX/SX, 80386DX/SX and below
- **Pentium-class** includes Pentiums (all clock speeds), P54C, AMD K5, Nexgen 586
- **P6 and beyond** includes P6 and competing P6-class processors
- **Other** includes 68XXX, PowerPC, and others

The window of opportunity for selling high volumes of Pentiums will be less than for 486 machines, due to the way the next generation of CPU, the P6, is introduced. In order to stay ahead of the competition, Intel has plans to aggressively ramp up production of P6 while the Pentium enjoys its volume sales, and the 486 continues selling during its demise.

For various reasons, including available production capacity, CPU architecture and implementation, and competitive issues, the P6 will have a swifter product introduction (PI) than the Pentium. It will also be produced in greater quantities, with more frequent and greater increases in CPU speed (than the Pentium), at reasonable cost. Any convergence of Windows 95 and Windows NT in 1997/1998 will benefit the P6, which has more optimization for symmetric multiprocessing (SMP) than its predecessor.

Design Implications

The accelerating rate of CPU PI means that from a marketing point of view PC manufacturers must bring products to market even faster (than at present), and accept that these products will have shorter lifetimes. The PC PI issues are also affected by the increasing technical complexity of the CPU and its supporting technology. The entire motherboard, from printed wire board (PWB) substrate, to the active and passive components upon it, will be expected to perform better, with less margin for error.

The need to introduce products based upon leading-edge CPUs has prompted Intel to manufacture motherboards designed specifically for its advanced CPUs, in order to prime the markets and disseminate design and manufacturing expertise.

Chapter 4
Major Manufacturers

Compaq and IBM Take 20 Percent Share

It was in 1994 that Compaq became the largest PC vendor in the world (and in Western Europe too), overtaking IBM, whose share (in Western Europe) contracted by almost 6 percent. Although Compaq shipped more units in Europe, IBM produced more in Europe during 1994. Dataquest believes that during 1995, Compaq will produce more PCs in Europe than IBM.

Table 4-1 shows how the 13 million PCs produced in Europe during 1994 were split by manufacturer. It lists the top 10 manufacturers, ranked by unit production share. The dominant producers were IBM and Compaq, each producing twice as many PCs as their closest rivals. During the first quarter of 1995, Compaq production grew by just over 30 percent. However, companies such as Siemens Nixdorf, Escom and Hewlett-Packard all grew by more than 45 percent.

Table 4-1
1994 PC Production in Europe by Manufacturer
(Thousands of Units)

Company	Unit Production	Production Share (%)	Cumulative Share (%)
IBM	1,500	11.5	11.5
Compaq	1,350	10.4	21.9
Apple	750	5.8	27.7
Olivetti	660	5.1	32.8
Dell	550	4.2	37.0
Vobis	550	4.2	41.2
Hewlett-Packard	500	3.8	45.0
Escom	425	3.3	48.3
Siemens Nixdorf	400	3.1	51.4
Digital	350	2.7	54.1
Others	5,965	45.9	100.0
Total Production	13,000		
Full-Build Production	5,600		

Source: Dataquest (July 1995 Estimates)

Virtually all companies selling PCs in Europe have a goal of being in the top five. All of those companies will try to support that objective by increasing local production. However, the PC market is very competitive, and the growth is coming from companies which purely focus on the PC market, such as Dell, Compaq and Escom, as well as certain "traditional" computer manufacturers such as Digital, Hewlett-Packard and Siemens Nixdorf which have invested heavily in PC production capability. The sector remains extremely competitive, with very thin profit margins. And it is likely that some of the "traditional" computer companies are not making a profit from their PC operations.

Production in Europe

Export Opportunities

European PC production exceeds consumption, and for the most part these machines are shipped to the Middle East and Africa, although in a very few cases they go elsewhere (such as Apricot shipping to Japan).

European Locations

Tracking PC production within Europe is a complex task. The various types of PC production are defined in chapter 2. Table 4-2 shows the manufacturing and design locations for the top 10 European PC producers.

Only 3 of the 10 largest companies have R&D operations within Europe. Of those, 2 of them (Olivetti and Siemens Nixdorf) are European-headquartered companies anyway, and the third (Hewlett-Packard) has chosen to base its PC operation in Europe for strategic business reasons. The remaining companies either perform R&D overseas (predominantly in the United States), or buy motherboards from Far Eastern motherboard manufacturers.

Table 4-2
PC Production and R&D Locations in Europe

Company	Location	Country	Full-Build OEM	Full-Build CEM	Part Stuffing	Screw-driver	R&D
IBM	Greenock	Scotland	✓	✓	✓		
	Kvant	Russia			✓		
Compaq	Erskine	Scotland	✓	✓	✓		
Apple	Cork	Ireland	✓				
Olivetti	Ivrea	Italy					✓
	Marcianise	Italy	✓				
	Scarmagno	Italy	✓				
Dell	Limerick	Ireland		✓	✓		
Vobis	Aachen	Germany			✓	✓	
	Würselen	Germany			✓		
	Siegen	Germany			✓		
	Eupen	Belgium			✓		
	Vienna	Austria			✓		
Hewlett-Packard	Grenoble	France					✓
	Lyon	France		✓	✓		
Escom	Brno	Czech Republic			✓		
	Swarzedz	Poland			✓		
	Nieuw-Vennep	Netherlands			✓		
	Irvine	Scotland			✓		
Siemens Nixdorf	Augsburg	Germany	✓			✓	✓
	Haubourdin	France	✓				
Digital Equipment	Ayr	Scotland	✓		✓		

Source: Dataquest (July 1995)

OEM Full-Build versus CEM Full-Build

This report concentrates on PCs which are full-build in Europe. Table 4-2 lists OEM full-build locations, which are straightforward. The table also lists manufacturers (and sites) which use CEMs for all, or part, of their full-build motherboard requirements. The IBM, Compaq, Dell and Hewlett-Packard (Lyon) plants all use CEMs to supply them. OEM business can move from one CEM to another, and so it is better to track the total quantity of outsourced production within Europe.

Production by Country

The UK and Ireland region dominates PC production within Europe, accounting for just over 46 percent. Germany has almost 19 percent of production, followed by France with 11 percent and Italy with 7 percent. Various historical factors mean that the United Kingdom and Ireland have a large CEM base, which helped to attract companies such as Dell and Compaq. Both Ireland and Scotland have also benefited from regional development policies which have influenced companies to invest there.

Investment in Production

Of the major producers, Compaq and Escom have both made announcements about PC production during the last year. During 1994, Compaq invested over $20 million in surface mount assembly equipment at its Erskine, Scotland plant. This has provided it with another source of motherboards in addition to those provided by CEMs, and Compaq plants in Singapore and Houston, Texas. Escom's factory at Brno in the Czech Republic is currently producing relatively low volumes of PCs for the Central and Eastern European markets; however, it has the capacity, depending on demand, to supply to Western Europe as well.

Other companies which have been investing over the last year include AST Research and Gateway 2000, both of which opened production facilities in Ireland. Tulip has invested in surface mount assembly capacity, and Viglen has opened a new production facility in London.

It is unlikely that there will be significant investment in new plants by many players over the next year. There is enough production capacity to supply PCs to Western Europe, and to Central and Eastern Europe in the short term.

Chapter 5

Teardown and Component Spend Analysis of the Dell Optiplex XM-590

The PC chosen for teardown is a Dell Optiplex XM-590. The XM-590 is based around the Intel Pentium CPU, running at 90 MHz. The main motherboard, together with the riser card (containing PCI and ISA expansion slots) and the cache card (containing the SRAM cache) have been included (in the teardown). Peripherals (such as HDDs, FDDs, and so on), and the power supply have not been included.

The following summary lists high-value components in the PC. Manufacturing and design advantages and disadvantages are also listed. The fully costed bill of materials of the Dell Optiplex XM-590 is in appendix A.

Teardown Summary

- Product Availability
  - August 1994
- Sourcing Summary
  - CPU: Pentium-90, 3.3V/Intel, USA
  - Core Logic: Neptune PCI/Intel, USA
  - Memory: Motorola, USA
  - Cache: Integrated Devices Inc., USA
  - Graphics: Vision864 controller, 64-bit, PCI/S3, USA; 24-bit RAMDAC/ SGS-Thomson, France
  - PWB: Nan Ya Plastics, Taiwan
  - Pentium Socket: AMP, USA
- Design and manufacturing advantages
  - Only one ASIC
  - All ICs except CPU are surface mount, and mounted on top side
  - Graphics controller implemented on motherboard
- Design and manufacturing disadvantage
  - 16MB main memory as standard, costs more than 8MB

Component Spend Analysis

Component spend analysis* uses the component pricing (from the BOM), and market forecasts for equipment 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 PC production in Europe from 1995 to 1999.

Figure 5-1 shows the split between semiconductors (including discretes), passives (including the RF/passive crystals), and miscellaneous components. The distribution of component costs in this figure is distorted by the proportion of the total cost attributed to the CPU and 16MB of RAM. These two components alone account for almost three-quarters of the total teardown cost. If these are removed from the equation, the component cost is distributed more evenly. Figure 5-2 shows the component cost distribution, not including the CPU and DRAM.

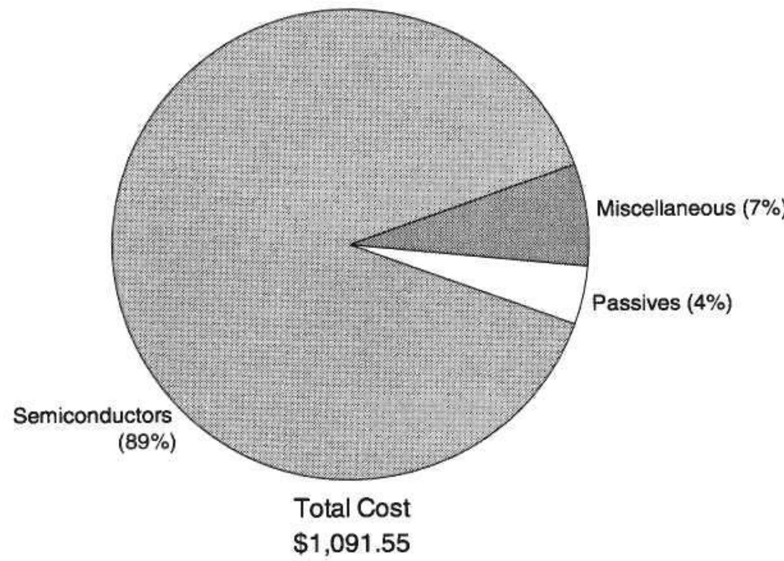
* Because the teardown analysis concerns all components on the motherboard, only production figures for full-build are used. Teardown cost refers to the cost of components listed in the BOM. The factory ASPs in Table 5-1 are averages, and are lower than the factory selling price for the specific PC (Dell XM-590) used here.

Table 5-1
Full-Build PC Production in Europe, Factory ASP and Factory Revenue-History and Forecast

	1993	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Full-Build (millions of units)	3.9	5.6	7.2	8.3	10.0	12.3	15.6	23%
Factory ASP ($)	$1,126	$1,135	$1,133	$1,138	$1,105	$1,113	$1,098	-1%
Factory Revenue ($B)	4.42	6.34	8.16	9.49	11.05	13.74	17.09	22%

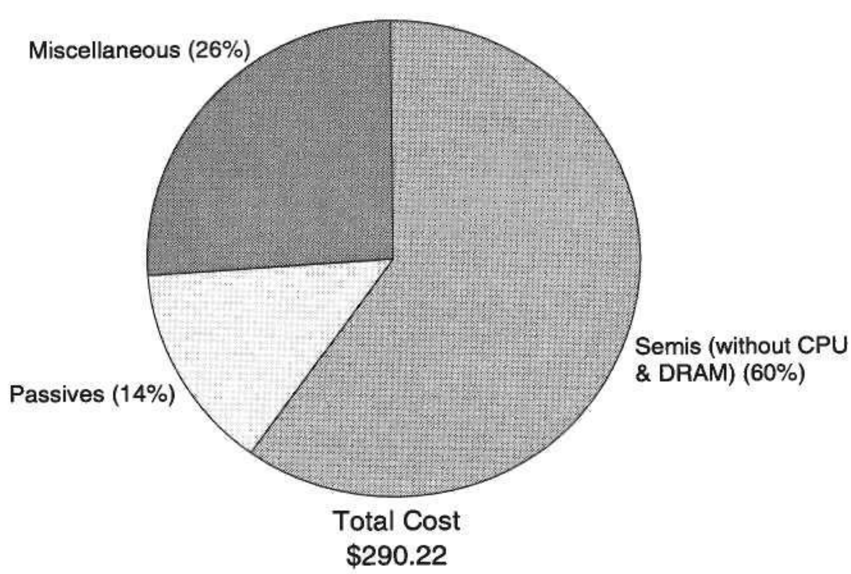
Source: Dataquest (July 1995 Estimates)

Figure 5-1
Component Cost Distribution (including CPU and DRAM)—Dell XM-590 Teardown



Source: Dataquest (July 1995 Estimates)

Figure 5-2
Component Cost Distribution (not including CPU and DRAM)—Dell XM-590 Teardown



Source: Dataquest (July 1995 Estimates)

Component Sector Analysis

The bill of materials is divided into component sectors. For the PC, 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 1995 and 1996 (and percent cost change 1995 to 1996)
- Total cost of a part in the PC (device cost × quantity) for 1995 and 1996
- The total volume of parts required by the market, for 1995 and 1996
- The total value of the market for a specific part (and the component sector), for 1995 and 1996

Integrated Circuits (ICs)

If you include the CPU and DRAM, then ICs account for 89 percent of the teardown cost. The 90-MHz Pentium, and 16MB of DRAM (together), constitute 73 percent of the teardown cost. The remaining semiconductor value is 16 percent of the teardown cost. Table 5-2 shows the IC spend analysis.

The core functionality is provided by the Intel Neptune-PCI chipset; the graphics capability is via the S3 graphics-controller and SGS-Thomson RAMDAC; and the PC uses only one ASIC (from National Semiconductor) in its design.

All the ICs (except for the CPU) are surface mount, on the top (component) side of the board.

We expect the value of core logic (the "chipset") ICs to grow by 10 percent over the next five years. This growth will be driven by the widespread adoption of multimedia functionality (such as MPEG-2) in hardware. Average CPU prices will remain static, or decline slightly, as newer high-value components replace the lower-priced (demising) CPUs.

The average cost of memory shipping as standard is likely to remain static (or decline slightly as memory production capacity increases), although the size of the memory will increase. Machines will start to ship with 8MB as standard. However, although Windows 95 users may demand 16MB, it is unlikely to ship as standard over the next couple of years.

Discrete Semiconductors

There are only two discrete semiconductors in the teardown—a voltage regulator (Motorola), and a diode. Table 5-3 shows the discrete semiconductor spend analysis.

The lack of discrete components is due, in part, to the inherently digital nature of PCs, and also to the fact that this particular model seems to have been designed to use the minimum number of (all types of) components.

Passive Components

The passive components make up 4.5 percent of the teardown cost; and of the passive components, connectors, headers and sockets make up 50 percent of the cost. There are a few pin in hole (PIH) tantalum and electrolytic capacitors, but the majority of the capacitors, resistors and inductors are surface mount. Table 5-4 shows the passive component spend analysis.

The types of component on PC motherboards have not changed a great deal over 15 years. Semiconductors have become more integrated, which in turn has reduced the need for some passive components. However, this trend has probably stopped. There is an ongoing requirement for termination resistors, and for decoupling and smoothing capacitors. In fact, with increases in CPU and bus speeds, these requirements will become even more important. There will also be a continued need for I/O connections to the motherboard, for internal and external power and data transfer.

Until PCs use optical interconnect, and PWBs provide internal decoupling capacitance, the number of passive components is likely to remain the same.

RF/Passive Components

There are only two RF/passive components in the teardown, both of which are clock crystals. Table 5-5 shows the RF/passive spend analysis.

Miscellaneous Components

Miscellaneous components includes the CMOS battery, the Pentium heat sink (which is cooled by the power supply fan), the PC "speaker" (in reality a piezo sounder), and the PWBs. Together they make up 7 percent of the teardown cost. Table 5-6 shows the miscellaneous components spend analysis.

The motherboard PWB is a six-layer design; this compares with the four layers that is considered standard for a 486 PC. This reflects the complexity of routing between the CPU and chipset (at PCI bus speeds) on a physically compact board, and observing design and manufacturing specifications.

Table 5-2
Dell XM-590—IC Spend Analysis

Device Reference	Device Type	Manufacturer	Quantity	Unit Cost ($) 1995 (Q2)	Unit Cost ($) 1996 (Q2)	Total Cost ($) 1995 (Q2)	Total Cost ($) 1996 (Q2)	Cost Change 1995 to 1996	Market Volume (M) 1995	Market Volume (M) 1996	Market Value ($M) 1995	Market Value ($M) 1996
Pentium 90 MHz	CPU	Intel	1	340.75	153.34	340.75	153.34	-55.0%	7.2	8.3	2,453.40	1,272.72
418	Voltage reference	Linear Technology	1	1.00	1.00	1.00	1.00	0.0%	7.2	8.3	7.20	8.30
DS1488M	Line driver, single-ended, RS232C, ITU-T V.24	National Semi.	2	0.14	0.13	0.28	0.26	-5.0%	14.4	16.6	2.02	2.16
DS1489AM	Line receiver, single-ended, RS232C programmable threshold, hysteresis	National Semi.	3	0.27	0.26	0.81	0.78	-5.0%	21.6	24.9	5.83	6.47
7406	Hex inverter buffer/driver, open collector, up to 30V output	Texas Instruments	3	0.17	0.16	0.51	0.48	-5.0%	21.6	24.9	3.67	3.98
E28F002BX-T80	Flash, 128K×16, 80ns	Intel	1	12.18	12.18	12.18	12.18	0.0%	7.2	8.3	87.70	101.09
V53C8256HK 45	DRAM, 256K×8, 45ns	Mosel-Vitalec	1	9.52	8.57	9.52	8.57	-10.0%	7.2	8.3	68.54	71.13
74ACT125	Buffer, quad-gated, three state	National Semi.	1	0.32	0.30	0.32	0.30	-5.0%	7.2	8.3	2.30	2.49
74F00	NAND gates, quad 2-input	Motorola	1	0.15	0.14	0.15	0.14	-5.0%	7.2	8.3	1.08	1.16
74F02	NOR gates, quad 2-input	Texas Instruments	2	0.15	0.14	0.30	0.28	-5.0%	14.4	16.6	2.16	2.32
74F04	Hex inverter	Texas Instruments	3	0.15	0.14	0.45	0.42	-5.0%	21.6	24.9	3.24	3.49
74F08D	AND gates, quad 2-input	Signetics	3	0.16	0.15	0.48	0.45	-5.0%	21.6	24.9	3.46	3.74
74F125	Buffer, quad-gated, three state	Motorola	3	0.21	0.20	0.63	0.60	-5.0%	21.6	24.9	4.54	4.98
74F138	Decoder/demultiplexer, 3 line to 8 line	Texas Instruments	1	0.21	0.20	0.21	0.20	-5.0%	7.2	8.3	1.51	1.66
74F245	Octal bus transceiver, three-state, true	Texas Instruments	5	0.27	0.26	1.35	1.30	-5.0%	36.0	41.5	9.72	10.79
74F32	OR gates, quad, 2-input	Texas Instruments	3	0.16	0.15	0.48	0.45	-5.0%	21.6	24.9	3.46	3.74
74FR244	Octal buffer/line driver, three-state, true	National Semi.	1	0.26	0.25	0.26	0.25	-5.0%	7.2	8.3	1.87	2.08

(continued)

Table 5-2 (Continued)
Dell XM-590—IC Spend Analysis

Device Reference	Device Type	Manufacturer	Quantity	Unit Cost ($) 1995 (Q2)	Unit Cost ($) 1996 (Q2)	Total Cost ($) 1995 (Q2)	Total Cost ($) 1996 (Q2)	Cost Change 1995 to 1996	Market Volume (M) 1995	Market Volume (M) 1996	Market Value ($M) 1995	Market Value ($M) 1996
74FCT373	Exclusive NOR gates, quad 2-input, open collector	Integrated Devices	2	0.47	0.45	0.94	0.90	-5.0%	14.4	16.6	6.77	7.47
S3384Q	Bus switches, 10-bit, high speed	Quality Semi.	7	1.36	1.16	9.52	8.12	-15.0%	50.4	58.1	68.54	67.40
71256-S15	SRAM, 32K×8, 15ns	Integrated Devices	8	6.05	4.84	48.40	38.72	-20.0%	57.6	66.4	348.48	321.38
S82378ZB	System chipset	Intel	1	8.29	6.63	8.29	6.63	-20.0%	7.2	8.3	59.69	55.03
S82433NX	Neptune PCI chipset	Intel	2	9.22	7.38	18.44	14.76	-20.0%	14.4	16.6	132.77	122.51
S82434NX	Neptune PCI chipset	Intel	1	17.11	12.83	17.11	12.83	-25.0%	7.2	8.3	123.19	106.49
86C864	Vision864 graphics controller	S3	1	22.42	19.06	22.42	19.06	-15.0%	7.2	8.3	161.42	158.20
CH9055C-S	Controller, clock	Chrontel	1	2.58	2.06	2.58	2.06	-20.0%	7.2	8.3	18.58	17.10
K028	Logic	Chrontel	1	1.16	1.10	1.16	1.10	-5.0%	7.2	8.3	8.35	9.13
PC87332VLJ	Super I/O controller, 3.3V	National Semi.	1	4.05	3.04	4.05	3.04	-25.0%	7.2	8.3	29.16	25.23
PC9011VLJ	Custom super I/O chip for Dell	National Semi.	1	4.39	3.29	4.39	3.29	-25.0%	7.2	8.3	31.61	27.31
PCI0640B	PCI IDE Controller	Calif. Micro Devices	1	6.27	5.02	6.27	5.02	-20.0%	7.2	8.3	45.14	41.67
MCM32T200 S70	SIMM, 8MB, 16 × 1M×4	Motorola	2	230.29	195.75	460.58	391.50	-15.0%	14.4	16.6	3,316.18	3,249.45
STG1703J-13	Graphics RAMDAC, 24-bit	SGS-Thomson	1	1.92	1.73	1.92	1.73	-10.0%	7.2	8.3	13.82	14.36
Total =						**$975.75**	**$689.76**				**7,025.40**	**5,725.01**

Source: Dataquest (July 1995 Estimates)

Table 5-3
Dell XM-590—Discrete Semiconductor Spend Analysis

Device Reference	Device Type	Manufacturer	Quantity	Unit Cost ($) 1995 (Q2)	Unit Cost ($) 1996 (Q2)	Total Cost ($) 1995 (Q2)	Total Cost ($) 1996 (Q2)	Cost Change 1995 to 1996	Market Volume (M) 1995	Market Volume (M) 1996	Market Value ($M) 1995	Market Value ($M) 1996
TIP125	Voltage regulator, 3.3V	Motorola	2	0.27	0.21	0.54	0.42	-22.0%	14.4	16.6	3.89	3.49
Diode	Diode, small		1	0.01	0.01	0.01	0.01	0.0%	7.2	8.3	0.07	0.08
Total =						0.55	0.43				3.96	3.57

Source: Dataquest (July 1995 Estimates)

Table 5-4
Dell XM-590—Passive Component Spend Analysis

Device Reference	Device Type	Manufacturer	Quantity	Unit Cost ($) 1995 (Q2)	Unit Cost ($) 1996 (Q2)	Total Cost ($) 1995 (Q2)	Total Cost ($) 1996 (Q2)	Cost Change 1995 to 1996	Market Volume (M) 1995	Market Volume (M) 1996	Market Value ($M) 1995	Market Value ($M) 1996
Elec. Capacitor	1500 uF/6.3V		2	0.33	0.31	0.66	0.62	-5.0%	14.4	16.6	4.75	5.15
Capacitor			277	0.03	0.03	8.31	8.31	-2.0%	1,994.4	2,299.1	59.83	68.97
Capacitor			2	0.03	0.03	0.06	0.06	-2.0%	14.4	16.6	0.43	0.50
Capacitor			4	0.04	0.04	0.16	0.16	-2.0%	28.8	33.2	1.15	1.33
Tant. Capacitor	EIA size D		11	0.05	0.05	0.55	0.55	-2.0%	79.2	91.3	3.96	4.57
Elec. Capacitor	22uF 25V	Elgen	7	0.05	0.05	0.35	0.35	-2.0%	50.4	58.1	2.52	2.91
Ceramic Capacitor			3	0.01	0.01	0.03	0.03	-2.0%	21.6	24.9	0.22	0.25
Inductor			17	0.05	0.05	0.85	0.85	-2.0%	122.4	141.1	6.12	7.06
Inductor			12	0.19	0.19	2.28	2.28	-2.0%	86.4	99.6	16.42	18.92
Resistor			497	0.01	0.01	4.97	4.97	-2.0%	3,578.4	4,125.1	35.78	41.25
Resistor			4	0.01	0.01	0.04	0.04	-2.0%	28.8	33.2	0.29	0.33
Resistor, axial	20 mm long		2	0.04	0.04	0.08	0.08	-2.0%	14.4	16.6	0.58	0.66
Resistor, axial	1/8W		12	0.01	0.01	0.12	0.12	-2.0%	86.4	99.6	0.86	1.00

(continued)

Table 5-4 (Continued)
Dell XM-590—Passive Component Spend Analysis

				Unit Cost ($)		Total Cost ($)		Cost Change	Market Volume (M)		Market Value ($M)	
Device Reference	Device Type	Manufacturer	Quantity	1995 (Q2)	1996 (Q2)	1995 (Q2)	1996 (Q2)	1995 to 1996	1995	1996	1995	1996
Fuse	Polyswitch		1	0.47	0.45	0.47	0.45	-5.0%	7.2	8.3	3.38	3.74
Header	Header, 1×3, 0.1-in. pitch		1	0.03	0.03	0.03	0.03	-2.0%	7.2	8.3	0.22	0.25
Header	Header, 1×4, 0.1-in. pitch		2	0.04	0.04	0.08	0.08	-2.0%	14.4	16.6	0.58	0.66
Header	Header, 2×13, 0.1-in. pitch		1	0.25	0.25	0.25	0.25	-2.0%	7.2	8.3	1.80	2.08
Header	Header, 2×17, 0.1-in. pitch		1	0.34	0.33	0.34	0.33	-2.0%	7.2	8.3	2.45	2.74
Header	Header, 2×20, 0.1-in. pitch		2	0.39	0.38	0.78	0.76	-2.0%	14.4	16.6	5.62	6.31
Header	Header, 2×3, 0.1-in. pitch		2	0.06	0.06	0.12	0.12	-2.0%	14.4	16.6	0.86	1.00
Header	Header, 2×4, 0.1-in. pitch		1	0.08	0.08	0.08	0.08	-2.0%	7.2	8.3	0.58	0.66
Connector	Connector, riser card slot		1	1.18	1.10	1.18	1.10	-7.0%	7.2	8.3	8.50	9.13
Connector	Connector, cache card slot		1	2.26	2.10	2.26	2.10	-7.0%	7.2	8.3	16.27	17.43
Connector	Connector, DS-15, female, monitor port	Foxconn	1	0.62	0.60	0.62	0.60	-3.0%	7.2	8.3	4.46	4.98
Connector	Connector, DS-25, female, parallel port	Sunridge	1	0.62	0.60	0.62	0.60	-3.0%	7.2	8.3	4.46	4.98
Connector	Connector, DS-9, male, serial port	Sunridge	2	0.34	0.33	0.68	0.66	-3.0%	14.4	16.6	4.90	5.48
Connector	Connector, power, keyed		1	0.38	0.37	0.38	0.37	-3.0%	7.2	8.3	2.74	3.07
Connector	Connector, ISA slot	Foxconn	5	0.48	0.47	2.40	2.35	-3.0%	36.0	41.5	17.28	19.51
Connector	Connector, PCI slot		2	0.58	0.56	1.16	1.12	-3.0%	14.4	16.6	8.35	9.30
Connector	Connector, double DIN-6, PS/2 style	Foxconn	1	0.67	0.65	0.67	0.65	-3.0%	7.2	8.3	4.82	5.40
Socket	Socket for coin-type battery		1	0.37	0.36	0.37	0.36	-2.0%	7.2	8.3	2.66	2.99
Socket	Socket, SIMM, 72 pin, metal latch, SnPb		4	0.96	0.93	3.84	3.72	-3.0%	28.8	33.2	27.65	30.88
Socket	Socket, DIP-24, 0.3-in. wide		4	0.10	0.10	0.40	0.40	-3.0%	28.8	33.2	2.88	3.32
Socket	Socket for Pentium-90	AMP	1	3.28	2.95	3.28	2.95	-10.0%	7.2	8.3	23.62	24.49
Total =						**$38.47**	**$37.50**				**211.97**	**236.63**

Source: Dataquest (July 1995 Estimates)

Table 5-5
Dell XM-590—RF/Passive Component Spend Analysis

Device Reference	Device Type	Manufacturer	Quantity	Unit Cost ($) 1995 (Q2)	Unit Cost ($) 1996 (Q2)	Total Cost ($) 1995 (Q2)	Total Cost ($) 1996 (Q2)	Cost Change 1995 to 1996	Market Volume (M) 1995	Market Volume (M) 1996	Market Value ($M) 1995	Market Value ($M) 1996
Crystal	14.3 MHz	ECS	2	0.36	0.34	0.72	0.68	-5.0%	14.4	16.6	5.18	5.64
Crystal	32 kHz		1	0.18	0.18	0.18	0.18	-2.0%	7.2	8.3	1.30	1.49
Total =						**$0.90**	**$0.86**				**6.48**	**7.14**

Source: Dataquest (July 1995 Estimates)

Table 5-6
Dell XM-590—Miscellaneous Component Spend Analysis

Device Reference	Device Type	Manufacturer	Quantity	Unit Cost ($) 1995 (Q2)	Unit Cost ($) 1996 (Q2)	Total Cost ($) 1995 (Q2)	Total Cost ($) 1996 (Q2)	Cost Change 1995 to 1996	Market Volume (M) 1995	Market Volume (M) 1996	Market Value ($M) 1995	Market Value ($M) 1996
CR2032	Battery, 3V, coin-type	Renata	1	0.45	0.43	0.45	0.43	-5.0%	7.2	8.3	3.24	3.57
Heat sink	Pentium-90 heat sink, 50 × 50 mm		1	1.25	1.19	1.25	1.19	-5.0%	7.2	8.3	9.00	9.88
QMX-05, speaker	Piezo buzzer	Star	1	0.18	0.17	0.18	0.17	-3.0%	7.2	8.3	1.30	1.41
Bare PWB (PCB)	Motherboard PWB	Nan Ya	1	56.90	58.04	56.9	58.04	2.0%	7.2	8.3	409.68	481.73
Bare PWB (PCB)	Riser-card PWB	Nan Ya	1	8.65	8.82	8.65	8.82	2.0%	7.2	8.3	62.28	73.21
Bare PWB (PCB)	Cache-card PWB		1	8.45	8.62	8.45	8.62	2.0%	7.2	8.3	60.84	71.55
Total =						**$75.88**	**$17.44**				**123.12**	**144.75**

Source: Dataquest (July 1995 Estimates)

High-Volume Pricing

The bill of materials pricing is based on component volumes of 100,000 units. This volume is more representative of component pricing for smaller producers than, for example, Compaq or IBM. Obviously, the large consumers of these components will buy in greater volume; in many cases direct from the manufacturer. Besides avoiding distribution, a manufacturer can source many part types from a single vendor, and negotiate further discounts.

Table 5-7 shows 1995 component pricing, based on quantities of 100,000 and 1 million units.

Table 5-7
1995 High-Volume Component Pricing for PCs

				1995 (Q2) Total Cost ($)	
Device Reference	Device Type	Manufacturer	Quantity	Vol. = 100,000	Vol. = 1 Million
ICs					
Pentium 90 MHz	CPU	Intel	1	340.75	291.63
418	Voltage reference	Linear Technology	1	1.00	0.94
DS1488M	Line driver, single-ended, RS232C, ITU-T V.24	National Semi.	2	0.28	0.26
DS1489AM	Line receiver, single-ended, RS232C programmable threshold,	National Semi.	3	0.81	0.76
7406	Hex inverter buffer/driver, open collector, up to 30V output	Texas Instruments	3	0.51	0.48
E28F002BX-T80	Flash, 128K×16, 80ns	Intel	1	12.18	10.77
V53C8256HK45	DRAM, 256K×8, 45ns	Mosel-Vitalec	1	9.52	8.41
74ACT125	Buffer, quad-gated, three state	National Semi.	1	0.32	0.30
74F00	NAND Gates, quad 2-input	Motorola	1	0.15	0.14
74F02	NOR Gates, quad 2-input	Texas Instruments	2	0.30	0.28
74F04	Hex Inverter	Texas Instruments	3	0.45	0.42
74F08D	AND gates, quad 2-input	Signetics	3	0.48	0.45
74F125	Buffer, quad-gated, three state	Motorola	3	0.63	0.59
74F138	Decoder/demultiplexer, 3 line to 8 line	Texas Instruments	1	0.21	0.20
74F245	Octal bus transceiver, three-state, true	Texas Instruments	5	1.35	1.27
74F32	OR Gates, quad, 2-input	Texas Instruments	3	0.48	0.45
74FR244	Octal buffer/line driver, three-state, true	National Semi.	1	0.26	0.24
74FCT373	Exclusive NOR gates, quad 2-input, open collector	Integrated Devices	2	0.94	0.89
S3384Q	Bus switches, 10-bit, high speed	Quality Semi.	7	9.52	7.86
71256-S15	SRAM, 32K×8, 15ns	Integrated Devices	8	48.40	37.16
S82378ZB	System chipset	Intel	1	8.29	6.36
S82433NX	Neptune PCI chipset	Intel	2	18.44	14.16
S82434NX	Neptune PCI chipset	Intel	1	17.11	12.14
86C864	Vision864 graphics controller	S3	1	22.42	18.51
CH9055C-S	Controller, clock	Chrontel	1	2.58	1.98
K028	Logic	Chrontel	1	1.16	1.09

(continued)

Table 5-7 (Continued)
1995 High-Volume Component Pricing for PCs

Device Reference	Device Type	Manufacturer	Quantity	1995 (Q2) Total Cost ($) Vol. = 100,000	Vol. = 1 Million
PC87332VLJ	Super I/O controller, 3.3V	National Semi.	1	4.05	2.87
PC9011VLJ	Custom super I/O chip for Dell	National Semi.	1	4.39	3.12
PCI0640B	PCI IDE Controller	Calif. Micro Devices	1	6.27	4.81
MCM32T200S70	SIMM, 8MB, 16 × 1M×4	Motorola	2	460.58	401.03
STG1703J-13	Graphics RAMDAC, 24-bit	SGS-Thomson	1	1.92	1.70
			Subtotal =	**975.75**	**831.31**
Discrete Semiconductors					
TIP125	Voltage regulator, 3.3V	Motorola	2	0.54	0.49
Diode	Diode, small		1	0.01	0.01
			Subtotal =	**0.55**	**0.50**
Passive					
Elec. Capacitor	1500 uF/6.3V		2	0.66	0.47
Capacitor			277	8.31	7.36
Capacitor			2	0.06	0.05
Capacitor			4	0.16	0.14
Tant. Capacitor	EIA size D		11	0.55	0.49
Elec. Capacitor	22uF 25V	Elgen	7	0.35	0.31
Ceramic Capacitor			3	0.03	0.03
Inductor			17	0.85	0.75
Inductor			12	2.28	2.02
Resistor			497	4.97	4.40
Resistor			4	0.04	0.04
Resistor, axial	20 mm long		2	0.08	0.07
Resistor, axial	1/8W		12	0.12	0.11
Fuse	Polyswitch		1	0.47	0.34
Header	Header, 1×3, 0.1-in. pitch		1	0.03	0.03
Header	Header, 1×4, 0.1-in. pitch		2	0.08	0.07
Header	Header, 2×13, 0.1-in. pitch		1	0.25	0.22
Header	Header, 2×17, 0.1-in. pitch		1	0.34	0.30
Header	Header, 2×20, 0.1-in. pitch		2	0.78	0.69
Header	Header, 2×3, 0.1-in. pitch		2	0.12	0.11
Header	Header, 2×4, 0.1-in. pitch		1	0.08	0.07
Connector	Connector, riser card slot		1	1.18	0.71
Connector	Connector, cache card slot		1	2.26	1.36
Connector	Connector, DS-15, female, monitor port	Foxconn	1	0.62	0.51
Connector	Connector, DS-25, female, parallel port	Sunridge	1	0.62	0.51
Connector	Connector, DS-9, male, serial port	Sunridge	2	0.68	0.56
Connector	Connector, power, keyed		1	0.38	0.31
Connector	Connector, ISA slot	Foxconn	5	2.40	1.99
Connector	Connector, PCI slot		2	1.16	0.96

(continued)

Table 5-7 (Continued)
1995 High-Volume Component Pricing for PCs

				1995 (Q2) Total Cost ($)	
Device Reference	Device Type	Manufacturer	Quantity	Vol. = 100,000	Vol. = 1 Million
Connector	Connector, double DIN-6, PS/2 style	Foxconn	1	0.67	0.56
Socket	Socket for coin-type battery		1	0.37	0.33
Socket	Socket, SIMM, 72 pin, metal latch, SnPb		4	3.84	3.18
Socket	Socket, DIP-24, 0.3-in. wide		4	0.40	0.33
Socket	Socket for Pentium-90	AMP	1	3.28	1.41
			Subtotal =	**38.47**	**30.78**
RF/Passive					
Crystal	14.3 MHz	ECS	2	0.72	0.58
Crystal	32 kHz		1	0.18	0.17
			Subtotal =	**0.90**	**0.75**
Miscellaneous					
CR2032	Battery, 3V, coin-type	Renata	1	0.45	0.20
Heat sink	Pentium-90 heat sink, 50 × 50 mm		1	1.25	0.55
QMX-05, speaker	Piezo buzzer	Star	1	0.18	0.12
Bare PWB (PCB)	Motherboard PWB	Nan Ya	1	56.90	44.09
Bare PWB (PCB)	Riser-card PWB	Nan Ya	1	8.65	6.70
Bare PWB (PCB)	Cache-card PWB		1	8.45	6.55
			Subtotal =	**75.88**	**58.20**
			Total =	**$1,091.55**	**$921.54**

Source: Dataquest (July 1995 Estimates)

Market Value in 1999

The 1999 forecasts for full-build PC production, and component sector values (in dollars), are used to predict the size of the European market for each component sector. Forecasts for 1999, in Table 5-8, are based on component quantities of 1 million units.

These forecasts are based on annual price reductions, based on component manufacturing efficiency improvements and overall market conditions. However, Dataquest believes that the total value of ICs will remain at a similar level over the next few years, as price cuts are matched by increased functionality. This means that in 1999 a "typical" high-volume PC will include whatever the current high-performance CPU is, together with sufficient DRAM to provide the required functionality.

Although the CPU and DRAM will offer more raw power in 1999, they will be priced at a similar level to 1995 prices.

Table 5-8
1999 High-Volume Component Pricing for PCs

	PC Content ($)		No. of PCs Full-Build (M)		Component Market Value ($M)	
Component Type	**1995**	**1999**	**1995**	**1999**	**1995**	**1999**
ICs	831.31	822.99	7.2	15.6	5,985.4	12,838.7
Discrete Semiconductors	0.50	0.40	7.2	15.6	3.6	6.2
Passives	30.78	25.06	7.2	15.6	221.6	391.0
RF/Passive	0.75	0.61	7.2	15.6	5.4	9.5
Miscellaneous	58.20	47.39	7.2	15.6	419.0	739.3
Total =	**921.54**	**896.46**			**6,635.1**	**13,984.8**

Source: Dataquest (July 1995 Estimates)

Appendix A
Bill of Materials

Table A-1
Dell Optiplex XM-590—Based on 100,000-Unit Component Quantities

Device Reference	Device Type	Manufacturer	Quantity	1995 (Q2) Unit Cost ($)	Package	1995 (Q2) Total Cost ($)
ICs						
Pentium 90 MHz	CPU	Intel	1	340.75	PGA-296	340.75
418	Voltage reference	Linear Technology	1	1.00	SOIC-8	1.00
DS1488M	Line driver, single-ended, RS232C, ITU-T V.24	National Semi.	2	0.14	SOIC-14	0.28
DS1489AM	Line receiver, single-ended, RS232C programmable threshold, hysteresis	National Semi.	3	0.27	SOIC-14	0.81
7406	Hev inverter buffer/driver, open collector, up to 30V output	Texas Instruments	3	0.17	SOIC-14	0.51
E28F002BX-T80	Flash, 128K×16, 80ns	Intel	1	12.18	TSSOP-40	12.18
V53C8256HK45	DRAM, 256K×8, 45ns	Mosel-Vitalec	1	9.52	SOJ-20	9.52
74ACT125	Buffer, quad-gated, three state	National Semi.	1	0.32	SOIC-14	0.32
74F00	NAND gates, quad 2-input	Motorola	1	0.15	SOIC-14	0.15
74F02	NOR gates, quad 2-input	Texas Instruments	2	0.15	SOIC-14	0.30
74F04	Hex inverter	Texas Instruments	3	0.15	SOIC-14	0.45
74F08D	AND gates, quad 2-input	Signetics	3	0.16	SOIC-14	0.48
74F125	Buffer, quad-gated, three state	Motorola	3	0.21	SOIC-14	0.63
74F138	Decoder/demultiplexer, 3 line to 8 line	Texas Instruments	1	0.21	SOIC-16	0.21
74F245	Octal bus transceiver, three-state, true	Texas Instruments	5	0.27	SOIC-20	1.35
74F32	OR gates, quad, 2-input	Texas Instruments	3	0.16	SOIC-14	0.48
74FR244	Octal buffer/line driver, three-state, true	National Semi.	1	0.26	SOIC-20	0.26
74FCT373	Exclusive NOR gates, quad 2-input, open collector	Integrated Devices	2	0.47	SOIC-20	0.94
S3384Q	Bus switches, 10-bit, high speed	Quality Semi.	7	1.36	TSSOP-24	9.52
71256-S15	SRAM, 32K×8, 15ns	Integrated Devices	8	6.05	SOJ-28	48.40
S82378ZB	System chipset	Intel	1	8.29	PQFP-208	8.29
S82433NX	Neptune PCI chipset	Intel	2	9.22	PQFP-160	18.44
S82434NX	Neptune PCI chipset	Intel	1	17.11	PQFP-208	17.11
86C864	Vision864 graphics controller	S3	1	22.42	PQFP-208	22.42
CH9055C-S	Controller, clock	Chrontel	1	2.58	SOIC-20	2.58
K028	Logic	Chrontel	1	1.16	SOIC-14	1.16

(continued)

Table A-1 (Continued)
Dell Optiplex XM-590—Based on 100,000-Unit Component Quantities

Device Reference	Device Type	Manufacturer	Quantity	1995 (Q2) Unit Cost ($)	Package	1995 (Q2) Total Cost ($)
PC87332VLJ	Super I/O controller, 3.3V	National Semi.	1	4.05	PQFP-100	4.05
PC9011VLJ	Custom super I/O chip for Dell	National Semi.	1	4.39	PQFP-100	4.39
PCI0640B	PCI IDE Controller	Calif. Micro Devices	1	6.27	PQFP-100	6.27
MCM32T200S70	SIMM, 8MB, 16 × 1M×4	Motorola	2	230.29	SIMM	460.58
STG1703J-13	Graphics RAMDAC, 24-bit	SGS-Thomson	1	1.92	PLCC-68	1.92
Discrete Semiconductors						
TIP125	Voltage regulator, 3.3V	Motorola	2	0.27	TO-220	0.54
Diode	Diode, small		1	0.01	SOT-23	0.01
Passive						
Elec. Capacitor	1500 uF/6.3V		2	0.33	SMT	0.66
Capacitor			277	0.03	SMT / 0805	8.31
Capacitor			2	0.03	SMT / 1206	0.06
Capacitor			4	0.04	SMT / 2012	0.16
Tant. Capacitor	EIA size D		11	0.05	SMT	0.55
Elec. Capacitor	22uF 25V	Elgen	7	0.05	PIH	0.35
Ceramic Capacitor			3	0.01	PIH	0.03
Inductor			17	0.05	SMT / 2012	0.85
Inductor			12	0.19	SMT / 1205	2.28
Resistor			497	0.01	SMT / 0805	4.97
Resistor			4	0.01	SMT / 1210	0.04
Resistor, axial	20 mm long		2	0.04	Axial	0.08
Resistor, axial	1/8W		12	0.01	PIH	0.12
Fuse	Polyswitch		1	0.47	DISC	0.47
Header	Header, 1×3, 0.1-in. pitch		1	0.03	PIH	0.03
Header	Header, 1×4, 0.1-in. pitch		2	0.04	PIH	0.08
Header	Header, 2×13, 0.1-in. pitch		1	0.25	PIH	0.25
Header	Header, 2×17, 0.1-in. pitch		1	0.34	PIH	0.34
Header	Header, 2×20, 0.1-in. pitch		2	0.39	PIH	0.78

(continued)

Table A-1 (Continued)
Dell Optiplex XM-590—Based on 100,000-Unit Component Quantities

Device Reference	Device Type	Manufacturer	Quantity	1995 (Q2) Unit Cost ($)	Package	1995 (Q2) Total Cost ($)
Header	Header, 2×3, 0.1-in. pitch		2	0.06	PIH	0.12
Header	Header, 2×4, 0.1-in. pitch		1	0.08	PIH	0.08
Connector	Connector, riser card slot		1	1.18	PIH	1.18
Connector	Connector, cache card slot		1	2.26	PIH	2.26
Connector	Connector, DS-15, female, monitor port	Foxconn	1	0.62	PIH	0.62
Connector	Connector, DS-25, female, parallel port	Sunridge	1	0.62	PIH	0.62
Connector	Connector, DS-9, male, serial port	Sunridge	2	0.34	PIH	0.68
Connector	Connector, power, keyed		1	0.38	PIH	0.38
Connector	Connector, ISA slot	Foxconn	5	0.48	PIH	2.40
Connector	Connector, PCI slot		2	0.58	PIH	1.16
Connector	Connector, double DIN-6, PS/2 style	Foxconn	1	0.67	PIH	0.67
Socket	Socket for coin-type battery		1	0.37	PIH	0.37
Socket	Socket, SIMM, 72 pin, metal latch, SnPb		4	0.96	PIH	3.84
Socket	Socket, DIP-24, 0.3-in. wide		4	0.10	DIP-24	0.40
Socket	Socket for Pentium-90	AMP	1	3.28	PIH	3.28
RF/Passive						
Crystal	14.3 MHz	ECS	2	0.36	Metal can	0.72
Crystal	32 kHz		1	0.18	Metal can	0.18
Miscellaneous						
CR2032	Battery, 3V, coin-type	Renata	1	0.45	Coin	0.45
Heat sink	Pentium-90 heat sink, 50 × 50 mm		1	1.25		1.25
QMX-05, speaker	Piezo buzzer	Star	1	0.18	PIH	0.18
Bare PWB (PCB)	Motherboard PWB	Nan Ya	1	56.90		56.90
Bare PWB (PCB)	Riser-card PWB	Nan Ya	1	8.65		8.65
Bare PWB (PCB)	Cache-card PWB		1	8.45		8.45
Total =						**$1,091.55**

Source: Dataquest (July 1995 Estimates)

Dataquest

a company of
The Dun & Bradstreet Corporation

Dataquest Europe Limited
Holmers Farm Way, Booker
High Wycombe, Bucks HP12 4XH
England
Phone: +44 1494 422 722
Fax: +44 1494 422 742

Dataquest Europe SA
Immeuble Défense-Bergères
345, avenue Georges Clémenceau
TSA 40002
92882 Nanterre Cedex 9
France
Phone: +33 1 41 35 13 00
Fax: +33 1 41 35 13 13

Dataquest GmbH
Kronstadter Strasse 9
81677 München
Germany
Phone: +49 89 93 09 09 0
Fax: +49 89 93 03 27 7

Dataquest Incorporated
1290 Ridder Park Drive
San Jose, CA 95131-2398
USA
Phone: +1 (408) 437-8000
Telex: 171973
Fax: +1 (408) 437-0292

From End August 1995
Dataquest Incorporated
251 River Oaks Parkway
San Jose, CA 95134
USA
Phone: +1 (408) 468-8000
Fax: +1 (408) 954-1780

Dataquest Services
Nine Technology Drive
PO Box 5093
Westborough, MA 01581
USA
Phone: +1 (508) 871-5555
Fax: +1 (508) 871-6262

Dataquest Global Events
3990 Westerly Place, Suite 100
Newport Beach, CA 92660
USA
Phone: +1 (714) 476-9117
Fax: +1 (714) 476-9969

Dataquest Japan K.K.
Shinkawa Sanko Building
1-3-17, Shinkawa, Chuo-ku
Tokyo 104
Japan
Phone: +81 (3) 5566-0411
Fax: +81 (3) 5566-0425

Dataquest Asia Pacific Ltd
7/F China Underwriters Centre
88 Gloucester Road
Wanchai
Hong Kong
Phone: +852 2824 6168
Fax: +852 2824 6138

Dataquest Korea
Suite 2407
Trade Tower
159 Samsung-dong
Kangnam-gu, Seoul 135-729
Korea
Phone: +82 (2) 551-1331
Fax: +82 (2) 551-1330

Representative Agencies in
Australia, Belgium,
Israel, Italy, South Africa,
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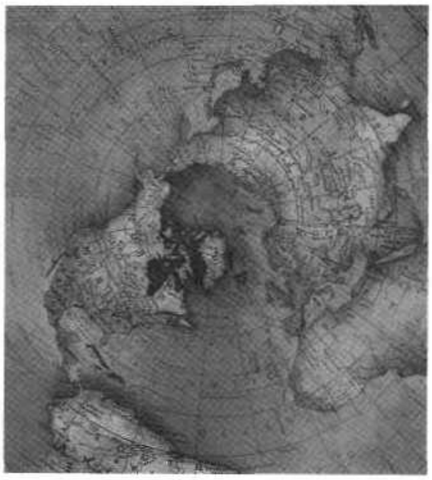
Digital Cellular Handsets: Implications for Component Consumption Within the European Market

Component Sector Analysis—Market Values

Market values in this section commencing for the tables commencing on page 11 in the above report (SAPM-EU-FR-9501), were ommitted. They are given below.

Table 4-2 IC		Table 4-3 Discrete		Table 4-4 Passive		Table 4-5 RF/Passive		Table 4-6 Miscellaneous	
Market Value ($M)		Market Value ($M)		Market Value ($M)		Market Value ($M)		Market Value ($M)	
1995	**1996**	**1995**	**1996**	**1995**	**1996**	**1995**	**1996**	**1995**	**1996**
75.7	100.5	100.1	135.9	12.8	18.6	36.8	51.6	11.4	16.0
28.0	37.2	7.4	10.7	3.7	5.4	105.1	147.4	102.6	145.4
70.0	93.0	0.8	1.1	9.0	13.1	48.2	65.4	7.5	10.0
70.0	93.0	3.8	5.5	9.0	13.1	58.5	82.1	10.5	14.8
59.3	78.8	0.5	0.7	43.7	63.2	29.3	41.0	8.5	12.0
42.0	58.9	42.0	60.8	15.2	22.0	25.0	35.0	9.0	12.8
12.4	17.3	**154.5**	**214.7**	**93.5**	**135.3**	135.1	159.6	**149.5**	**211.0**
51.4	66.8					**438.0**	**582.2**		
115.1	149.5								
142.4	178.6								
171.3	222.5								
77.6	103.0								
86.7	115.1								
201.5	252.8								
167.7	260.0								
10.0	14.0								
13.1	17.8								
60.1	79.8								
1,454.1	**1,938.1**								



Dataquest

Digital Cellular Handsets: Implications for Component Consumption Within the European Market

Focus Report

1995

Program: Electronic Equipment Production Monitor
Product Code: SAPM-EU-FR-9501
Publication Date: June 19, 1995
Filing: Focus Studies

Digital Cellular Handsets: Implications for Component Consumption Within the European Market

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For More Information...

Robin Daines .... +44 1494 422 725
Internet address .... rdaines@dqeurope.com
Via fax .... +44 1494 422 742

Dataquest

a company of The Dun & Bradstreet Corporation

Table of Contents

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Chapter 1
Executive Summary and Introduction

Market, Production and Product Overview

- The forecast for digital handset production within Europe is 9.5 million units in 1995, and 31.7 million units in 1999. This represents a compound annual growth rate (CAGR) of 42 percent.
- During 1995, exports will account for 26 percent of European production.
- In 1994, of 5.4 million digital handsets produced, 77 percent of the production was shared as follows:
  - Motorola: 31 percent
  - Nokia: 28 percent
  - Ericsson: 18 percent
- The estimate of lost production opportunities during 1994 is 500,000 units (attributed to component shortages).
- Average factory selling prices for a digital handset are estimated as follows:
  - 1995: $420
  - 1999: $260
- The 1995 average component-sector costs (component volume of 100,000 for pricing purposes) are estimated as:
  - ICs: $153
  - Discretes: $16
  - Passives: $9.8
  - RF/passive: $46
  - Miscellaneous: $16
- The 1995 average component-sector costs (component volume of 1 million for pricing purposes) are estimated as:
  - ICs: $122
  - Discretes: $13
  - Passives: $7.9
  - RF/passive: $37
  - Miscellaneous: $13
- The 1999 average component-sector costs (component volume of 1 million for pricing purposes) are forecast as:
  - ICs: $87
  - Discretes: $8
  - Passives: $6.4
  - RF/passive: $26
  - Miscellaneous: $9
- The 1995 market values (component volume of 100,000 for pricing purposes):
  - ICs: $1,454 million
  - Discretes: $154 million

- Passives: $94 million
- RF/passive: $438 million
- Miscellaneous: $150 million

- The 1999 market values (component volume of 1 million for pricing purposes) are forecast as:
  - ICs: $2,775 million
  - Discretes: $254 million
  - Passives: $203 million
  - RF/passive: $836 million
  - Miscellaneous: $285 million

Introduction

This Focus Report is one in a series of evaluations of key types of electronic equipment. These items of equipment are leading indicators of electronic market growth within Europe. For each product type, the report lists the 10 largest producers, or those responsible for 75 percent of production, within Europe. The reports detail manufacturing and design locations, unit production, equipment bill of materials, and average high-volume component pricing.

Evaluation Methodology

Representative, leading-edge, typically configured models are acquired monthly 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.

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 Procurement Service
- Dataquest's Mass Storage Service
- Cost models
- Press releases
- Industry quotes and surveys
- Catalogues and distributor information
- Industry sources

Component prices are based on 100,000-unit component quantities (not handset quantities). In addition, component prices based on 1 million-unit component quantities (not handset quantities) are provided. 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.

Chapter 2
The Cellular Marketplace: Analog versus Digital

If quartz watches were the affordable, and flauntable, way of demonstrating that you were part of the consumer electronics revolution during the 1970s, then mobile phones must have been their equivalent during the 1980s. The telecommunications manufacturers hope that the newer digital handsets, with all the additional features they offer, will continue to be the "must have" product of the 1990s.

Analog cellular production in Europe peaked during 1994, and we expect the number of analog subscribers to peak during 1996. Analog is now targeted at those consumers without a "business need" for a cellular phone. It is a very cheap entry level into the cellular market, and effective marketing should maintain the analog networks at (or near) full capacity for some time to come.

The big growth in cellular use, for both new and existing subscribers, is going to come from the GSM and DCS-1800 networks. The initial marketing of GSM was as a "trade-up" network for existing users, which offered tangible benefits when compared with analog.

With the introduction of DCS-1800, the technical features of the digital systems are marketed as benefits that you just cannot obtain from analog. Features such as guaranteed privacy of conversations, computer data transmission and improved sound quality appeal to both existing cellular subscribers and consumers contemplating their first purchase.

Unit Production

The forecast CAGR of digital handset production (within Europe) between 1994 and 1999 is 42 percent. This contrasts with the declining production of analog handsets within Europe. Continued investment by Japanese multinational producers, as well as indigenous European companies, will result in higher production levels of digital handsets. Table 2-1 shows Dataquest's forecast of European cellular handset production from 1995 to 1999.

Production of analog handsets in Europe peaked during 1994. Figure 2-1 shows the decline in analog production, together with the rapid growth in digital production. The forecast for production of digital handsets is an order of magnitude greater than the peak (during 1994) in analog production.

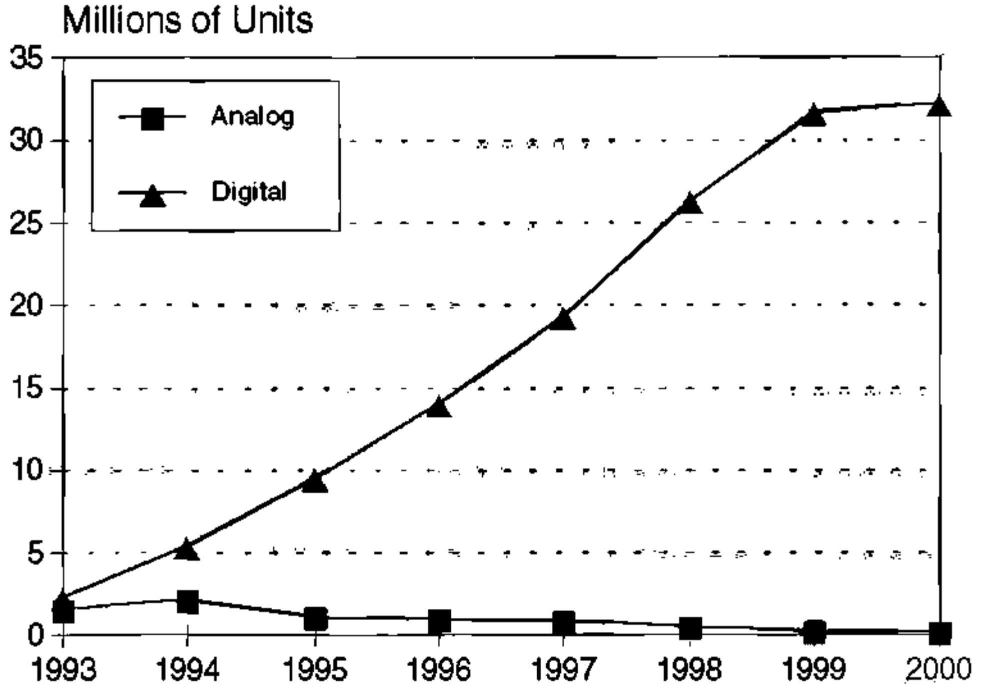
Most of the handset manufacturing capacity within Europe is allocated for production of digital units. This means that some analog handsets are imported to supplement local production. Imports account for more than half of the analog handsets sold in Europe. However, about 26 percent of European digital production is exported to non-European markets.

Table 2-1
Cellular Handset Production in Europe—History and Forecast
(Millions of Units)

	1993	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Digital Units	2.3	5.4	9.5	14.0	19.3	26.3	31.7	42%
Analog Units	1.6	2.1	1.1	0.94	0.87	0.5	0.3	-30%

Source: Dataquest (June 1995 Estimates)

Figure 2-1
European Cellular Handset Production



Source: Dataquest (June 1995 Estimates)

Chapter 3

Major Manufacturers

Big Three Dominate the Market

In the rapidly growing market for cellular, very few of the smaller manufacturers could supply digital handsets in the required volumes. Between them, Motorola, Nokia and Ericsson had almost 80 percent of European digital handset production. This stems from investment (by the big three) in digital handset products and manufacturing capacity, in anticipation of the explosion in the marketplace. The total of 5.4 million digital units, based on preliminary figures for 1994 unit production, breaks down as shown in Table 3-1.

Table 3-1
European Digital Cellular Handset Production by Manufacturer (Thousands of Units)

	Units Produced		Production Share (%)	
Manufacturer	1994	1993	1994	1993
Motorola	1,678	344	31%	28%
Nokia	1,515	281	28%	22%
Ericsson	974	248	18%	20%
Siemens	541	179	10%	14%
AEG/Matra	271	63	5%	5%
Others	433	137	8%	11%
Total	5,412	1,252	100%	100%

Source: Dataquest (June 1995 Estimates)

Although the big three expected a high level of demand for digital handsets in 1994, even they were caught out by the spectacular rate of growth. This caused component (and therefore handset) shortages towards the end of 1994, and into early 1995.

It is unlikely that Motorola, Nokia and Ericsson can continue to command this share of the digital handset market. The competition for handset production has mainly been from other European producers such as Siemens, AEG/Matra and Alcatel, each with relatively small shares of production. However, several Japanese multinationals, including Sony, NEC and Mitsubishi, are entering the digital arena. These large companies will inevitably erode the existing production share, leading to increasingly fractured distribution.

European Locations

Table 3-2 lists current European R&D and manufacturing locations.

Early 1995 saw announcements from several companies proclaiming their commitment to digital cellular within Europe. Mitsubishi announced plans to build GSM handsets at its plant in Rennes in France. Sony will begin production of GSM handsets at Colmar in France during September.

Nokia has installed capacity to effectively double production of handsets at its factory in Salo, Finland. And Amstrad has announced investment of $30 million at the Dancall production facility in Denmark.

Table 3-2
GSM Handset OEM Locations in Europe

Company	City	Country	R&D	Production
Motorola	Easter Inch	Scotland		✓
	Flensburg	Germany		✓
Nokia	Bochum	Germany	✓	✓
	Camberley	England	✓	
	Oulu	Finland	✓	
	Salo	Finland		✓
Ericsson	Kumla	Sweden		✓
	Linköping	Sweden		✓
	Lunde	Sweden	✓	
Siemens	Kamp Linsfort	Germany	✓	✓
	Bocholt	Germany		✓
AEG/Matra	Berlin	Germany		✓
	Ulm	Germany	✓	

Source: Dataquest (June 1995)

Further Investment

Dataquest's forecast for handset production is based upon the very strong consumer demand for digital cellular. Sophisticated marketing will strengthen this demand, leading to the risk of demand outstripping supply. This scenario occurred in late 1994 and early 1995, and was usually attributed to component shortages. Components cited include digital signal processors (DSPs) and flash memory ICs, as well as tantalum capacitors. We would estimate lost production opportunities of 500,000 units.

Whatever the reasons, although component manufacturers must be able to supply the volume required, they are usually dependent upon procurement planners who work at the handset manufacturer. Management of the materials supply chain is critical when dealing with very strong product demand. Production forecasts that are continuously increasing require ongoing investment in manufacturing capacity, and to a lesser extent in manufacturing technology. We expect further investment in handset production facilities, from both existing manufacturers and new entrants to the market.

While digital sustains a higher margin than analog, it will continue to command companies' attention within Europe. From a development and manufacturing point of view, there is a strong pool of digital communications expertise within Europe. These people could be a scarce commodity over the next couple of years. Digital cellular (unlike the more mature analog) is a product facing ongoing development. Continuing integration of semiconductor devices (and other components), together with frequent model and variant changes, will keep production facilities stretched, just to maintain production yields.

Chapter 4

Teardown and Component Spend Analysis of a Nokia 2140 (DCS-1800) Handset

In this chapter we summarize the high-value electronic components in the handset. We also highlight positive and negative aspects of the design and manufacture of the product. The fully costed bill of materials (BOM) of the *Nokia 2140* is in appendix A. Semiconductor spend analysis is made of main components of the handset.

Teardown Analysis

- Product availability
  - January 1994: GSM version (Nokia 2110)
  - March 1994: DCS-1800 version (Nokia 2190)
  - April 1994: DCS-1800 version (*Nokia 2140*)
- Sourcing summary
  - DSP: AT&T, USA
  - ASIC "core": NEC, Japan
  - Microcontroller: Hitachi, Japan
  - Flash memory: Intel, USA
  - Power amplifier: Motorola, USA
  - Antenna switch: Murata, Japan
  - Radio ICs: Siemens, Germany
  - SRAM: Sony, Japan
  - PCB: ATS, Austria
  - SIM card holder: ITT–Cannon, Japan
  - LCD and driver: Japan
  - SAW filter: Siemens–Matsushita, Japan
- Design and manufacturing advantages
  - 99 percent of components on the main PCB are SMT—fast placement, small size
  - SIM smart card is smaller than credit card–size
  - Efficient use of PCB real estate
  - Lightweight (metal-alloy) internal casing
- Design and manufacturing disadvantages
  - Using ASICs to implement proprietary functionality—higher cost than using commodity parts
  - Use of (very small) 0402 SMT components—relatively higher cost
  - Possible hand placement of some SMT reflowed components—slower placement, higher cost

Component Spend Analysis

Component spend analysis uses the component pricing from the bill of materials and market forecasts for handset production to calculate the market size for each type of component. The BOM can be found in appendix A. Table 5-1 gives a forecast for European production of digital handsets.

Table 4-1
Cellular Handset Units Produced, Factory ASP and Factory Revenue—History and Forecast

	1993	1994	1995	1996	1997	1998	1999	CAGR 1994-1999
Units Produced (M)	2.3	5.4	9.5	14.0	19.3	26.3	31.7	42%
Factory ASP ($)	600	480	420	380	340	300	260	-12%
Factory Revenue ($M)	1,386	2,598	3,992	5,331	6,563	7,883	8,251	26%

Source: Dataquest (June 1995 Estimates)

Technology Drivers

The dominant factors affecting the development of components used in digital handsets are the "wants and needs" of the end users. The key factors are as follows:

- **Cost:** This is predominantly driven by production volumes for both components and assembled units. Increasing levels of component integration help reduce cost, at both a component and a system level. Although the manufacturing cost is not as significant as the material cost, improving the design and assembling fewer components simplifies the manufacturing process.
- **Size:** The size of digital handsets is not a key buying criterion at the moment. There becomes a point at which a product becomes physically too small, and the use of folding parts impairs ease of use.
- **Weight:** Handset weight, although dependent upon component content, is predominantly affected by the battery used. Battery weight can be reduced by operating at a lower voltage, coupled with power management capabilities.
- **Talk time/standby time:** Cellular users are even more loath to use an AC adapter (for operation) than laptop PC users. Therefore, battery life is an important consideration. The expectation of handset batteries is that they are lightweight, while also offering a long life. Without any significant breakthrough in battery cell technology, these goals can only be achieved through low-voltage operation, coupled with power management capabilities. Many handset vendors will be moving to 3V operation this year, based on 3V components available now. There will be a move to 2.7V operation over the next couple of years.
- **Features:** The ability to send faxes and PC data using a digital handset will be one of the major selling points in the future. Moving beyond data transmission using the V.42 (compression and correction) protocol and on to proposed ISDN and multimedia services is likely to require additional handset functionality. Multimedia messaging, electronic mail and Global Positioning System (GPS) services will all require more sophisticated handsets, if the associated PC is to become redundant.
- These features will depend upon increased semiconductor integration. Even if the integration only covers basic telephone operation, it would free PCB real estate for any additional semiconductor content. Increased functionality, with existing battery lifetime, would require more sophisticated power management, possibly coupled with operation at an even lower voltage than at present.

Component Sector Analysis

The bill of materials is divided into component sectors. For the digital handset these sectors are covered in the tables indicated:

- ICs, Table 4-2
- Discrete semiconductors, Table 4-3
- Passives, Table 4-4
- RF/passive, Table 4-5
- Miscellaneous, Table 4-6

For each component sector the following information is listed:

- Device reference, device type, quantity, and manufacturer (where known)
- Average device cost for 1995 and 1996 (and percentage cost change 1995 to 1996)
- Total cost of the parts in a handset (device cost × quantity) for 1995 and 1996
- The total volume of parts required by the market, for 1995 and 1996
- The total value of the market for a specific part (and the component sector), for 1995 and 1996

Integrated Circuits (ICs)

ICs represent 64 percent of the component cost in the handset (36 percent of the 1995 average factory selling price). Table 4-2 shows the IC spend analysis. We expect the value of ICs within the handset to increase (as a proportion of handset value) each year.

It is the ICs that will implement the increased functionality demanded by handset users. While we expect the core telephony functions to be implemented on a (highly integrated) two-chip set, any new features will be introduced as multipart chip sets, until they too can be integrated.

IC packaging technology will continue to be fine-pitch surface mount. There is likely to be a trend towards a reduction in the thickness of packages, with thin PQFPs, similar to the thin SOPs in use today.

Looking at this particular handset, the high-cost components include the ASICs, the flash memory, the microcontroller and the DSP. These high-value components are typically those suitable for further integration. Availability of DSPs for telephone handsets has been tight, mainly because the ICs used have been designed specifically for digital cellular applications. When products are designed around semi-custom ICs, there is little or no opportunity for substitution.

Discrete Semiconductors

Discrete semiconductors make up 6.7 percent of the cost of this model. The spend analysis is in Table 4-3. However, the quantity of discrete semiconductors used in a handset varies between manufacturers. This depends upon their approach to implementing certain functions. For example, an RF power amplifier could be implemented by using a prepackaged solution (as in this case), or it could be designed using power transistors, and other components, on the PCB.

Passive Components

The passive components are defined as capacitors, resistors, inductors and transformers. They make up 4 percent of the cost of this model. The spend analysis is in Table 4-4. Most of the components are decoupling capacitors and termination resistors. However, the resistors used are very small (0402-outline) surface-mount components, and they can only be assembled using specific pick-and-place machinery. The 0402 components tend to cost slightly more, both to manufacture and to assemble, than (for example) 0805 components.

RF/Passive Components

RF/passive components are defined as crystal oscillators, filters, the antenna switch, and other non-semiconductor RF parts. They make up 19 percent of the cost of this model. Table 4-5 shows the spend analysis.

A part such as the SAW filter is relatively expensive. Many of these compact high-frequency parts are being made in volume for the first time, and still attract a premium price. The price of the (product-specific) antenna switch is likely to fall rapidly as production volumes increase.

Miscellaneous Components

Miscellaneous components includes the LCD display, the PCB, the smart-card reader, and the audio transducers. They make up 6.3 percent of the cost of this model. The spend analysis is in Table 4-6.

The LCD is mature technology and, assuming high manufacturing yields, is a low-cost component. The PCB is manufactured in Europe. This gives the handset manufacturer more control over design modifications, and more flexibility with delivery volumes and scheduling. Prices for smart card holders will continue to drop as volumes continue to increase for this relatively new component.

Table 4-2
Nokia 2140—IC Spend Analysis

Device Reference	Device Type	Manufacturer	Quantity	Unit Cost ($) 1995 (Q2)	Unit Cost ($) 1996 (Q2)	Total Cost ($) 1995 (Q2)	Total Cost ($) 1996 (Q2)	Cost Change 1995-96 (%)	Market Volume (M) 1995	Market Volume (M) 1996
PMB2306T	CMOS PLL	Siemens	2	3.98	3.58	7.96	7.16	-10	19.0	28.1
SA701DT2613	Prescaler	Philips	1	2.95	2.66	2.95	2.66	-10	9.5	14.0
PMB2403	Receiver	Siemens	1	7.37	6.63	7.37	6.63	-10	9.5	14.0
PMB2205S	Modulator	Siemens	1	7.37	6.63	7.37	6.63	-10	9.5	14.0
RW1466B	RF	AT&T	1	6.24	5.62	6.24	5.62	-10	9.5	14.0
547A51	Op. amp.		2	2.21	2.10	4.42	4.20	-5	19.0	28.1
AT28C64B	EEPROM	Atmel	1	1.30	1.24	1.30	1.24	-5	9.5	14.0
NMP4375050/RFI005	ASIC		1	5.41	4.76	5.41	4.76	-12	9.5	14.0
NMP4375048/ESA-LP	ASIC	NEC	1	12.11	10.66	12.11	10.66	-12	9.5	14.0
H8-536	Micro H8-536	Hitachi	1	14.98	12.73	14.98	12.73	-15	9.5	14.0
NMP43575052	ASIC	SGS-Thomson	1	18.02	15.86	18.02	15.86	-12	9.5	14.0
ST5080D		SGS-Thomson	1	8.16	7.34	8.16	7.34	-10	9.5	14.0
CXK58257ATMX2	256K SRAM	Sony	3	3.04	2.74	9.12	8.21	-10	28.5	42.1
1616S11/LY331	DSP	AT&T	1	21.20	18.02	21.20	18.02	-15	9.5	14.0
E28F008SA-85	8M flash	Intel	1	17.65	18.53	17.65	18.53	+5	9.5	14.0
587336			1	1.05	1.00	1.05	1.00	-5	9.5	14.0
L341/H7660SIBA			1	1.38	1.27	1.38	1.27	-8	9.5	14.0
LCD Driver		Japanese	1	6.32	5.69	6.32	5.69	-10	9.5	14.0
Total ($) =						153.01	138.20			

Source: Dataquest (June 1995 Estimates)

Table 4-3
Nokia 2140—Discrete Semiconductor Spend Analysis

Device Reference	Device Type	Manufacturer	Quantity	Unit Cost ($) 1995 (Q2)	Unit Cost ($) 1996 (Q2)	Total Cost ($) 1995 (Q2)	Total Cost ($) 1996 (Q2)	Cost Change 1995-96 (%)	Market Volume (M) 1995	Market Volume (M) 1996
XHWE5133 (Discrete Hybrid)	Power amp.	Motorola	1	10.53	9.69	10.53	9.69	-8	9.5	14.0
Transistors		Various	39	0.02	0.02	0.78	0.76	-2	370.7	547.1
Transistors		Various	2	0.04	0.04	0.08	0.08	-2	19.0	28.1
BCP 69		Philips	2	0.20	0.20	0.40	0.39	-2	19.0	28.1
U34	Diode	SGS-Thomson	1	0.05	0.05	0.05	0.05	-2	9.5	14.0
LEDS	LEDS		26	0.17	0.17	4.42	4.33	-2	247.1	364.7
Total ($) =						**16.26**	**15.30**			

Source: Dataquest (June 1995 Estimates)

Table 4-4
Nokia 2140—Passive Component Spend Analysis

Device Reference	Device Type	Manufacturer	Quantity	Unit Cost ($) 1995 (Q2)	Unit Cost ($) 1996 (Q2)	Total Cost ($) 1995 (Q2)	Total Cost ($) 1996 (Q2)	Cost Change 1995-96 (%)	Market Volume (M) 1995	Market Volume (M) 1996
Polarized Caps		Various	27	0.05	0.05	1.35	1.32	-2	256.6	378.8
Elec. Caps	3300uF/16V	Rubicon	1	0.39	0.38	0.39	0.38	-2	9.5	14.0
MLCC		Various	95	0.01	0.01	0.95	0.93	-2	902.9	1,332.7
Inductors		Various	19	0.05	0.05	0.95	0.93	-2	180.6	266.5
Resistors		Various	230	0.02	0.02	4.60	4.51	-2	2,185.9	3,226.4
Transformers		Various	4	0.40	0.39	1.60	1.57	-2	38.0	56.1
Total ($) =						**9.84**	**9.64**			

Source: Dataquest (June 1995 Estimates)

Table 4-5
Nokia 2140—RF/Passive Component Spend Analysis

				Unit Cost ($)		Total Cost ($)		Cost Change	Market Volume (M)	
Device Reference	Device Type	Manufacturer	Quantity	1995 (Q2)	1996 (Q2)	1995 (Q2)	1996 (Q2)	1995-96 (%)	1995	1996
KDS4A 60.200	Oscillator	KDS	1	3.87	3.68	3.87	3.68	-5	9.5	14.0
NKG3009C	TCXO	NDK	1	11.06	10.51	11.06	10.51	-5	9.5	14.0
S+M B4557	SAW filter	Siemens–Matsushita	1	5.07	4.66	5.07	4.66	-8	9.5	14.0
S D17321	Bulk filter		2	3.08	2.93	6.16	5.85	-5	19.0	28.1
S D18321	Bulk filter		1	3.08	2.93	3.08	2.93	-5	9.5	14.0
ID130		FDK	1	2.63	2.50	2.63	2.50	-5	9.5	14.0
DFY21R74C1R84BFDA	Antenna switch	Murata	1	14.22	11.38	14.22	11.38	-20	9.5	14.0
Total ($) =						**46.09**	**41.50**			

Source: Dataquest (June 1995 Estimates)

Table 4-6
Nokia 2140—Miscellaneous Component Spend Analysis

				Unit Cost ($)		Total Cost ($)		Cost Change	Market Volume (M)	
Device Reference	Device Type	Manufacturer	Quantity	1995 (Q2)	1996 (Q2)	1995 (Q2)	1996 (Q2)	1995-96 (%)	1995	1996
LCD		Japanese	1	1.20	1.14	1.20	1.14	-5	9.5	14.0
Bare PCB		ATS, Austria	1	10.80	10.37	10.80	10.37	-4	9.5	14.0
Mini Smart Card Holder		ITT–Cannon	1	0.79	0.71	0.79	0.71	-10	9.5	14.0
Buzzer			1	1.10	1.06	1.10	1.06	-4	9.5	14.0
Microphone			1	0.89	0.85	0.89	0.85	-4	9.5	14.0
Speaker			1	0.95	0.91	0.95	0.91	-4	9.5	14.0
Total ($) =						**15.73**	**15.04**			

Source: Dataquest (June 1995 Estimates)

High-Volume Pricing

The bill of materials pricing is based on component volumes of 100,000 units. This volume is more representative of component pricing for smaller producers than, for example, Motorola, Nokia and Ericsson. Obviously, the large consumers of these components will buy in greater volume; in many cases direct from the manufacturer. Besides avoiding distribution, a manufacturer can source several part types from a single vendor, and negotiate further discounts.

Table 4-7 shows 1995 component pricing, based on quantities of 100,000 and 1 million units.

Table 4-7
1995 High-Volume Component Pricing for Cellular Handsets

				1995 (Q2) Total Cost ($)	
	Device Type	Manufacturer	Quantity	Vol. = 100,000	Vol. = 1 Million
ICs					
PMB2306T	CMOS PLL	Siemens	2	7.96	5.26
SA701DT2613	Prescaler	Philips	1	2.95	2.41
PMB2403	Receiver	Siemens	1	7.37	6.02
PMB2205S	Modulator	Siemens	1	7.37	4.66
RW1466B	RF	AT&T	1	6.24	5.09
547A51	Op. amp.		2	4.42	4.01
AT28C64B	EEPROM	Atmel	1	1.3	1.18
NMP4375050/RFI005	ASIC		1	5.41	4.22
NMP4375048/ESA-LP	ASIC	NEC	1	12.11	10.04
H8-536	Micro H8-536	Hitachi	1	14.98	9.58
NMP43575052	ASIC	SGS-Thomson	1	18.02	14.05
ST5080D		SGS-Thomson	1	8.16	6.66
CXK58257ATM×2	256K SRAM	Sony	3	9.12	7.44
1616S11/LY331	DSP	AT&T	1	21.2	15.23
E28F008SA-85	8M flash	Intel	1	17.65	19.27
587336			1	1.05	0.95
L341/H7660SIBA			1	1.38	1.18
LCD Driver		Japanese	1	6.32	5.16
Total ($) =				153.01	122.41
Discrete Semiconductors					
XHWE5133 (Discrete Hybrid)	Power amp.	Motorola	1	10.53	9.07
Transistors		Various	39	0.78	0.54
Transistors		Various	2	0.08	0.06
BCP 69		Philips	2	0.4	0.28
U34	Diode	SGS-Thomson	1	0.05	0.03
LEDS	LEDS		26	4.42	3.04
Total ($) =				16.26	13.01

(continued)

Table 4-7 (Continued)
1995 High-Volume Component Pricing for Cellular Handsets

	Device Type	Manufacturer	Quantity	1995 (Q2) Total Cost ($) Vol. = 100,000	Vol. = 1 Million
Passives					
Polarized Caps		Various	27	1.35	1.03
Elec. Caps	3300uF/16V	Rubicon	1	0.39	0.30
MLCC		Various	95	0.95	0.72
Inductors		Various	19	0.95	0.72
Resistors		Various	230	4.6	3.50
Transformers		Various	4	1.6	1.60
Total ($) =				9.84	7.87
RF/Passive					
KDS4A 60.200	Oscillator	KDS	1	3.87	2.86
NKG3009C	TCXO	NDK	1	11.06	9.84
S+M B4557	SAW filter	Siemens–Matsushita	1	5.07	4.17
S D17321	Bulk filter		2	6.16	5.48
S D18321	Bulk filter		1	3.08	2.74
ID130		FDK	1	2.63	2.34
DFY21R74C1R84BFDA	Antenna switch	Murata	1	14.22	9.44
Total ($) =				46.09	36.87
Miscellaneous					
LCD		Japanese	1	1.2	1.10
Bare PCB		ATS, Austria	1	10.8	8.08
Mini Smart Card Reader		ITT–Cannon	1	0.79	0.66
Buzzer			1	1.1	1.03
Microphone			1	0.89	0.83
Speaker			1	0.95	0.89
Total ($) =				15.73	12.58

Source: Dataquest (June 1995 Estimates)

Market Value in 1999

Forecasts for handset production in 1999 and component-sector values (in dollars) are used to predict the size of the European market for each component sector. Forecasts for 1999 in Table 4-8 are based on component quantities of 1 million units.

These forecasts are based on annual price reductions, on component manufacturing efficiency improvements, and on overall market conditions. Forecasts for sectors such as semiconductors are also influenced by technical factors; these include increased integration and low-voltage operation.

Table 4-8
1999 High-Volume Component Pricing for Cellular Handsets

	Handset Content ($)		No. of Handsets (M)		Component Market Value ($M)	
Component Type	1995	1999	1995	1999	1995	1999
ICs	122.41	87.44	9.5	31.7	1,163	2,775
Discrete Semiconductors	13.01	7.99	9.5	31.7	124	254
Passives	7.87	6.41	9.5	31.7	75	203
RF/Passive	36.87	26.34	9.5	31.7	350	836
Miscellaneous	12.58	8.99	9.5	31.7	120	285
Total ($) =	192.7	137.2			1,832	4,352

Source: Dataquest (June 1995 Estimates)

Table A-1
Nokia 2140 (DCS1800)—Based on 100,000 Units Volume

Device Reference	Device Type	Manufacturer	Quantity	1995 (Q2) Unit Cost ($)	Package	Pins	1995 (Q2) Total Cost ($)
ICs							
PMB2306T	CMOS PLL	Siemens	2	3.98	SOP	14	7.96
SA701DT2613	Prescaler	Philips	1	2.95	SOP	8	2.95
PMB2403	Receiver	Siemens	1	7.37	Fine SOP	20	7.37
PMB2205S	Modulator	Siemens	1	7.37	Fine SOP	20	7.37
RW1466B	RF	AT&T	1	6.24	Fine SOP	14	6.24
547A51	Op. amp.		2	2.21	SOP	8	4.42
AT28C64B	EEPROM	Atmel	1	1.30	TSOP	24	1.30
NMP4375050/RFI005	ASIC		1	5.41	QFP	60	5.41
NMP4375048/ESA-LP	ASIC	NEC	1	12.11	QFP	200	12.11
H8-536	Micro H8-536	Hitachi	1	14.98	QFP	84	14.98
NMP43575052	ASIC	SGS-Thomson	1	18.02	SOP	24	18.02
ST5080D		SGS-Thomson	1	8.16	SOP	24	8.16
CXK58257ATM×2	256K SRAM	Sony	3	3.04	TSOP	24	9.12
1616S11/LY331	DSP	AT&T	1	21.20	QFP	100	21.20
E28F008SA-85	8M flash	Intel	1	17.65	TSOP	32	17.65
587336			1	1.05	SOP	8	1.05
L341/H7660SIBA			1	1.38	SOP	8	1.38
LCD Driver		Japanese	1	6.32	Chip-on-glass		6.32
Discrete Semiconductors							
XHWE5133 (Discrete Hybrid)	Power amp.	Motorola	1	10.53	Hybrid		10.53
Transistors		Various	39	0.02	SOT 23		0.78
Transistors		Various	2	0.04	SOT89		0.08
BCP 69		Philips	2	0.20	SOT 23		0.40
U34	Diode	SGS-Thomson	1	0.05			0.05
LEDS	LEDS		26	0.17	SMT/0603		4.42

(continued)

Table A-1 (Continued)
Nokia 2140 (DCS1800)—Based on 100,000 Units Volume

Device Reference	Device Type	Manufacturer	Quantity	1995 (Q2) Unit Cost ($)	Package	Pins	1995 (Q2) Total Cost ($)
Passives							
Polarized Caps		Various	27	0.05	SMT		1.35
Elec. Caps	3300uF/16V	Rubicon	1	0.39	PTH		0.39
MLCC		Various	95	0.01	SMT/0805		0.95
Inductors		Various	19	0.05	SMT/0805		0.95
Resistors		Various	230	0.02	SMT/0402		4.60
Transformers		Various	4	0.40	SMT		1.60
RF/Passive							
KDS4A 60.200	Oscillator	KDS	1	3.87	LCC	4	3.87
NKG3009C	TCXO	NDK	1	11.06			11.06
S+M B4557	SAW filter	Siemens-Matsushita	1	5.07	LCC	8	5.07
S D17321	Bulk filter		2	3.08			6.16
S D18321	Bulk filter		1	3.08			3.08
ID130		FDK	1	2.63	C flip top		2.63
DFY21R74C1R84BFDA	Antenna switch	Murata	1	14.22	K3072995		14.22
Miscellaneous							
LCD		Japanese	1	1.20	13.8 cm²		1.20
Bare PCB		ATS, Austria	1	10.80	6 layer		10.80
Mini Smart Card Holder		ITT-Cannon	1	0.79	SMT		0.79
Buzzer			1	1.10	PTH		1.10
Microphone			1	0.89	PTH		0.89
Speaker			1	0.95	SMT		0.95
Total ($) =							**240.93**

Source: Dataquest (June 1995 Estimates)

Dataquest

a company of
The Dun & Bradstreet Corporation

Dataquest Europe Limited
Holmers Farm Way, Booker
High Wycombe, Bucks HP12 4XH
England
Phone: +44 1494 422 722
Fax: +44 1494 422 742

Dataquest Europe SA
Immeuble Défense-Bergères
345, avenue Georges Clémenceau
TSA 40002
92882 Nanterre Cedex 9
France
Phone: +33 1 41 35 13 00
Fax: +33 1 41 35 13 13

Dataquest GmbH
Kronstadter Strasse 9
81677 München
Germany
Phone: +49 89 93 09 09 0
Fax: +49 89 93 03 27 7

Dataquest Incorporated
1290 Ridder Park Drive
San Jose, CA 95131-2398
USA
Phone: +1 (408) 437-8000
Telex: 171973
Fax: +1 (408) 437-0292

Dataquest Services
Nine Technology Drive
PO Box 5093
Westborough, MA 01581
USA
Phone: +1 (508) 871-5555
Fax: +1 (508) 871-6262

Dataquest Global Events
3990 Westerly Place, Suite 100
Newport Beach, CA 92660
USA
Phone: +1 (714) 476-9117
Fax: +1 (714) 476-9969

Dataquest Japan K.K.
Shinkawa Sanko Building
1-3-17, Shinkawa, Chuo-ku
Tokyo 104
Japan
Phone: +81 (3) 5566-0411
Fax: +81 (3) 5566-0425

Dataquest Asia Pacific Ltd
7/F China Underwriters Centre
88 Gloucester Road
Wanchai
Hong Kong
Phone: +852 2824 6168
Fax: +852 2824 6138

Dataquest Korea
Suite 2407
Trade Tower
159 Samsung-dong
Kangnam-gu, Seoul 135-729
Korea
Phone: +82 (2) 551-1331
Fax: +82 (2) 551-1330

Representative Agencies in
Australia, Belgium,
Israel, Italy, South Africa,
Spain, Singapore and Thailand.

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