European
Semiconductor Application Markets
Newsletters

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Research *Newsletter*

TECHNOLOGY STOCKS FALL TO BARGAIN BASEMENT LEVELS—SO WHAT?

*Sic transit gloria mundi.**
—Thomas à Kempis, 1420

DATAQUEST PERSPECTIVE

Stocks are down. Way down. Not since 1974 have technology stocks reached such depressed levels. This decline has important implications for the entire technology community.

Table 1 provides revenue, profit, and stock data for an arbitrary selection of US technology companies for August 23, 1990. This table provides information on companies of various industries, large and small, old and new, and gives a representative sample of some better known technology stocks.

Clearly, stocks have taken a beating, with most falling dramatically from their 52-week highs. Most of these stocks peaked during the summer. For example, two months ago, on Friday June 22, the *Wall Street Journal's* "Heard on the Street" headline was: "Pros Put Chips on Extended Run-Up in Semiconductors." On this date, Motorola hit its high for the year. In the ensuing weeks, share prices have tumbled.

Why? A confluence of several factors has caused Wall Street to lose confidence in technology companies:

- Concern over the general business environment including competition, especially foreign, and the ability of companies to deal with rapidly changing markets and falling prices
- Disappointing profits and profit outlook for companies (Margins are skinny.)
- Unpleasant surprises in second-quarter reports including several major companies such as Businessland, Digital Equipment, and Texas Instruments
- Concerns over recession and its effect on cyclical stocks
- The Mideast crisis and the perceived certainty of negative economic effects

Although the Dow Jones average has fallen about 16 percent from its high, technology stocks have fallen 30 to 50 percent, more or less. Companies with problems have been hammered—N.E.T. from 34.375 to 6.0, Businessland from 11.0 to 2.5, Oracle from 28.374 to 12.75, Adaptec from 24.0 to 11.25, Conner Peripherals from 31.0 to 20.75.

Companies with good earnings now have low P/E ratios—Chips & Technologies at 6, for example. Companies with low earnings have low market capitalization—for example, Texas Instruments at 36 percent. Many companies, such as Seagate, are priced below book value. Across the board, these low values for high-tech stocks are unprecedented.

IMPLICATIONS

It is not likely that this debacle will be reversed rapidly. Once burned, investors will be twice shy. Technology companies must adjust to the long-term consequences:

- Liquidity difficulties
- Increased acquisition and licensing activity
- Opportunity

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*How swiftly pass the glories of the world.

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TABLE 1
Technology Company
Financial Data and Stock Price

Company	Fiscal Year 1989 Revenue ($M)	Latest Revenue Second Quarter 1990 ($M)	Latest Profit Second Quarter 1990 ($M)	8/23/90 Stock Price ($)	Stock Price 12-Month High ($)	Number of Shares (Millions)	Market Capitalization ($M)	Market Capitalization as Percent of Revenue (Latest Quarter)	P/E Ratio (Latest Quarter)	Stock Price Percent Decline
Advanced Micro Devices Incorporated	1,105	268	(5.92)	5.500	11.375	82.10	452	42	-	52
Apple Computer Incorporated	5,284	1,365	119.76	33.750	45.625	129.00	4,354	80	9.09	26
Applied Materials Incorporated	502	144	10.46	26.750	40.500	16.80	449	78	10.74	34
American Telephone & Telegraph Company	35,210	9,025	657.00	31.500	47.000	1,075.00	33,863	94	12.89	33
Chips & Technologies, Incorporated	218	82	6.29	10.375	25.500	15.28	159	48	6.30	59
Compaq Computer Corporation	2,876	862	104.28	45.250	67.875	39.40	1,783	52	4.27	33
Conner Peripherals Incorporated	705	304	26.65	20.750	31.000	45.50	944	78	8.86	33
Cypress Semiconductor Corporation	199	54	8.51	9.750	15.625	38.30	373	173	10.97	38
Digital Equipment Corporation	12,742	3,365	74.39	63.000	103.375	122.00	7,686	57	25.83	39
Hewlett-Packard Company	11,899	3,242	178.00	32.750	53.125	238.00	7,795	60	10.95	38
International Business Machines	62,710	16,495	1,410.00	97.250	123.125	581.10	56,512	86	10.02	21

(Continued)

TABLE 1 (Continued)
Technology Company
Financial Data and Stock Price

Company	Fiscal Year 1989 Revenue ($M)	Latest Revenue Second Quarter 1990 ($M)	Latest Profit Second Quarter 1990 ($M)	8/23/90 Stock Price ($)	Stock Price 12-Month High ($)	Number of Shares (Millions)	Market Capitalization ($M)	Market Capitalization as Percent of Revenue (Latest Quarter)	P/E Ratio (Latest Quarter)	Stock Price Percent Decline
Integrated Device Technology Incorporated	181	49	0.26	4.125	10.875	25.50	105	54	101.14	62
Intergraph Corporation	860	254	16.55	14.000	23.500	53.90	755	74	11.40	40
Intel Corporation	3,127	968	170.69	32.500	52.000	188.80	6,136	158	8.99	38
Lotus Development Corporation	556	175	23.46	17.000	39.250	42.39	721	103	7.68	57
LSI Logic Corporation	547	160	6.20	8.375	13.000	41.10	344	54	13.88	36
Mentor Graphics Corporation	380	101	3.65	12.250	26.000	36.90	452	112	30.96	53
Micron Technology Incorporated	446	84	1.81	7.750	16.375	36.70	284	85	39.29	53
Motorola Incorporated	9,620	2,715	161.00	65.375	88.375	130.00	8,499	78	13.20	26
Octel Communications Corporation	87	36	4.94	17.250	27.750	15.20	262	181	13.27	38
Oracle Corporation	971	334	52.96	12.750	28.375	136.8	1,744	130	8.23	55
Quantum Corporation	446	163	17.34	14.500	25.750	27.59	400	61	5.77	44
Seagate Technology, Incorporated	2,413	668	29.69	9.125	19.750	51.78	472	18	3.98	54
Silicon Graphics Incorporated	264	120	11.20	24.000	40.875	17.20	413	86	9.21	41

(Continued)

TABLE 1 (Continued)
Technology Company
Financial Data and Stock Price

Company	Fiscal Year 1989 Revenue ($M)	Latest Revenue Second Quarter 1990 ($M)	Latest Profit Second Quarter 1990 ($M)	8/23/90 Stock Price ($)	Stock Price 12-Month High ($)	Number of Shares (Millions)	Market Capitalization ($M)	Market Capitalization as Percent of Revenue (Latest Quarter)	P/E Ratio (Latest Quarter)	Stock Price Percent Decline
Silicon Valley Group Incorporated	131	47	0.43	6.625	13.750	10.20	68	36	39.29	52
Sun Microsystems Incorporated	1,765	700	49.10	26.000	37.125	85.20	2,215	79	11.28	30
Tandem Computers Incorporated	1,633	472	32.44	13.875	30.125	101.40	1,407	75	10.84	54
Texas Instruments Incorporated	6,522	1,592	11.00	26.750	44.000	84.9	2,271	36	51.62	39
VLSI Technology Incorporated	289	85	2.40	5.625	12.250	23.80	134	40	13.95	54
Varian Associates, Incorporated	1,344	344	(34.10)	28.750	34.750	19.90	572	42	-	17
Western Digital Corporation	992	294	9.48	9.250	14.875	29.10	269	23	7.10	38
Xerox Corporation	16,441	4,255	(254.00)	39.000	68.500	101.70	3,966	23	-	43

Source: Dataquest (September 1990)

Lack of Liquidity

Already, the decline in public stocks has led to the cancellation of IPOs. Clearly, current prices are not prices that companies want to, or can, take back to the market; it is likely that Sun, for example, will cancel its intended offering. Exacerbating the problem, the newly conservative banking industry is steering clear of (perceived) risky high-tech companies. This movement is already in evidence in the Northeast.

Capital will be increasingly scarce and conservation of capital must become a priority for most companies. Reminiscent of Peter Drucker's advice, "Sell the mailroom!", more and more nonessential or noncritical activities will be farmed out, especially those that are capital intensive—such as wafer fabs and MIS departments. More nonstrategic business units will be sold.

Companies that are not public, and some that are, will look more actively at non-market-financing alternatives including selling part or all of the companies. Entrepreneurs will think twice about wanting to be a public company. On the other side of the coin, low share prices make LBOs increasingly attractive. Going private could be a trend of the 1990s. Cash will be king.

Acquisitions

Loss of liquidity reduces the options of companies, and low share prices definitely will induce salivation among corporate predators. A large percentage of companies are priced significantly below key takeover benchmarks—such as one times revenue. Both seller and buyer activity is sure to increase. For those companies that view this activity as unwholesome, defense mechanisms will be studied and installed.

In the United States, cultural reluctance toward acquisitions is nonexistent. Friendly and unfriendly acquisition by corporate and financial interests inevitably will rise.

Will low share prices create a fire sale to foreign interests? Because foreign stock markets were hit hard and because foreign companies generally are reticent to indulge in international cross-cultural acquisitions of a predatory (unfriendly) nature, a fire sale to Asian interests is unlikely. Buyouts of this nature will be the exception rather than the rule; nevertheless, some activity is bound to occur. On the other hand, lack of domestic liquidity historically has sent companies abroad for financing—such as Amdahl—and this will happen again: More technology and ownership will go abroad.

Lack of financing alternatives will encourage companies to sell parts or pieces of themselves, or to license or sell technology at more attractive prices. Participation in these activities may be more attractive to foreign establishments.

Opportunity

Established companies—i.e., those with cash or a high stock price—will see ample opportunity for acquisitions of technology or other beneficial strategic arrangements with other companies. Indeed, we think that an effect of the stock slide will be to bring, by necessity, the US high-tech community closer as interests, assets, and technology are traded for mutual advantage.

Companies that have the lowest (perceived) stock prices relative to value can take heart. Now is the time to move with alacrity and rewrite stock options—a onetime chance to secure and lock in exceptional talent.

Some companies will take advantage of low share prices and below book values to buy back their own stock. Intel already announced its intention to do this, and other companies are sure to follow.

Bernadette Cesena
Frederick Zieber
Ralph Finley

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Research *Newsletter*

WORLDWIDE SEMICONDUCTOR INDUSTRY OUTLOOK, SECOND QUARTER 1990: OUT OF THE TROUGH

INTRODUCTION

The worldwide semiconductor industry recession, which began in the third quarter of 1989, has ended. Dataquest believes that the first quarter of 1990 was the final quarter of negative growth and that positive worldwide growth will resume in the second quarter of 1990.

The personal computer business, in the dumps during the second half of 1989, has begun to turn around dramatically, particularly in Europe. Semiconductor industry sources indicate that their orders from PC companies suddenly have rebounded. In addition, 1Mb DRAM production cuts by Japanese companies have resulted in a slowing of price attrition. Finally, 32-bit microprocessor demand remains high, particularly for the 80386 SX and DX, both of which have been on allocation for several months.

We expect semiconductor demand to continue to strengthen over the coming months. However, because of the recession from the third quarter of 1989 through the first quarter of 1990, the overall industry decline for 1990 will be 0.7 percent. We believe that growth will continue through 1993, which will be the peak year of this cycle, increasing by 26.5 percent. Notably, this peak year will be of lesser magnitude than the peaks of 1984 and 1988, which increased 47.5 percent and 33.0 percent, respectively. Although we expect semiconductor penetration in electronic equipment to continue to increase, the overall electronic equipment market is maturing and experiencing slower growth, and relationships between semiconductor suppliers and semiconductor users are smoothing out the bumps in the semiconductor demand curve.

Figure 1 shows actual worldwide semiconductor industry revenue compound annual growth rates (CAGRs) from 1977 through 1989 and forecast CAGRs from 1990 through 1994.

Table 1 compares our April 1989 forecast for 1990 with our current forecast.

Table 2 shows our worldwide semiconductor revenue forecast from 1989 through 1994.

REGIONAL TRENDS

From 1989 through 1994, we believe that the areas of Asia/Pacific and Rest of World (Asia/Pacific-ROW) together will represent the fastest-growing regional market for semiconductors, due to the immaturity of the market and the fast-growing economies of the region, which can still absorb considerable electronic equipment production growth through domestic demand. We believe that Europe will be the second-fastest growing region, mainly due to the "1992 Effect," which is driving trends to produce semiconductors locally in Europe for consumption there and also driving trends toward standardization across Europe for such things as cellular phone technology. We expect North America and Japan to grow at a slower rate—between 13 and 14 percent—because neither of these regions has the same impetus for growth as Asia or Europe.

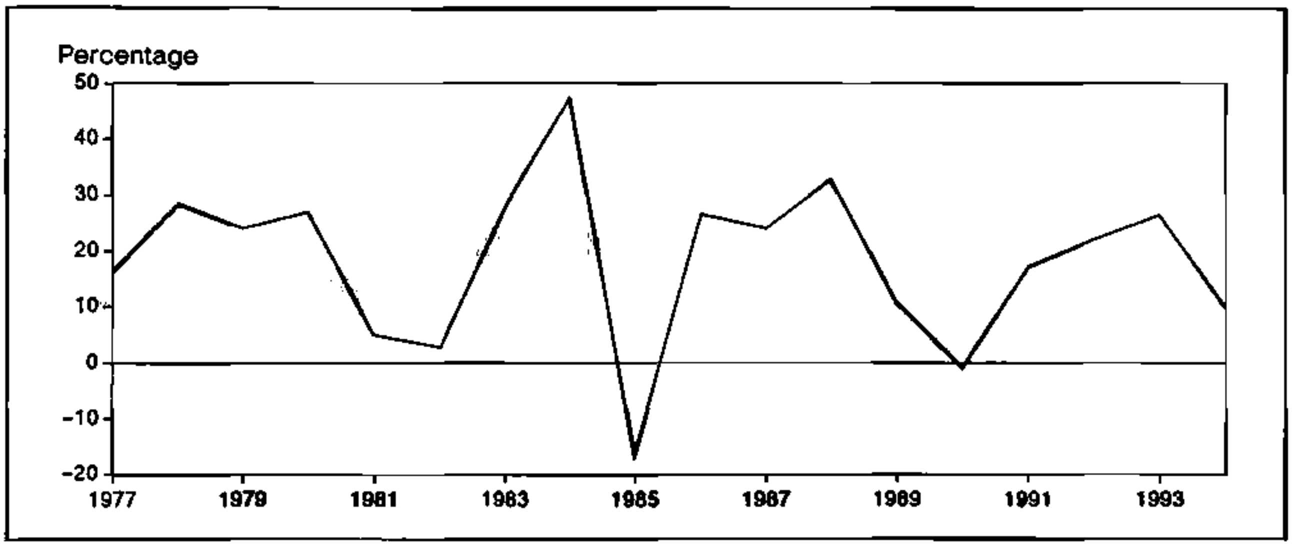
North America

Dataquest still expects U.S. GNP to grow more slowly in 1990 than in 1989 and to resume stronger growth in 1991. Interest rates will be lower in 1990 as well, but they will increase in 1991.

Although we are now seeing a definite pickup in order activity, we still expect 1990 to be a slow year, with an annual semiconductor revenue decline of 3.1 percent. This decline can be largely attributed to the severe price declines of

1Mb DRAMs that occurred in the second half of 1989 and the first quarter of 1990. Although the DRAM price free-fall has ended and DRAM unit growth will be strong, particularly in the second half of the year, MOS memory will decline 14.6 percent from 1989 to 1990.

Figure 1
Worldwide Semiconductor Revenue
Annual Percent Change



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Source: Dataquest
April 1990

Table 1
Comparison of 1989 and 1990 Forecasts* for Worldwide Semiconductor Revenue
(Percent Change by Geographic Region)

Region	Q1 1990	Q2 1990	Q3 1990	Q4 1990	Total 1990
North America 1989	(1.9%)	(0.3%)	2.3%	3.9%	(3.8%)
North America 1990	(4.4%)	(0.6%)	4.9%	5.4%	(3.1%)
Japan 1989	(2.8%)	3.5%	3.2%	4.5%	(1.3%)
Japan 1990	(4.1%)	1.0%	4.2%	5.3%	(2.0%)
Europe 1989	0.4%	2.2%	(1.3%)	4.9%	2.5%
Europe 1990	3.7%	1.8%	1.8%	5.6%	2.1%
Asia/Pacific-ROW 1989	1.2%	3.0%	3.2%	4.3%	6.5%
Asia/Pacific-ROW 1990	(1.3%)	5.9%	9.2%	6.1%	6.1%
Total World 1989	(1.5%)	2.0%	2.2%	4.3%	(0.5%)
Total World 1990	(2.6%)	1.2%	4.6%	5.5%	(0.7%)

*April 1989 and April 1990

Source: Dataquest
April 1990

Table 2
Worldwide Semiconductor Revenue by Geographic Region (Millions of Dollars)

Region	1989	1990	1991	1992	1993	1994	CAGR 1989-1994
North America	17,707	17,165	19,951	24,045	30,539	33,519	13.6%
Percent Change	11.8%	(3.1%)	16.2%	20.5%	27.0%	9.8%	
Japan	22,908	22,449	26,051	31,577	39,316	43,240	13.5%
Percent Change	10.3%	(2.0%)	16.0%	21.2%	24.5%	10.0%	
Europe	9,537	9,737	11,376	13,905	17,454	19,162	15.0%
Percent Change	12.3%	2.1%	16.8%	22.2%	25.5%	9.8%	
Asia/Pacific-ROW	6,263	6,646	8,202	10,559	13,992	15,666	20.1%
Percent Change	8.9%	6.1%	23.4%	28.7%	32.5%	12.0%	
Total World	56,415	55,997	65,580	80,086	101,301	111,587	14.6%
Percent Change	10.9%	(0.7%)	17.1%	22.1%	26.5%	10.2%	

Source: Dataquest
April 1990

Japan

Japanese GNP is expected to grow more slowly than in 1989, between 4.0 and 4.9 percent, but it still will experience stronger growth than the GNPs of the United States and Europe. Capital spending plans in Japan are good this year. The yen-to-dollar exchange rate bears watching, as usual, because a sharp move in either direction could negatively impact Japanese semiconductor producers. The 1989 yen-to-dollar exchange rate was 138 yen per dollar; in 1990, it is 149 yen per dollar.

Semiconductor demand and supply are now coming into balance in Japan. Severe memory price declines have ended, and some products, such as CMOS standard logic, are in short supply. The industrial electronics sector is strong; in particular, production of personal computers is picking up.

A particularly promising sign is the beginning of a recovery in Japanese production of consumer electronics. In recent years, this sector was particularly hard hit by the movement of consumer equipment production offshore, particularly to Asia/Pacific, but also to North America and Europe. We believe that camcorder and color TV production in Japan will recover this year.

Europe

The major European economies are expected to have GNP growth higher than in the United States but below the growth rates of Japan and Asia/Pacific-ROW. The United Kingdom, however, is experiencing economic problems. A recent Dun & Bradstreet survey indicates that U.K. business expectations are at an extremely low level.

We expect the European semiconductor market to grow 2.1 percent in 1990, faster than the markets of either North America or Japan but slower than the market in Asia/Pacific-ROW. Personal computer makers recently have placed six months of orders with semiconductor suppliers in Europe, an event unexpected only two months ago. Undoubtedly, this surge in orders is partly due to the assumption that DRAM prices fell as far as they could in the first quarter, eliminating the need to "wait for next month" and perhaps causing PC makers to overstock at fire sale prices.

Despite a recent ruling by the General Agreement on Tariffs and Trade (GATT) indicating that European local content laws are not legal, the European Community Commission now has the opportunity to prove the need for such laws. Although this ruling implies that companies making electronic equipment in Europe need not purchase chips diffused in Europe, Dataquest believes that compelling reasons still exist for non-European companies to continue with their plans for both semiconductor and electronic equipment production in Europe.

Asia/Pacific-ROW

The Asian economies are expected to continue to grow faster than the economies of the other major regions of the world. This growth will fuel Asian domestic demand for all types of electronic

Table 3
Worldwide Semiconductor Revenue by Category (Millions of Dollars)

Category	1989	1990	1991	1992	1993	1994	CAGR 1989-1994
Total Semiconductor	56,415	55,997	65,580	80,086	101,301	111,587	14.6%
Percent Change	10.9%	(0.7%)	17.1%	22.1%	26.5%	10.2%	
Total IC	46,514	45,788	54,126	66,786	86,413	95,600	15.5%
Percent Change	13.3%	(1.6%)	18.2%	23.4%	29.4%	10.6%	
Bipolar Digital	4,644	4,085	4,379	4,620	4,899	4,640	0
Percent Change	(10.7%)	(12.0%)	7.2%	5.5%	6.0%	(5.3%)	
Bipolar Memory	591	489	435	382	348	307	(12.3%)
Percent Change	(14.2%)	(17.3%)	(11.0%)	(12.2%)	(8.9%)	(11.8%)	
Bipolar Logic	4,053	3,596	3,944	4,238	4,551	4,333	1.3%
Percent Change	(10.2%)	(11.3%)	9.7%	7.5%	7.4%	(4.8%)	
MOS Digital	32,783	32,234	38,535	48,745	65,295	72,479	17.2%
Percent Change	21.5%	(1.7%)	19.5%	26.5%	34.0%	11.0%	
MOS Memory	16,133	14,265	17,310	22,710	31,311	35,663	17.2%
Percent Change	38.0%	(11.6%)	21.3%	31.2%	37.9%	13.9%	
MOS Micro	8,081	8,668	10,021	11,982	15,915	17,525	16.7%
Percent Change	13.1%	7.3%	15.6%	19.6%	32.8%	10.1%	
MOS Logic	8,569	9,301	11,204	14,053	18,069	19,291	17.6%
Percent Change	5.1%	8.5%	20.5%	25.4%	28.6%	6.8%	
Analog	9,087	9,469	11,212	13,421	16,219	18,481	15.3%
Percent Change	2.3%	4.2%	18.4%	19.7%	20.8%	13.9%	
Total Discrete	7,561	7,775	8,628	10,008	11,093	11,683	9.1%
Percent Change	(0.7%)	2.8%	11.0%	16.0%	10.8%	5.3%	
Total Optoelectronic	2,340	2,434	2,826	3,292	3,795	4,304	13.0%
Percent Change	7.4%	4.0%	16.1%	16.5%	15.3%	13.4%	

Source: Dataquest
April 1990

equipment, including consumer equipment, computers, peripherals, and telecommunications equipment. In 1989, domestic consumption growth far outstripped export growth in most Asia/Pacific-ROW countries; we expect this trend to continue.

Even in the grim year of 1990, the Asia/Pacific-ROW semiconductor market will grow 6.1 percent, with a negative first quarter and strong quarterly growth thereafter.

PRODUCT TRENDS

The real story for 1990 is that virtually every other product category will outstrip the performance of MOS memory, with the exception of bipolar digital ICs, which continue to be replaced by CMOS and BiCMOS chips.

Although MOS memory will decline in 1990, over the long term we expect it to resume its historically high growth.

Dataquest has heard recently that Japanese companies are beginning to leave the standard logic market, thus opening up this market to the possibility of shortages—which already are occurring in Japan—and also opening up the market to U.S. and European participants.

Table 3 shows our worldwide forecast for the major semiconductor categories.

DATAQUEST ANALYSIS

We are gratified that our forecast appears to be coming true. For more than a year we have predicted that the second half of 1989 and the first quarter of 1990 would be periods of negative growth for the semiconductor industry, followed by increased growth. Now we are seeing clear signals of renewed industry health, with a definite pickup in order activity. We expect to see billings improve in the second quarter. Some companies are reporting to Dataquest that they experienced record bookings months in February and March.

The Japanese companies, by cutting their production of DRAMs, have forced memory out of its free-fall, paving the way for supply-demand balance. The resurgence of the personal computer market, combined with single-sourcing strategies by U.S. companies for 32-bit microprocessors, is keeping the microprocessor market healthy.

All in all, we are cautiously optimistic about the second quarter, and we continue to foresee stronger growth emerging in the last half of 1990.

Patricia S. Cox

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Research *Newsletter*

A PREVIEW OF THE 1990s

INTRODUCTION

Most sectors of the electronics industry will experience slower growth rates during the early 1990s. Reduced growth is anticipated for many reasons, such as the following:

- The proliferation of new products and technological advances during the past few years has grown faster than most users' ability to absorb these products fully.
- The path toward standardization remains crooked, and connectivity of existing and new equipment will become more of an issue—to the user.

The electronics industry will undergo basic structural changes during the 1990s. These changes will result from the globalization of telecommunications networks, the maturation of sectors of the computer industry, the ongoing expansions in the Asia/Pacific area, continued company consolidations and alliances, and the new market potentials in Eastern Europe.

These are only a few highlights of Dataquest's views about the 1990s. This newsletter discusses some of the significant events of 1989, major trends anticipated for the next few years, and how these trends will influence the outlook for the mid-1990s and beyond.

The following is a brief summary of Dataquest's first quarter Forecast Forum. It is a preview of the in-depth analyses and forecasts that will be provided by each of our Industry Service Groups in their upcoming publications and conferences.

U.S. ECONOMY: SLOWER GROWTH IN 1990

The 1990s will commence in a slow growth mode, with no recession anticipated in the near future. The first half of 1990 will be affected directly by the lingering impact of 1989 events. Two key 1989 events that contributed to the slow start in 1990 are the large consumer price increases in food, energy, and apparel, and the two natural disasters, Hurricane Hugo and the San Francisco Bay Area earthquake.

Consumer spending (i.e., personal consumption) constitutes two-thirds of the gross national product (GNP). The GNP has been affected strongly by rising prices, and this increase in prices is fostering cautious spending by consumers. The natural disasters have caused a reduction in output from South Carolina and California, respectively.

According to The Dun & Bradstreet Corporation, real GNP is expected to grow at 2.4 percent in 1990, down from 4.4 percent and 2.9 percent in 1988 and 1989, respectively. Slower growth in 1990 should lead to reduced inflation rates and to a slight rise in the unemployment rate. In 1991, the economy is predicted to bounce back, with real GNP expected to be 3.4 percent.

TELECOMMUNICATIONS MARKET: MIXED GROWTH

Forecast growth for the telecommunications industry as a whole remains mixed. Overall, we expect the U.S. telecommunications market to grow a little more than 5 percent in revenue between 1989 and 1990. The greatest influence on this market is its growth rate in the revenue traditionally attributed to local and long distance calling services. This sector will account for 88 percent of the total market, or $148 billion in 1990. The equipment side of the market will grow faster at 9 percent and will account for slightly more than $29 billion in 1990. In Europe, we expect total telecommunications services to grow at almost double the U.S. rate, or 9 percent. Equipment revenue is expected to parallel that of the United States, at approximately 9 percent.

The major forces driving telecommunications include the following:

- Globalization of worldwide networks, markets, and standards
- Rapid movement to a digital telecommunications network
- Transition from an engineering perspective to a marketing focus
- Continued consolidations and alliances

The telecommunications marketplace truly became international during the late 1980s. The ramifications of the recent events taking place in Europe, alone, are monumental. To meet these rapidly evolving markets requires the globalization of networks and standards. We believe that excellent opportunities exist for expansion in Europe and the Pacific Rim regions. The expansion of all geographic markets will create opportunities for further investments in the 1990s.

The digitalization of the network poses problems and presents potential. As a result of a digital network, bandwidth (data-carrying capability) will no longer be an issue or a constraint. Simultaneous video, data, and voice transmission will become a reality once standards are finalized. One step along this road is the implementation of the Open Network Architecture (ONA) standard. Implementation of this, or other standards, will create a new "information services" market—potentially large markets for gateway products, and, we believe, the eventual unbundling of traditional Telco (i.e., local and long distance charges) services.

The acceptance of the Integrated Services Digital Network (ISDN) has been lower than anticipated; however, usage is expected to increase at a steady pace from the existing 85,000 access lines in service to 1.4 million access lines in service by 1994. Today, ISDN enjoys broad industry support, all critical standards are in place, field trials are under way at selected locations, and initial "islands" of local services are available.

As the telecommunications industry moves from an engineering-driven market, the key factors for success will change. Although technology is important, customer service and support, solution-based applications, personal communications, distribution, and account management will be the focus for successful companies in the 1990s.

We expect mergers, acquisitions, consolidations, and alliances to continue; partially as a result of competition, but also as a result of the globalization of the industry. Companies continue to seek options that create the necessary financial and marketing resources to crack the ever-rising entry barriers in both the domestic and international markets.

The 1990s portends to be an interesting and tumultuous decade for the telecommunications industry.

COMPUTER SYSTEMS MARKET: UNEVEN GROWTH

The computer systems market is likely to see a period of uneven growth over the next several years, in both the business and technical segments. Dataquest believes that the market will be growing at a slower rate than has been experienced in the past several years. Listed below are factors that can influence the market during the 1990s.

Dataquest believes that the following factors work against a continued period of high growth, negatively affecting the market:

- Maturing market—The business segment, representing approximately 80 percent of the total market, is exhibiting slower growth.
- Average selling prices (ASP)—The ASPs of many systems are continuing downward, resulting in narrower profit margins and stalling revenue growth.
- Gap between hardware and software technology—Much advanced hardware technology is underutilized because of the dearth of applications.
- Standards—The standards battle is confusing to users, and many people are waiting to see which standard will prevail before investing in new systems.
- Movement away from large systems—With smaller, yet more powerful, systems gaining wide acceptance, many users are moving away from large mainframes.

The potential for a sustained high rate of growth does exist. Dataquest believes that there are a number of factors that may have a positive effect on the computer systems market, as follows:

- Continued expansion of the base—Several new markets, such as on-line transaction processing (OLTP), distributed processing, and newly opened geographical markets, can cause renewed vigor in the market.

- New software for existing systems—Software to utilize existing systems fully will drive users to the next generation of hardware.
- New applications and technology—New applications and technology are being explored that could drive new growth in the market, such as video E-mail, artificial intelligence embedded in relational databases, and the client/server architecture.
- Technical workstations—Movement of more technical workstations into the business segment of the market can fuel the workstation market.
- Standards—Standards offer users the ability to mix and match systems to provide the best solution.

Even with the introduction of new technologies and the opening of new markets, Dataquest does not believe that these new technologies will be in widespread use until the 1993 to 1995 time frame. We believe that ASPs will continue to drop, squeezing margins even further. The growth of proprietary systems will continue to decline while systems based on open architectures will grow at a much faster rate than proprietary systems.

Standards can be a boon or a bust for the market. Dataquest believes that standards will continue to emerge. Open standard systems offer users investment protection, a secure upgrade path, and interoperability. On the other hand, we believe that standards will never be settled fully, causing confusion among users.

New markets offer some hope that a double digit rate of growth can be maintained. Distributed processing and OLTP offer major opportunities. The potential for a large, new market for technology in Eastern Europe is encouraging.

Examining all of the factors that are likely to impact the computer systems market, Dataquest is forecasting that the market will grow at a reduced rate through the early 1990s to mid-1990s and then see a return to higher growth rates in the latter half of the decade.

UNIX SYSTEMS SOFTWARE: STEADY GROWTH

The outlook for the UNIX system software market is good. Dataquest believes that continued strong growth will occur in this market. A number of factors affecting the UNIX market will allow the market to continue to maintain strong growth, such as the following:

- Workstations—One of the fastest growing markets in computer systems, workstations are in large part fostering the movement of UNIX into the business segment of the market.
- Growth of multiprocessing computers—Multiprocessing computers are moving computer technology from the scientific environment into the mainstream commercial computer market as file servers.
- Decline of proprietary systems—The market is moving to the open standard of UNIX and toward open systems, away from proprietary systems.
- IBM's entry into the UNIX market—Dataquest believes that IBM's newest entry, RISC System/6000, brings more credibility to the commercial marketplace for RISC-based UNIX systems, especially among the Fortune 100 companies.
- Expanding markets—Europe is moving to UNIX in a big way. The Japanese are enthusiastic about UNIX for real-time and industrial applications and for workstations.

Really, UNIX is an enabling technology. It is becoming a check-off item for people buying systems. The use of UNIX protects a company's investment in training and hardware. The UNIX market is in a strong period of growth, and we believe that it will continue for the next several years. Graphical user interfaces that shield the complexity of UNIX's command language, the PC DOS-to-UNIX software applications, and fault-tolerant UNIX systems will help UNIX make major inroads into the commercial market in the coming years.

PERSONAL COMPUTER MARKET: SLOWER GROWTH

Dataquest's preliminary market estimates show that 1989 U.S. PC unit shipments grew by an estimated 8 to 9 percent. Our forecast at the beginning of last year was 10.2 percent growth for the U.S. market. We predicted that worldwide PC unit shipments would increase by 10.3 percent. Preliminary figures show that the worldwide market grew by approximately 10 percent. Most companies did not do as well as we had anticipated at the beginning of 1989; however, almost every company increased its unit shipments over 1988.

The number of PC models available in 1989 almost doubled over the previous year. More than 1,000 PC vendors/models are in the market. This large number is primarily because there are few barriers to entering this industry. It is easy to buy a motherboard and a box to go around it and get into the PC business; however, the success rate is low.

The speed at which technology changes was exemplified when Compaq announced the LTE notebook PC, which is a 7-pound, 40MB hard disk, 286-based product with a floppy disk. At the same time, another company came out with their "new" product. This new product was an 8-pound, no hard disk, 8088-based notebook PC, priced $500 above Compaq's LTE.

On a unit basis, the 286-based machines were still the highest-selling boxes in both the worldwide and U.S. markets during 1989. The 386-based PCs sold extremely well in 1989, to the extent that Intel Corporation is currently pushing its limits of production. Preliminary estimates are that the 386 SX sold 1.2 million units in the United States in 1989.

During 1989, improvements in color LCD technology resulted in the introduction of color laptop PCs. Dataquest expects to see many more color LCD laptops in the 1990s, particularly as color technology improves. These products will be expensive and probably will not gain wide market acceptance for at least another few years.

Some extended industry standard architecture (EISA) and microchannel-compatible products were introduced in 1989. So far, EISA products have been confined to the very high end of the PC market, which is primarily 486-based products. Our forecast for the EISA market is that it will parallel the 486 market. The 486 line probably will have only microchannel-compatible or EISA architecture.

With the U.S.S.R. and the Eastern Bloc opening up, PC vendors are excited about selling into these new markets. The major problem, however, is converting currency. Vendors also are trying to learn how to sell products into these new markets.

APPLICATIONS MARKETS: CONTINUED GROWTH, SLOWER RATE

Many computer companies today are looking to the applications area as a panacea for many of their problems. The applications markets currently are growing faster than the computer market, but slower than they have in previous years. Forecast growth is between 10 and 15 percent through the middle of the 1990s and single-digit for the remainder of the decade.

In general, the applications markets are maturing and experiencing consolidation and partnering similar to that of the computer market. For example, in the CAD/CAM area, approximately two mergers and/or acquisitions per month occurred during the past 18 months. Because of these maturing market conditions, success in the 1990s will not depend solely upon a company's technological prowess, but on its ability to manage distribution problems and instill a favorable market perception.

Clearly, the proliferation of nonstandard products has become an issue that must be resolved as soon as possible. For example, currently there are so many variations of UNIX that each one is almost a proprietary product. The real growth potential of many applications hinges on a convergence of the many different standards. Many companies currently are having difficulty implementing their next-generation systems because of the wide array of development alternatives.

From the applications market perspective, many companies already have purchased most of the technology they can use currently. A huge market is developing for companies/individuals to assist the end users efficiently integrate their current systems.

Key areas of interest for applications during the 1990s include the following:

- Increased decentralization of applications
- The workstation as the "computer market" of the decade

Key markets/software technologies for the 1990s include these:

- Document imaging—Emerging
- Color publishing—Embryonic stage
- Multimedia—Technology that can be embedded in or give a face-lift to many applications

DISPLAY TERMINAL MARKET: CONTINUED CONTRACTION

Preliminary estimates of the U.S. display terminal market show approximately a 3 percent reduction from the 1988 unit level. Dataquest forecast a slight increase in the 1989 market; however, that did not happen, primarily because of the softness in the minicomputer market and events surrounding the 3270.

The 3270 market was nearly 100,000 units less than expected. Had that segment held, the display terminal market would have been essentially flat in 1989. Most major vendors experienced reduced 3270 demand, particularly IBM.

In total, the industry is expected to experience a continued slow contraction, both in unit shipments and in the number of vendors. Mergers and acquisitions will continue, and some companies will just simply drop out of the market.

Although expected in the long run, the dramatic growth in the high-end PC and workstation markets during the past couple of years changed the structure of the display terminal market. Recent advancements in LANs also accelerated the replacement of display terminals by intelligent terminals.

For the most part, terminal prices have stabilized. In fact, a few vendors have increased prices by 5 to 10 percent; however, a continuation of significant price increases is not expected in the long run.

We believe that current technology is sufficient for most display terminal applications. Enhancements will be offered; however, there appears to be no major technological changes on the horizon.

Although slower growth is expected for the total display terminal market, we see new opportunities and growth in the processing, X Window, and ISDN display terminal segments.

ELECTRONIC PRINTER MARKET: MODERATE, SLOWER GROWTH

Preliminary estimates of the 1989 electronic printer market show unit growth rates approximately 10 percent less than we forecast a year ago. Many factors contributed to this softness in the market. Perhaps the most significant factor is that users are trying to integrate more of the features and functions of their existing equipment, rather than spend money on new systems.

Dataquest expects a general softening to appear in several segments of the computer market through late 1990 or mid-1991. Reduced computer demand and the trend toward more integration (interconnection of existing printers and other equipment) will translate into slightly reduced growth rates, particularly for serial and line printers.

The real growth area remains in the page printer market. The 8-page-per-minute (ppm) printer has been the industry standard page printer for nearly five years. During 1989, the introduction and acceptance of many 4-ppm to 6-ppm printers has resulted in a structural change in the market. More than 100 different new models were introduced at COMDEX; the result has been a major change in both improved cost/performance and user acceptance.

The 4- to 6-ppm printer, priced at $1,000, now allows the user to do much more than a few years ago—for about the same cost (with the daisywheel printer costing more than $1,000 four years ago). Printing speeds are faster and the quality is much better. It is now easy to reprint pages that were too time-consuming and/or too costly to reprint with previous technologies.

The recent advances in printer/printing technology resulted from the availability of faster processors, more on-board memory, and improved software (particularly for descriptive languages, such as PostScript). The user is moving to a higher level of quality expectations.

These enabling technologies will continue to lead the user to even higher levels of expectation, which, in turn, will foster the development of improved hardware and software for better-looking type, font styles, graphics, and color. These trends will continue, and we expect many exciting advances in printing technology and user acceptance during the 1990s.

COMPUTER STORAGE MARKET: STEADY GROWTH

Most sectors of the computer storage market saw significant growth during 1989. Although preliminary estimates of the 1989 unit market indicate that most sectors experienced somewhat slower growth than previously anticipated, slower was still double-digit growth in several areas, and many new and exciting things are still happening in the magnetic storage industry.

As expected, the small rigid disk market grew by more than 20 percent in 1989. The 5.25-inch disk market contracted again; however it did not shrink as much as previously forecast. CD ROMs are on track with earlier expectations. Selected tape storage forecasts are being reduced; however, there is still plenty of life in that market. Tape storage is essential to backing up all of the new, higher-density disk drives that are entering the storage market.

Dataquest believes that the trends in computer storage through the mid-1990s will be similar to those of the past few years—with smaller, denser products replacing their larger, less dense counterparts. The new 2.5-inch disk drives (or smaller) and CD ROMs will penetrate many new products during the next couple of years.

The magnetic storage industry is experiencing mergers and consolidations similar to several other sectors of the electronic industry—in this case, the activity is mostly at the top. The larger firms are profitable; the smaller ones are not. During 1989, more than 15 companies, in many cases founders of a specific technology, filed Chapter 11 and/or were bought out by larger firms. We see a continuation of this trend—the big are getting bigger.

Many exciting changes are predicted for the storage market for the 1990s, particularly in the area of continued rapid increase in magnetic recording densities. What amounts to a revolution in the areas of increased densities and improved cost/performance is on the horizon. We expect several progressive moves to occur in the optical disk industry during the next year or two. In other areas, we expect the following:

- Gigabit-per-square-inch recording densities soon will be commonplace
- 500 megabits will be on a single 3.5-inch disk
- 1.5- to 2.5-inch rotating disks and many other new products will drive down the cost of rotation magnetic storage to 20 cents per megabit during the next few years.

SEMICONDUCTOR MARKET: SLOW START, THEN STEADY GROWTH

In October 1988, Dataquest forecast that the worldwide semiconductor market would grow 10 percent in 1989; our preliminary numbers show that the market did indeed grow 10 percent, with negative quarter-to-quarter growths in the first, third, and fourth quarters. We believe that the worldwide semiconductor market will turn the corner in the second quarter of 1990, when positive growth will resume after three consecutive quarters of negative growth.

The areas of North America, Asia-Pacific, and ROW will have the strongest growth rates. Japan and Europe both will experience negative growth. No region is expected to grow more than 3 percent in 1990.

During 1990, the 68040 and 80486 microprocessors will be widely available. These powerful microprocessors, mixed-mode ASICs, and higher-density DRAM devices all will require advances in high-speed interconnect packaging technology.

The competitive pressures in the semiconductor industry are continuing to grow. More and more, microprocessors have become proprietary, with only a single vendor producing today's state-of-the-art devices. Pricing pressures remain high in the DRAM arena. This market is doubly hard to enter because of the extremely high, approaching the half-billion dollar mark, cost of building a fab to produce DRAMs.

Questions exist about the status of the U.S.-Japan semiconductor trade agreement, which is due to expire in September 1991. The goal under the agreement was for non-Japanese companies to hold 20 percent of the Japanese semiconductor market by 1991. Our 1989 figures show that foreign penetration of the Japanese market is less than 11 percent (10 percent for North American companies). Will the agreement be renegotiated and/or extended? That remains to be seen.

The slump in the semiconductor market also is driving down capital investment in new semiconductor plants and equipment; we expect capital spending to show a slight drop in 1990. In 1989, the Asia/Pacific region surpassed Europe in the amount of capital spending for the first time. Japan continues to be the leader in this area. Due to increasing chip complexity, semiconductor-manufacturing equipment continues to grow more expensive—thus, raising the barriers of entry and allowing the rich to get richer and the poor to get poorer.

Clearly, 1990 will be a year of challenges for the global semiconductor industry. However, we believe that the worst is over and that current stabilizing factors—such as inventory control, order improvement, and DRAM production control—are setting the groundwork for an industry recovery. Combined with the favorable economic conditions predicted to persist through 1990 and 1991, we expect the industry to complete its recovery this year and grow at a modest clip in 1991 and beyond.

The topics presented above, as well as many other issues affecting the short-range forecasts and outlook through the mid-1990s, will be discussed at length in Dataquest Conferences (see conference schedules on the next page), including our assessment of technology changes and many of the product and market opportunities of the 1990s.

Dataquest's Industry Services and Central Research Group contributed substantially to the contents of this newsletter.

Paul Wittrock

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1990 Conference Schedule

Semiconductor User and Application Markets	February 12-13	San Francisco, California
Service and Support *(Ledgeway Service Industry Executive Conference)*	April 9-10	Boston, Massachusetts
Japanese Components	April 12-13	Tokyo, Japan
Document Processing	April 23-26	Palm Springs, California
Electronic Publishing	*April 23*	
Electronic Printers	*April 24-25*	
Copying and Duplicating	*April 24-25*	
Color	*April 26*	
Computer Storage	May 2-4	San Jose, California
Dataquest Seminar at SEMICON/West	May 23	San Francisco, California
Opportunity Europe Seminar	TBA (May)	Boston, Tarrytown, San Jose
European Components	June 6-8	Paris, France
Display Terminal and Graphics and Imaging	June 18-19	Monterey, California
European Electronic Printers	June 25-27	Amsterdam, The Netherlands
European Copying and Duplicating	June 27-29	Amsterdam, The Netherlands
Personal Computer	June 27-29	Monterey, California
Distributed/Technical Computing	September 26-28	To Be Announced
Information Systems and Automation	October 1-5	Tokyo, Japan
Semiconductor	October 8-10	Monterey, California
Strategic Industry	October 9-10	Taipei, Taiwan
European Telecommunications	October 10-12	Nice, France
Telecommunications	November 5-7	Monterey, California
European Computers	December 4-7	Barcelona, Spain

For reservations or further information about these conferences, call (800) 624-3282 in the United States, 81-3-546-3191 in Japan, or 33-1-48-97-3100 in France.

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Research *Newsletter*

THE HUNTERS AND THE HUNTED—RESTRUCTURING OF TELECOMS MARKET CONTINUES

INTRODUCTION

In October this year, Dataquest published a newsletter on the effective acquisition of Telettra by Alcatel (refer to ESAM newsletter 1990-22 "Alcatel Strengthens Its Number One Position"). In the newsletter, Dataquest analysed the logic behind the move, and commented on some of the factors behind the ongoing restructuring of the equipment supply industry for European public telecoms.

Just one month after the publication of that newsletter, Northern Telecom (NT) of Canada announced that it had made an agreed bid for the United Kingdom's STC, resulting in further consolidation of the industry. This newsletter expands upon the earlier one by analysing the market and describing some of the major market forces. It then goes on to consider the NT bid in order to better explain some of the issues facing telecoms companies. It concludes by considering what the future may hold for the remaining major suppliers.

MARKET ANALYSIS

The equipment supply market for European public telecoms is currently valued at an estimated $13 billion per annum. Although the market will continue to grow, it will be at a very slow rate; overall, it will remain relatively static.

This market comprises approximately 50 percent central office and 50 percent transmission. This needs further elaboration in order to clarify the nature of the market; we shall consider each of these two major segments in turn:

- Central Office—a fairly *coherent* market which consists of the sale of local and transit lines to national operating companies. Growth will continue in line shipments over the short term, but will decline in volume from 1993 onwards. Continued reduction in prices per line will result in an initially static market value that will start to reduce fairly sharply in 1993. This declining market value will be partially offset by the increasing sales of product upgrades—in other words, improving the features of existing systems without increasing the quantity of local lines.
- Transmission—this is a much more fragmented market than central office, with many more fairly discrete product segments. Transmission is defined as including cable-based systems, radio-based systems and telecoms cable. The market will experience growth over the next five years, but this tends to hide the fact that the various different product segments are at varying points in their life cycles and are each experiencing different growth rates.

COUNTRIES AND COMPETITORS

The market is summarized in Table 1, which shows the central office and transmission market values for each of the main European markets and their major suppliers (excluding licensees).

The most striking conclusion of the analysis is the domination of the market by the three main European suppliers—Alcatel, Siemens and Ericsson. These all have strong market positions in several European countries, in addition to very substantial sales outside of Europe.

The balance of major suppliers falls mainly into two categories: local companies with a strong national business (e.g. GPT); and international suppliers trying to penetrate the European market (e.g. AT&T).

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TABLE 1
European Public Telecoms Equipment Supply Market by Country and Supplier 1989

Country	Segment	Market Value ($B)	Major Suppliers
France	Central Office	0.7	Alcatel
	Transmission	1.2	Alcatel, SAT, Philips
Germany	Central Office	1.2	Siemens, Alcatel
	Transmission	1.4	Siemens, Alcatel, Bosch, Philips
Italy	Central Office	0.8	Italtel, Ericsson, Alcatel, Siemens
	Transmission	0.8	Alcatel, Ericsson, Pirelli, Siemens, Italtel
United Kingdom	Central Office	1.0	GPT, Ericsson, NT/STC, AT&T
	Transmission	1.0	STC, GPT, BICC, AT&T
Spain	Central Office	0.7	Alcatel, Ericsson, AT&T
	Transmission	0.5	Alcatel, Ericsson, AT&T
Rest of Europe	Central Office	2.2	Ericsson, Alcatel, Siemens, AT&T, NT
	Transmission	1.5	Alcatel, Siemens, Ericsson, Nokia, AT&T, NEC
Total	Central Office	6.6	Alcatel, Siemens, Ericsson
	Transmission	6.4	Alcatel, Siemens, Ericsson

Source: Dataquest (December 1990)

In the transmission area, in addition to the major suppliers listed, a number of niche suppliers are operating in specific product areas. Due to the fragmented nature of the market. Opportunities will continue to exist for such niche players within this market.

MARKET FORCES

The European public telecoms market is a complex one. However, four major factors are at play in shaping the market:

- Technology life cycles
- Liberalization and deregulation
- Customer demand
- Competition

Technology Life Cycles

Technological advances are being made at an ever-increasing pace. The availability of new technology results in a natural desire to implement the latest advances in commercially available systems. Therefore, the typical life cycle of the technology being deployed is decreasing. In public telecoms there are many examples of this. In the central office environment, Strowger automatic mechanical switching technology was deployed for well over 50 years. This was gradually superseded by crossbar switching technology during the early 1960s, and later, by electronic switching technology in the mid-1970s. During the 1980s electronic switching, in turn, was superseded by digital SPC switching, a market which is now approaching maturity.

In the field of transmission, availability of digital transmission techniques combined with single-mode optical fiber has led to the constant increase of bandwidths. Now, as one level of capacity becomes commercially available, so a higher capacity is being achieved in telecoms laboratories. Through the late 1970s and particularly through the 1980s, systems capacities rapidly increased from 2 Mbit/s to 565 Mbit/s. Today, 2.4-Gbit/s systems are being developed and will shortly be deployed within networks; 10-Gbit/s systems are already being considered.

To maintain competitive, state-of-the-art product lines, suppliers have to invest increasing amounts of money into research and development activities. Typical amounts invested in R&D now range from 10 to 15 percent of turnover, depending on the scale of turnover and the breadth of product range.

Liberalization and Deregulation

Historically, national networks for public telecoms have been run by government departments, with investment decisions centrally planned and controlled by governments. The telecoms networks were considered to be national assets which needed to be protected from outside influence. One result of this situation was that operating companies had very strong links with local equipment suppliers, from whom they sourced most of their major equipment requirements.

Now, however, markets are becoming increasingly subject to liberalization and deregulation (and sometimes privatization) by national governments. This has led to pressure being put on operating companies to behave more like purchasing companies in open, competitive markets. Pressure from EC initiatives will ensure that this trend continues.

One result of liberalization and deregulation is that national operating companies are becoming more and more reluctant to fund R&D programs. Although such funding does still happen, either explicitly or implicitly, the degree to which it happens has reduced dramatically, and in many countries all major R&D programs now have to be funded by private ventures.

Customer Demand

With time, customers are becoming more sophisticated in terms of their requirements for telecoms services. This is particularly true for large corporate customers who view telecoms networks as being vital in improving the overall efficiency and effectiveness of their operations.

Customers no longer accept only the basic services that have traditionally been offered by national operating companies. They are aware of technological advances and also of service offerings in other countries, so they demand, of their own local operating companies, new services and a better overall quality of service.

Competition

These three combined market forces inevitably lead to much greater competition—primarily in the equipment supply market but ultimately between the national operating companies.

Technological advances enable the improvement of networks and the offering of new services, and customers demand the best possible level of service. In a deregulated market, national operating companies have to respond to these demands and ensure that their networks (and, indeed, overall business) are capable of supporting modern requirements in a cost-effective manner. As they come under more financial pressure to achieve good returns on investment, they are passing the pressure on to their suppliers.

The major suppliers are faced with better opportunities in terms of new technologies and resulting products and systems, but have to recover their increasing research and development costs over shorter product life cycles. They therefore seek to expand their geographic market coverage in order to generate higher sales volumes, enabling them to keep the required R&D levels while maintaining their own objectives for return on investment.

With deregulation and the gradual lowering of trade barriers in Europe, increased competition is not only made possible but is actively promoted. The end result is that the major national suppliers can no longer continue to thrive on local business alone. While relatively small companies may be able to succeed through tight focus on niche-market opportunities, the major suppliers have to achieve growth through international expansion. However, while creating more competition abroad, they are at the same time faced with increased competition in their home markets.

NORTHERN TELECOM AND STC

Against this background, NT recently made an agreed bid for STC. NT had a turnover in 1989 in excess of $6 billion, all of it generated from telecoms markets. It achieved phenomenal growth through the 1980s by being one of the first telecoms companies to introduce fully digital, central office switching systems. Based on its DMS switch, it made major inroads into the RBOC market in the United States, and succeeded in maintaining its market share through the late 1980s. An analysis of NT's 1989 sales is shown in Table 2.

The company is now, above all, a public telecoms equipment business, but with a strong subsidiary business in the private telecoms market. DMS is very much the flagship product; it and supporting technology form the core of its operations.

NT is laying the foundations for future products and systems with its main program, "FiberWorld" and new product announcements. With these it hopes to secure long-term business prospects.

The major issue facing the company is how to break out from the North American market. With 95 percent of its sales being generated in the United States and Canada, continued growth and profitability in the long term will have to be achieved by building successful businesses in other geographic markets. In order to help achieve some level of "internationalization," NT acquired a 27 percent stake in STC in 1987. This included the remaining 25 percent of STC still owned by ITT, which had historically owned all of it.

STC used to be the UK operating arm of ITT. When ITT merged with CGE's communications business to form Alcatel, STC was the one major European telecoms business which was excluded from the deal. As a part of its growth strategy, STC took over ICL in 1983 with a view to starting the much talked-about convergence of communications and computing technologies. By 1985, STC suffered a major financial crisis as a result of rapid growth, but it managed to survive and consolidate its business only after a boardroom coup and the injection of tough, new, senior executives.

Throughout the late 1980s, STC very successfully transformed its financial position and became a highly profitable organization. In order to continue successfully into the 1990s, however, it has to grow its international business substantially.

Since 1983, the original STC Telecoms and ICL have continued to be run as virtually separate companies, emphasizing that there was little real synergy between the two industries. Earlier this year STC finally announced it was to sell 80 percent of ICL to Fujitsu. The balance of STC consisted of telecoms (64 percent), and components and distribution (36 percent). These two divisions had a combined 1989 turnover of £991 million. An analysis of the core telecoms business is shown in Table 3.

With a world-leading submarine systems business, a good position in the emerging CT2/PCN markets, and 35 percent of sales being generated from outside the United Kingdom, the company appears to be very soundly based. However, the submarine system business is, by its very nature, rather erratic. The CT2/PCN markets will not start to generate cash for some years, and within transmission and miscellaneous telecoms, 75 percent of turnover was generated by just one customer, British Telecom.

STC has found it incredibly difficult to break away from its history as a UK subsidiary of a multinational company responsible for selling only into the UK market. Despite continuous efforts to build international business, STC remained highly dependent upon the BT market.

Table 2
NT Sales Analysis 1989

Product Area	Percent Share	Country	Percent Share
Central Office	54%	United States	59%
Transmission	10%	Canada	36%
Cable and Outside Plant	9%	Rest of World	5%
Business Communications	24%		
Other	3%		
Totals	100%		100%

Source: Dataquest (December 1990)

TABLE 3
STC Telecoms Sales Analysis 1989

Product Area	Percent Share	Country/Customer	Percent Share
Submarine Systems	29%	BT	50%
Transmission and Cable	34%	Other United Kingdom	15%
Other Telecoms	26%	Rest of World	35%
Non-Telecoms	11%		
Totals	100%		100%

Source: Dataquest (December 1990)

THE LOGIC BEHIND THE ACQUISITION

STC understood perfectly well the necessity to find some form of very close collaboration in order to secure its own future in telecoms. It was (and still is) working with a range of European companies, both in terms of joint product development and provision of European sales channels.

However, progress was (perhaps inevitably) very slow, with little or no impact on short-term revenues. With the sale of ICL, STC was faced with the choice of either using the cash to find a suitable acquisition, or realizing its own potential as an attractive acquisition target. Particularly with Alcatel's acquisition of Telettra, the former option became very limited. STC was approached by several companies with a view to taking over the remaining STC business; one of these was NT.

NT is fundamentally a public telecoms equipment company. Any major move, such as the acquisition of STC, must be aimed at strengthening its position in this market. Within public telecoms it has made some impact on minor European countries (Austria and Turkey), but with the exception of the United Kingdom, has failed to make any impact on the larger European markets. In the United Kingdom it has sold DMS switches to Mercury and also to BT for specialized applications. Its share of the European market is substantially less than 2 percent.

A primary objective, according to NT, is to use STC as a vehicle for increasing its presence in the European market, helping it to generate additional sales of its central office (and ultimately transmission) products. Clearly NT feels the need to achieve a substantially greater market share in the important European market, to help it fulfil its long-term growth objectives.

The most important factors behind the acquisition are:

- The existing relationship: STC is already a known quantity to NT.
- STC has a strong position in the UK market, and provides a good sales channel into BT.
- A substantial portion of the UK switching network will not start to be digitized until the second half of the 1990s, presenting an opportunity for NT's DMS.
- STC is a company with a strong position in the EC.
- It has been building relationships with continental European telecoms companies.
- STC has a strong technology base.
- It holds potential synergy from its respective R&D programs, particularly for synchronous transmission products.
- STC will improve NT's access into the UK private switching market.

A key issue behind all of this, is the fact that companies can only substantially penetrate the major European public telecoms markets by some form of joint venture, merger or acquisition with a local company. Only the acquisition option gives an immediate impact in terms of increasing business levels. It will not have escaped NT's attention that opportunities for the acquisition of suitable local companies are rapidly disappearing. STC presented one of the last few suitable targets.

WAS IT A GOOD MOVE?

In as much as NT has acquired a profitable company, and the acquisition will probably do STC more good than harm, it must be viewed as a good move. However, where is the real synergy in the move? And to what extent will STC help NT to achieve its European objectives? These questions need to be asked.

The following negative points must be raised against the undoubted positive points listed in the previous section:

- STC does *not* provide a sales channel into continental European markets.
- The potential availability of the UK central office market to NT is very limited—a share of one-third of 8 million lines, not commencing for perhaps 5 years.
- The so-called next-generation switching products are a very long-term proposition.
- NT will find it difficult to lever its FiberWorld products into European markets, even if a good sales channel is established.
- STC is developing products in collaboration with European companies, which are effectively competitive to FiberWorld.

In summary, short-term benefits are very limited and there is a big question mark over the extent to which STC will help NT to penetrate continental Europe, even in the medium to long term. NT now has a much stronger UK market position, and has the potential to rationalize transmission R&D programs and strengthen product offerings. Although NT paid a high price, it will shortly benefit from the cash generated by the sale of ICL stock to Fujitsu. Other elements of STC could also be sold off to generate further cash, without adversely impacting NT's objectives.

On balance, and given the restricted options for making a real impact on the European market, it may well prove to have been the correct strategy. However, NT needs to work hard to ensure that it gets maximum benefit from STC's assets, particularly if it wishes to use STC as a springboard into Europe—a strategy that NT itself has announced. NT/STC need to try to rapidly build upon the foundations laid by STC, while not disrupting the existing relationships.

DATAQUEST ANALYSIS

Trends in the supply market for public telecoms equipment are clear: continued industry restructuring being driven by irreversible market forces. While national protectionist activities will prolong the process, the inevitable end result is further reductions in the quantity of major suppliers that are left in the market. The only questions unanswered are how long the remaining companies will keep their independence? And at what stage will the restructuring stop?

In order to provide a partial answer to these questions, we need to look at all the active, major companies in the market (that is, those supplying a public telecoms product range that is relatively comprehensive). These can be grouped into three categories:

- Alcatel, Siemens and Ericsson
- Other European suppliers
- Non-European suppliers

The companies in the first group are all continuing to consolidate their positions, and actively dominate the European market. This will not change.

Basically it can be said that there must be a very large question mark over all companies which fall into the middle category. While niche marketing strategies can be successfully employed by relatively small companies that are visionary, flexible and capable of rapid reaction, this is not a strategy that has been made to work by larger companies. STC is an example of a company that has tried.

Larger companies are locked into a situation demanding that continued growth and market expansion is a necessary strategy to ensure long-term, independent survival and success. At the same time, the critical-mass threshold is getting higher and higher.

Looking ahead five years, it is difficult to envisage more than one of the companies from the "other European supplier" category still surviving and thriving with a comprehensive product range, with possibly room for one specialist telecoms cable supplier. It is probably fair to say that if there are more, then the EC has not succeeded in removing or reducing the trade barriers that it is trying to eradicate.

The continued presence (and possible financial success) of US and Japanese companies trying to penetrate the European market is very much dependent on how determined they are to build a presence and what level of investment they are prepared to make. Their combined share of the European market will undoubtedly grow.

Over the next five years, the market will continue to be characterized by suppliers being divided into the hunters and the hunted. Industry restructuring will stop there. Having said that, the scale of the task facing the hunters in maximizing benefits from their acquisition activities, should not be underestimated. Alcatel has taken a long time and a vast amount of senior management effort trying to rationalize its organization and product ranges since its formation in 1986. NT must work very hard to gain maximum benefit from its acquisition of STC.

Looking ahead ten years, the success of the remaining few suppliers may well depend on their skill in managing to best effect, diverse geographical organizations—consisting of a mixture of their own divisions and acquired or merged businesses.

John Dinsdale
Jonathan Drazin

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Research Newsletter

ISDN IC MARKET IN EUROPE, PART 3: THE LONG-TERM OUTLOOK

EXECUTIVE SUMMARY

European consumption this year of ISDN-dedicated ICs is estimated at $27.8 million, compared with Dataquest's prediction of $35 million two years ago. We forecast a 38 percent compound annual growth rate (CAGR) as the most likely outlook for the ISDN IC market over the period 1990 to 1995, yielding a total revenue of $140 million by the end of the period.

Recent ISDN IC demand has come predominantly from public infrastructure applications (switches, line cards and terminations) and has, so far, been independent of subscriber take-up. Consequently, the present market is dominated by revenues in U-interface and, to a lesser extent, S-interface ICs. This pattern will inevitably adjust in favor of the other ISDN functions as demand for terminal equipment begins to appear. By 1995, we expect unit demands for the major functions (U- and S-interfaces, link controllers, voice codecs and rate adapters) to become comparable.

The chief hurdles—full service coverage and pan-European compatibility of ISDN standards—are not scheduled to be overcome in Europe before 1992. In the interim, we expect major demand for ISDN semiconductors will result from non-ISDN applications such as pair gain.

A SERIES OF THREE NEWSLETTERS

This is the final newsletter of a three-part series that has looked at the market for narrow-band ISDN ICs in Europe. It presents the results of a survey of vendors' estimates for the current 1990 market, and shows a revised forecast for the period 1991 to 1995. Some estimates of the likely long-term scenario for narrow-band ISDN ICs in the year 2000 are also given.

Readers should refer to the first newsletter, "ISDN—The ICs and Their Applications, Part 1," 1989-1, for an explanation and glossary of ISDN concepts. The second newsletter, "ISDN—The Early Markets, Part 2," 1989-2, gives an explanation of the key factors affecting ISDN's uptake in Europe, although the forecasts it contained are now superseded by this newsletter.

INTRODUCTION

Dataquest's market forecast for the consumption of ISDN semiconductors is based on a "bottom up" model that sums subforecasts for each major application that consumes ISDN-dedicated ICs (Lotus 1-2-3 copies are available to ESAM subscribers at $300 each, and to non-subscribers at $1,000 each). The model is based upon the following critical issues and assumptions which are discussed in this newsletter:

- Semiconductor content by ISDN function, per major application
- PTT rollout plans for ISDN Basic and Primary Rate coverage across Europe
- ISDN price projections per function
- Levels of penetration per ISDN Basic and Primary Rate lines of the major ISDN applications
- Resolution of factors critical to ISDN's uptake: coverage; tariffs; standards; availability of applications; and market awareness

ISDN SEMICONDUCTORS

The market for ISDN semiconductor ICs depends crucially on the future demand from a handful of applications. Each function in Table 1 is sold today as a single IC. As revenue grows, we expect multiple functions to be combined onto a single IC. For example, the digital ISDN telephone,

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currently requiring four ISDN ICs, might be integrated into one. However, sales volumes are not nearly high enough for this to be considered today.

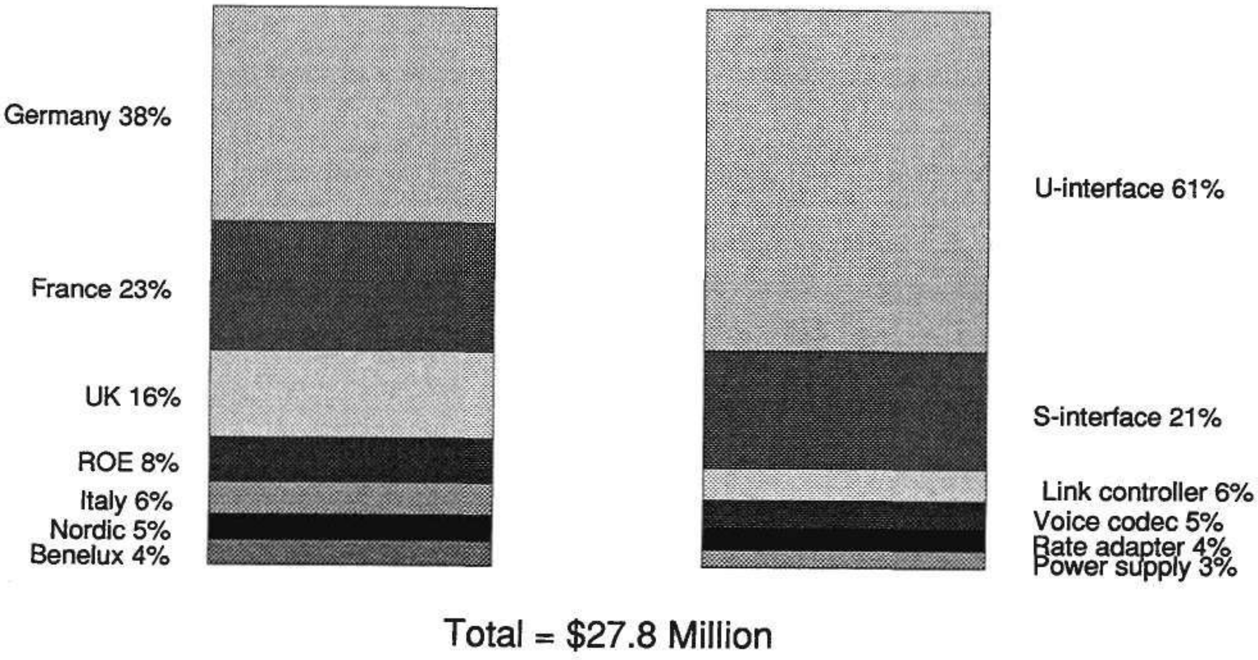
For Basic Rate communication with the public network, the U-interface function is most prevalent because it is a prerequisite to both line cards (Line Terminations) in the central office, and to terminations (Network Termination 1) in subscribers' premises. Its prevalence is compounded in revenue terms because it is the most costly to implement on silicon. For these reasons, the revenue of U-interface ICs in Europe, currently exceeds that of all other ISDN functions added together (see Figure 1).

TABLE 1
ISDN Function Content by Application—Key Assumptions

	ISDN Chip Type					
Application	U-interface	S-interface	Codec	Rate Adapter	Link Control	Power Supply
Facsimile (Group IV)		1			1	
Telephone		1	1		1	1
PC Card		1	1		1	
CO Line Card	1				0.25	
Pair Gain + Line Card	2		2		1	
Subscriber Termination (NT1)	1	1				
Intelligent Workstation		1	1	1	1	1

Source: Dataquest (November 1990)

FIGURE 1
European 1990 ISDN IC Revenue Estimated by Region and Function



Source: Dataquest (November 1990)

Many office environments are expected to use the S-interface to connect terminal equipment, with exceptions in cases where it is costly or impractical to install the 4-wire cable needed for the S-interface. In such instances, a low-cost proprietary U-interface is likely to be used.

Normally, the S-interface and attached terminals are powered by a local mains supply. However, in case of local power failure, the CCITT ISDN standards specify an emergency mode whereby designated terminals can draw power from the PSTN across the U-interface. A market is expected to develop for highly efficient ICs with switch-mode power that are dedicated to meeting these standards. Digital telephones will be the main applications for these ICs, particularly those connected directly to the NT1 termination in small offices and, eventually, private homes.

ISDN ROLLS OUT—FEW SUBSCRIBERS TODAY

True ISDN services have been launched in each of the main European countries: France, Germany and the United Kingdom. Substantial investment in public ISDN infrastructure has already commenced in each region. Table 2 shows our key assumptions regarding the installed base of Basic and Primary Rate ISDN lines in Western Europe.

Bundespost Telekom has recently installed 230,000 Basic Rate ISDN lines, with contracts for the switch and line card portions of the infrastructure going to Alcatel-SEL and Siemens. Orders for subscriber terminations have gone to Philips Kommunikations Industrie (PKI) and other smaller companies. However, prospects for a rapid succession of repeat orders from Bundespost Telekom are dimmed by the fact that, to date, little over 5,000 of these lines are currently in use (see Figure 2).

France Telecom's Numeris service was launched nearly two years ago. Again, uptake is limited, with only 3,000 Basic Rate lines currently in service. Further, the rate at which France Telecom can extend coverage beyond city islands is limited because, unlike its switches, only a small proportion of France's long-distance trunk network is digital. Consequently, despite France Telecom's proactive approach towards the marketing of ISDN, we do not expect particularly strong uptake in France over the 1990 to 1993 period.

British Telecom commenced trial of its true ISDN Basic Rate service earlier this year, and currently has only 200 lines accessed. Full-scale launch commences in January 1991. British Telecom's mature, long-distance digital network is expected to allow full, nationwide ISDN coverage by the end of next year. Over the 1991 to 1992 period, the service will be supported using 90,000 remote multiplexed lines supplied by STC Telecoms. Further ISDN spending will be placed with GPT and, later, Ericsson for Basic Rate line card extensions to their System-X and AXE-10 central office switches.

On a worldwide perspective, and in terms of ISDN lines *actually in service* (see Figure 2), Europe lags far behind the United States, where some 120,000 Basic Rate services are now in use. Europe's take-up of Basic Rate lines is also exceeded by Japan where more than 10,000 lines are in service. However, Europe currently has the largest number of Primary Rate lines in use.

Table 2
Assumptions for Basic and Primary Rate ISDN Line Installed Base in Europe (Thousands of Lines)

	Basic Rate		Primary Rate	
Region	1992	1995	1992	1995
France	300	350	8.0	20
Germany	310	470	14.0	21
Italy	100	260	4.0	10
United Kingdom	170	360	5.0	15
Rest of Europe	120	300	10.0	21
Total	1,000	1,740	41.0	87

Source: Dataquest (November 1990)

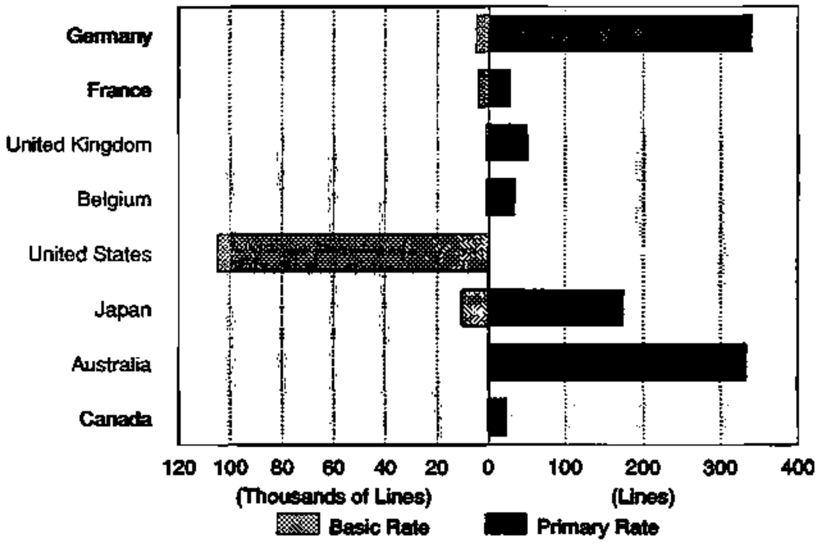
PRICE PROJECTIONS

We expect rapid price erosion over the first few years as volume markets for ISDN ICs unfold. To secure design-ins, many of the ISDN ICs presently on the market support multiple features and bus interfaces and, consequently, occupy larger die sizes than necessary. Prices will decline as volume, and hence, competition develops, quickened by rationalization of unnecessary features and shifts to smaller line geometrics. Table 3 shows the price assumptions that connect our unit forecasts to market revenue; they are not intended as forecasts of price *per se*.

ISDN—THE CRITICAL FACTORS

Discussions with experts in the ISDN community have led us to conclude that there is no one factor inhibiting ISDN's uptake in Europe. Unattractive ISDN tariffs are often cited as the most fundamental reason why ISDN is slow to emerge. But this obstacle cannot be the only factor, because there are clear cases where certain end-user segments (small offices and large decentralized organizations) could derive demonstrable cost advantages from adoption of ISDN today—although few, so far, have chosen to do so.

Figure 2
Public ISDN Lines in Service Worldwide
(As of End September 1990)



Source: Siemens, Dataquest (November 1990)

Table 3
ISDN IC Price Projections by Function—Key Assumptions
(More than 10,000 Contracts, Single Function per IC)

IC Function	1990	1992	1995
S-interface	$6.00	$4.55	$3.00
U-interface	$35.00	$26.50	$17.50
Rate Adapter (V.110/120)	$8.50	$6.40	$4.25
Link Controller	$6.00	$4.55	$3.00
Voice Codec	$5.00	$3.80	$2.50
Power Supply	$3.80	$2.88	$1.90

Source: Dataquest (November 1990)

We believe the following three factors (in order of priority) most limit ISDN's immediate uptake:

- **Limited geographical coverage.** Large decentralized organizations (e.g., chain stores, banks) are one of the most promising potential users of ISDN for communication. However, such users require complete coverage before they can adopt. Today, ISDN services are only available in small islands; full national coverage in the United Kingdom is not expected before the end of 1991, or in France and Germany before the end of 1992.
- **Low availability of applications.** Few companies have, so far, launched general-purpose ISDN applications suitable for use on a variety of computer platforms. We foresee that LAN-to-LAN bridges, which use the PSTN to link two or more office LANs, are one of the most promising applications. Many versions of these, usually in the form of PC adapter cards, have appeared already. However, their success is closely linked to the availability of one other application: the PABX-to-LAN interface, where progress towards standardization is slow.
- **Standards.** The PTTs' adherance to national protocols, which differ from the CCITT Blue Book recommendations, implies that terminal manufacturers must install costly, multipurpose, standard firmware into their ISDN products to allow them to work in each country. Standardization is also lacking in services that supplement voice communication (e.g., call forwarding, conferencing and identification), presently making it impractical to supply the same telephone keyboard layout in all European countries.

  The European Telecommunications Standards Institute (ETSI) plans to achieve full standardization of both public signalling and customer premise supplementary services by 1992. Although standards remain to be decided and adhered to at a European level, many PBX and terminal manufacturers already claim their equipment can interwork across different national ISDN services.

For the above reasons, we foresee 1992 as a transition year for ISDN, marking its transformation from a theoretical solution into a practical one.

VIDEO-TELEPHONY—A TRIGGER?

One common view exists that ISDN's adoption will be triggered by uniquely new applications that employ ISDN as the communications medium. Following the arrival of the new CCITT H.261 video-conferencing standard, the videophone might be regarded as a strong candidate.

The semiconductor content of videophones is currently very high, about $800 per unit. This is why the first-generation H.261 videophones cost over $25,000 each—and, of course, one needs two to communicate.

For videophones to sell in volumes comparable to normal telephones, they must sell at comparable prices, this implies a semiconductor content reduction of nearly 100 times. With such an enormous discrepancy between present prices and what is affordable, there is little precedent for videophones to become volume products until well *after* ISDN has achieved widespread adoption, in the late 1990s.

We expect video-teleconferencing systems to proliferate first; these will eventually pave the way for a videophone market. However, we believe that over the next two to three years video-teleconferencing's initial high prices will restrict it to a small number of large organizations.

Consequently, neither videophone nor video-conferencing can be expected to give ISDN line uptake a significant push for many years. Instead, we expect that ISDN compatibility will gradually diffuse its way into many key existing applications. Table 4 gives our assumptions for the rate at which this will proceed as a proportion of total shipments for three years: 1992, 1995 and 2000. (These penetrations are consistent with the ISDN line rollout figures given in Table 3.)

POTS AND PAIR GAIN—A CRUEL IRONY?

It is ironical that, in the near term, one of the greatest sources of demand for ISDN ICs will come not from ISDN applications but from the PTTs' expansions of their plain old telephone services. They are likely to achieve this in many cases through the use of "pair gain"—a term that describes the use of a single Basic Rate ISDN twisted-pair line to support two voice lines.

Pair gain is attractive because it makes more efficient use of the existing installed base of copper lines. Greater multiples of voice lines are being considered by using higher bit-rate U-interfaces than the 144 Kbit/s Basic Rate, and by using low

TABLE 4
ISDN Penetration into Total Unit Shipments
(Percent)

	Year		
Equipment Type	**1992**	**1995**	**2000**
Facsimile	0.0%	3.0%	50.0%
Telephone, Residential	0.0%	1.0%	10.0%
Telephone, Business	0.6%	5.0%	30.0%
Personal Computers (PC Adapter Cards)	2.0%	20.0%	40.0%
CO Line Cards	1.0%	2.5%	20.0%
PBX Line Cards	0.3%	3.0%	20.0%

Source: Dataquest (November 1990)

bit-rate ADPCM codecs, but progress is currently hampered by cost, availability and power consumption. Pair gain may be one of the first applications where ISDN-dedicated ICs will appear—in this case a U-interface and a PCM voice codec integrated as one part.

Manufacturers of pair gain units in Europe include Alcatel–Telettra (Italy), ECI (Israel), and GPT, Landis & Gyr, Marconi, STC, and Telspec (all United Kingdom). In Western Europe, demand for pair gain is greatest in the United Kingdom, where British Telecom plans to purchase 150,000 units over the coming two to three years. Other moves towards pair gain are being considered in Germany and Switzerland. We may expect substantial demand for pair gain systems to originate from Eastern Europe where there will be massive pressures to boost subscriber densities as economically as possible.

MARKET ANALYSIS

Our vendor survey shows the European ISDN semiconductor market this year to be $27.8 million. In order of market share, the top three vendors are estimated to be Siemens Components, Mietec–Alcatel, and Mitel. Other major suppliers with revenues currently exceeding $1 million are AMD, National Semiconductor, and SGS-Thomson.

Present demand originates mainly from a small number of large orders for public lines. We estimate that more than a third of these went into last year's order from Bundespost Telekom for Basic Rates lines, resulting in major business for Mietec–Alcatel and Siemens Components.

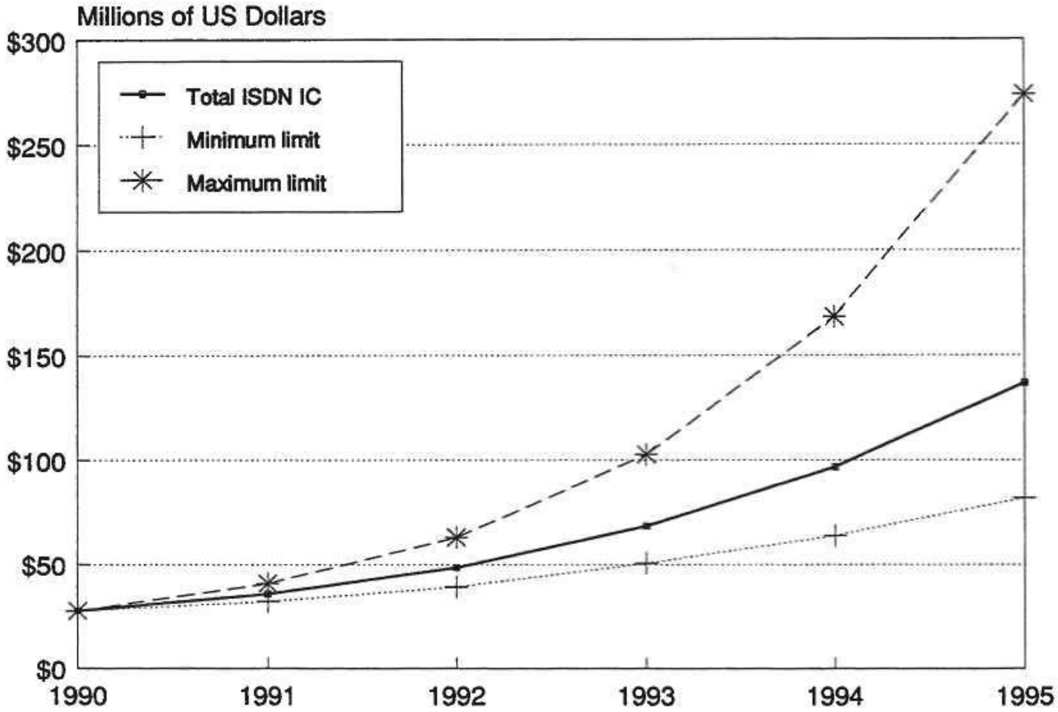
The present market is dominated by U-interface and S-interface IC shipments (see Figures 1 and 3). As subscriber interest in ISDN grows, we foresee that demand will shift towards customer premise equipment so that, by 1995, unit shipments of the major ISDN functions (excluding power supply ICs) will become comparable. However, in revenue terms, we expect the U-interface to continue to dominate, commanding 70 percent of the total market.

ISDN power supply ICs depend heavily on the market for digital telephones that can operate in emergency from line-fed power. The main source of demand for these telephones will be in the residential market, although this is not expected to develop until well after 1995.

The solid line in Figure 3 shows our estimates for ISDN uptake based on the PTT installed base estimates of Table 2. It shows a moderate 25 to 30 percent annual growth through to 1992, due largely to the fact that new orders for public infrastructure are unlikely to be forthcoming until better utilization of the existing ISDN installed base is achieved. Beyond 1992, the prospects look more positive, and we forecast a quickening of market growth to 40 percent CAGR for the 1992 to 1995 period.

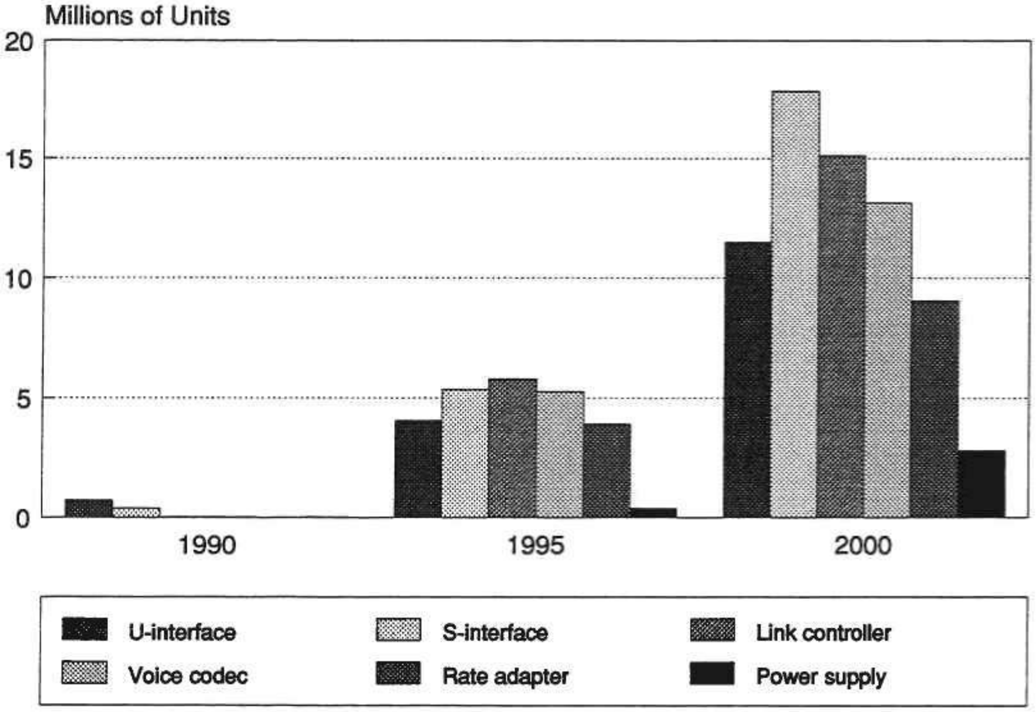
Knowledge of probable penetrations for ISDN equipment makes it possible to forecast the relative mix of ISDN functions, as depicted in Figure 4, with some confidence. However, accurate total ISDN forecasts are less straightforward, because they depend on the complicated interrelationships between the issues already discussed. By 1995, the most probable outlook for ISDN semiconductor consumption is $140 million. The maximum and minimum lines in Figure 3 give our view of the extreme limits to which the market could reach, between $80 and $280 million in 1995.

FIGURE 3
Total Forecast European ISDN Semiconductor Consumption



Source: Dataquest (November 1990)

FIGURE 4
European ISDN Unit Consumption Estimated by Function



Source: Dataquest (November 1990)

CONCLUSIONS

In terms of hardware cost per unit bandwidth, we already note that ISDN makes more cost-effective use of twisted-pair subscriber loops than conventional hardware such as analog telephones and modems. In particular, Basic Rate gives data rates (144 Kbit/s) unachievable using the fastest modems (18 Kbit/s) but at comparable prices.

The PTTs have made similar observations, but their current plans for ISDN are limited by their lack of coverage and how it fits into their portfolio of other services. However, it is clear that they will use ISDN internally as the most effective way of running their networks.

We expect pair gain to play an important role in drawing ISDN closer to the customers' premises—certainly more so than video-telephony. Pair gain offers a seamless transition from analog voice telephony to ISDN. Attracted by the opportunities to sell inexpensive, additional telephone lines, PTTs will prefer to fit Basic Rate line cards to their switches rather than lay more cable. While this is not a particularly encouraging sign for manufacturers of ISDN terminal equipment, it is clear consolation for vendors of ISDN semiconductors.

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Research *Newsletter*

ALCATEL STRENGTHENS ITS NUMBER ONE POSITION

INTRODUCTION

Fiat of Italy and CGE of France have announced a far-reaching alliance, involving a share and business swap between the two companies, and also an agreement to form a group to explore a range of technologies of common interest to them. Undoubtedly it is the public telecommunications business which is at the heart of the agreement, and which has been the driving force behind the move.

Fiat has effectively sold Telettra to Alcatel.

Telettra will be merged with Alcatel's Italian subsidiary (FACE), although Fiat will hold a 25 percent share in the merged company. This further strengthens Alcatel's position as the largest European telecoms manufacturing company. Indeed, Alcatel was already the second-largest telecoms manufacturing company in the world, and this alliance could well move it above its other major rival, AT&T.

ALCATEL

Alcatel NV was formed in 1986 by the merger between CGE's communications business and ITT of the United States. It is 61.5 percent owned by CGE and 37 percent owned by ITT, with the balance being owned by Crédit Lyonnais. Alcatel is effectively a massive conglomerate of strong national subsidiaries, many of which have leading positions in their own markets. At least seven of its major European subsidiaries had 1989 turnovers well in excess of $500 million—and only three of these subsidiaries are based in France.

Its total turnover for 1989 was ECU 12.8 billion (approximately $14.1 billion), and its net income was ECU 478 million ($525 million).

Alcatel's business is above all else in telecoms manufacturing and marketing, and the company has a very comprehensive product range covering virtually all aspects of the telecoms market. Indeed, due to its history, one of its main issues and priorities has been to rationalize competing product lines to prevent duplication of effort and products, and to gain maximum benefit from its substantial scale. Alcatel's business is split as given in Table 1.

TABLE 1
Alcatel's Sales Analysis

Product Areas	Percent Share	Countries	Percent Share
Central Office	25%	France	29%
Transmission	14%	Germany	17%
Cables	28%	Italy	9%
Business Systems	21%	Spain	10%
Other	12%	Rest of Europe	17%
		Rest of World	18%
Total	100%		100%

Source: Dataquest (November 1990)

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TELETTRA

Teletttra is 90 percent owned by Fiat, with the remaining 10 percent being held by Telefónica, the Spanish PTT. This shareholding reflects its business—basically an Italian company but with a major subsidiary in Spain. The Spanish subsidiary is itself 90 percent owned by Telettra, with the balance again owned by Telefónica.

Telettra's 1989 turnover was L 1.62 trillion ($1.2 billion), on which it earned a net income of L 200 billion ($150 million).

Telettra is a telecommunications company, with a small business in defense systems. Its transmission business constitutes by far the largest part of its turnover.

While having a strong position in the Italian and Spanish transmission markets, the major issue facing Telettra was how to consolidate and grow this business when faced with both much larger competitors, and the enormous problems encountered in trying to enter new markets. Telettra's business split is given in Table 2.

THE ITALIAN MARKET

The Italian market is, to say the least, very complicated. In contrast with the other major European markets, it has a complicated national telecommunications infrastructure, with several operating companies and a diverse supplier base. As an example, in the central office market, there are no less than five major suppliers supplying four different product ranges.

The estimated total Italian telecoms turnover of the major telecoms suppliers is shown in Table 3.

One key feature of the Italian market is the major influencing role of politics, individuals and central government. As an example, a merger between Italtel and Telettra had been long planned, but finally collapsed in 1987 due to disagreement over how the new company (Telit) would be managed and to what extent it would be free from central control or influence.

TABLE 2
Telettra's Sales Analysis

Product Areas	Percent Share	Countries	Percent Share
Transmission	63%	Italy	51%
Central Office	14%	Spain	29%
Other Telecoms	15%	Rest of Europe	6%
Defense	8%	Rest of World	14%
Total	100%		100%

Source: Dataquest (November 1990)

TABLE 3
Major Players in the Italian Telecoms Market

	1989 Turnover		
Company	Billion	$B	Primary Focus
Italtel	L 1,900	$1.4	Central office
Telettra	L 800	$0.6	Transmission
Alcatel	ECU 0.6	$0.7	Central office, cable, business systems
Siemens	L 500	$0.4	Central office, transmission
Ericsson	L 600	$0.4	Central office

Source: Dataquest (November 1990)

THE SPANISH MARKET

The Spanish market also has a fairly diverse supply industry, and in many ways represents the most open major market in Europe. Having said that, Alcatel is by far the largest supplier to the market. It also has great growth potential due to the relatively underdeveloped state of the network.

The estimated total Spanish telecoms turnover of the major telecoms suppliers is shown in Table 4.

Telefónica appears keen to promote further competition in Spain and a number of other major suppliers are successfully building a Spanish business—perhaps the most notable being AT&T.

THE LOGIC BEHIND THE MOVE

Quite simply, this move:

- Further strengthens Alcatel's position within the European telecoms industry
- Allows Fiat to focus more tightly on its core business, which is far removed from telecoms

In Italy, Alcatel and Telettra combined now have a dominant share of the transmission market in addition to Alcatel's strong position within the central office market. Together they are the equal of Italtel in turns of telecoms turnover within the country. In Spain, the combined company is by far and away the major player in the market, having well over 50 percent share of the central office market and approaching a 100 percent share of many areas within the transmission market.

While Alcatel has consolidated its position in these two major European markets, Telettra (and Fiat) has solved the problem of simply not being big enough in an industry that is increasingly characterized by large-scale suppliers. As a part of the Alcatel group it can now afford (or at least have access to) much larger R&D programs, and enable the benefits of rationalization and scale.

On its own Telettra could only have survived by an increased focus on "niche" markets or by entering into wide-ranging collaborations or joint ventures with other companies—a strategy demanding much high-level focus and attention. As it was owned by an automobile manufacturer and contributed considerably less than 5 percent of the total turnover of Fiat, it is highly questionable whether such a strategy would have worked. Fiat looked for a buyer, and has effectively sold Telettra for a very good price before the going got too tough.

For Alcatel, there must have been an added technology-based motivation behind the move. While it will not have been the prime reason, Telettra's advanced technology and products in digital cross-connect systems must have made it an even more attractive proposition. This key technology/product area will become ever more important within public telecoms over the next decade, and it represented the one obvious gap in Alcatel's otherwise comprehensive transmission product range. While there are, no doubt, many short-term issues to resolve, Alcatel has effectively plugged this gap.

DATAQUEST ANALYSIS

This alliance is further evidence, if any were needed, of the necessity for rationalization within the public telecoms industry in Europe. The telecoms market is now characterized by shortening product life cycles and resulting greater requirements for privately funded investment in R&D. The market is simply too small to support the large number of national suppliers which have historically existed. Every year, the number of medium-size suppliers is decreasing while the very few companies with larger telecoms turnover continue to grow even bigger. While there are still many opportunities for small companies, the middle ground is disappearing.

TABLE 4
Major Players in the Spanish Telecoms Market

	1989 Turnover		
Company	**Billion**	**$B**	**Primary Focus**
Alcatel	ECU 1.0	$1.1	Central office, transmission
Telettra	L 400	$0.3	Transmission
Ericsson	L 700	$0.5	Central office

Source: Dataquest (November 1990)

This has implications for the few remaining medium-size companies. As pointed out by STC after its recent sale of ICL stock to Fujitsu, one strategic option for enabling the longer-term success of the relatively smaller companies is the forming of a pan-European grouping of telecoms suppliers—but the options for finding appropriate partners has now narrowed even further. The acquisitive nature of the few remaining truly worldwide players is clearly not being halted by the collaborative plans of their smaller competitors.

The ongoing restructuring and rationalization of the industry also has implications for non-European companies keen to penetrate the market or grow their European public telecoms businesses. The target list for potential acquisitions or joint ventures is shrinking for them too. The opportunity to make a *really* major impact on the market is disappearing rapidly.

The interesting question now is how much longer the few remaining medium-size companies in this market will continue as "independent" companies.

As a footnote, it is also worthwhile commenting on the inability of the Italian government effectively to build a national champion in public telecoms. In the end, commercial and marketing pressures have won out over political intervention, and there must now be a very large question mark over the medium- to long-term survival of Italtel as an "independent" Italian company.

(This newsletter was originally published by Dataquest's European Telecommunications Industry Service.)

John Dinsdale
Jonathan Drazin

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Research *Newsletter*

WORKSTATIONS—RAMPING UP THE GROWTH

EXECUTIVE SUMMARY

From a recent Dataquest survey we estimate that 48,095 workstations were manufactured in Europe during 1989. This figure represents 54 percent of the total workstations (88,875 units) sold in this marketplace, and 17 percent of worldwide production. The results of our survey suggest that only 23.7 percent (21,045 units) of total workstation sales in Europe accounted for semiconductor sales on the European market.

The high growth of the end-user market, combined with local production, is expected to prompt a rapid rise in the general consumption of semiconductors for workstations. The European market for workstation semiconductors is expected to be $22.2 million this year, and we forecast that this will rise, with a 69 percent compound annual growth rate (CAGR), to $182.2 million in 1994.

WORKSTATION DEFINITION

Dataquest defines workstations as: any computer that is intended for multitask use by one operator, but this excludes 80x86-based machines that normally run MS-DOS or OS/2-type operating systems. Consequently, personal computers (see ESAM newsletter 1990-14 "PC Production in Europe, 1989—Preliminary Update") are excluded from this survey. Typically, most workstations use VMS (Digital), UNIX or UNIX-like operating systems such as DOMAIN (Apollo) or HP-UX (Hewlett-Packard).

EUROPEAN WORKSTATION PRODUCTION

Table 1 shows the main workstation manufacturers and production activity in Europe. Table 2 shows workstation production and shipments, and makes the distinction between total production and *effective* production; the latter counts only those units where semiconductors are procured in Europe. In total 48,095 units were produced during 1989—of which 43.8 percent were effectively produced. According to manufacturers' estimates, total production is set to nearly double to 70,850 units this year, with the proportion effectively produced dropping slightly to 40.7 percent. With many new plans announced to help ramp up production this year, the scenario for the years ahead looks very different.

In terms of semiconductor consumption, we estimate that Digital is the largest consumer, producing a total of 20,900 DECstations (RISC-based) and VAXstations (CISC-based) at its Ayr plant in Scotland last year. Second largest is Hewlett-Packard/Apollo, at its Böblingen plant in West Germany, with an estimated 17,900 unit production of CISC-based workstations. Third is Intergraph, which manufactured 4,950 RISC-based units in 1989.

Sun is scheduled to produce 9,000 units of Sun SPARC machines this year—accounting for 12.7 percent of total production in Europe—and it expects to more than double this figure next year. By mid-1991, it expects to be subcontracting the manufacture of printed circuit boards (PCBs) to ICL (Kidsgrove, UK). This is to keep all its workstation assembly operations in Linlithgow (which has capacity to produce 2,000 units per week). Bull HN is expected to announce plans later this year to launch a workstation product to be manufactured in Europe.

IBM

IBM has assembly facilities for its RISC-based RS-6000 workstation at its Santa Paloma plant in Italy. Although we estimate that some

TABLE 1
Workstation Production Activity in Europe

Manufacturer	Subcontractor	Town	Country	Country of Origin	Board Assembly	Board Test	Workstation Assembly	Local Semiconductor Procurement
Acorn	AB Electronics	Cardiff	United Kingdom	United Kingdom	✓	✓	✓	✓
Cetia	Cetia	Toulon	France	France	✓	✓	✓	✓
Digital	Digital	Ayr	United Kingdom	United States	✓	✓	✓	(Spares Only)
HP/Apollo	HP/Apollo	Böblingen	West Germany	United States	✓	✓	✓	✓
IBM	IBM	San Paloma	Italy	United States	NA	NA	✓	(Captive Sales Only)
Impuls	Impuls	Vienna	Austria	Austria	✓	✓	✓	✓
Intergraph	Intergraph	Nijmegen	Netherlands	Netherlands		✓	✓	
Parsys	Thorn EMI Micrologic	Bedford	United Kingdom	United Kingdom	✓	✓	✓	✓
Silicon Graphics	Silicon Graphics	Neuchatel	Switzerland	United States		✓	✓	
Sun Microsystems	Sun Microsystems	Linlithgow	United Kingdom	United States	✓	✓	✓	(Commencing late 1990)

NA = Not Available
Source: Dataquest (October 1990)

TABLE 2
Workstation Unit Production Shipments in Europe

	1988			1989			1990			1991		
Manufacturer	CISC Total	RISC Total	Total	CISC Total	RISC Total	Total	CISC Total	RISC Total	Total	CISC Total	RISC Total	Total
Acorn	0	0	0	0	1,250	1,250	0	3,200	3,200	0	5,250	5,250
Cetia	970	0	970	1,800	0	1,800	1,800	200	2,000	2,000	600	2,600
Digital	18,750	0	18,750	20,500	400	20,900	23,500	2,700	26,200	19,700	6,600	26,300
HP/Apollo*	12,059	0	12,059	17,900	0	17,900	23,500	0	23,500	26,300	0	26,300
IBM*	NA	NA	NA	NA	NA	NA	NA	6,000	6,000	NA	NA	NA
Impuls	50	2	52	50	20	70	40	40	80	30	60	90
Intergraph*	0	4,500	4,500	0	4,950	4,950	0	5,500	5,500	0	6,100	6,100
Parsys	0	0	0	0	25	25	0	50	50	0	75	75
Silicon Graphics*	0	935	935	0	1,200	1,200	0	1,320	1,320	0	1,450	1,450
Sun Microsystems	0	0	0	0	0	0	0	9,000	9,000	0	29,750	29,750
Totals	31,829	5,437	37,266	40,250	7,845	48,095	48,840	28,010	76,850	48,030	49,885	97,915
Effective Production	13,079	2	13,081	19,750	1,295	21,045	25,340	3,490	28,830	28,330	35,735	64,065

* Estimated
NA = Not Available
Source: Dataquest (October 1990)

3,000 units of workstations were manufactured at the plant up until August 1990, we believe the plant has capacity to reach an estimated 15,000 units. Originally, IBM was expected to procure semiconductors locally for workstation production at Santa Paloma, but this has been postponed. Although we were unable to survey IBM, our belief is that IBM's semiconductor consumption is largely derived from its capative sales.

RISC AND CISC APPLICATIONS

Workstations based on CISC processors still dominate the market, accounting for 63.5 percent of total European workstations produced (see Table 3). Most of these have been designed around the 68000 series; very few 80x86-series processors have penetrated European manufacturing and it now appears that they are fading from this segment. The increasing availability of applications software for RISC UNIX-based platforms and the advent of Sun Microsystems' large manufacturing facilities in the United Kingdom means that the uptake of RISC workstation production is clearly underway. Other RISC processors in volume applications are: the Intergraph Clipper, SGS-Thomson's transputer series, Acorn's ARM processor, Intel's i860, and Motorola's 88000 part.

TABLE 3
European Workstation Production and Semiconductor Consumption Forecast

Microprocessor Type	1988	1989	1990	1991	1992	1993	1994
European Sales (Units)	61,250	88,875	134,157	189,857	263,779	353,347	460,265
CISC							
68000 series	31,779	40,200	48,800	48,000	NA	NA	NA
80x86 series	50	50	40	30	NA	NA	NA
Total CISC (Units)	31,829	40,250	48,840	48,030	46,161	44,754	43,392
RISC							
MIPS R2000/3000	935	1,600	4,020	8,050	NA	NA	NA
Intel i860	0	0	0	0	NA	NA	NA
Acorn ARM	0	1,250	3,200	5,250	NA	NA	NA
Sun SPARC	0	0	9,000	29,750	NA	NA	NA
Motorola 88000	0	0	200	600	NA	NA	NA
AMD 29000	0	0	0	0	NA	NA	NA
Inmos Transputer Series	2	45	90	135	NA	NA	NA
Intergraph Clipper	4,500	4,950	5,500	6,100	NA	NA	NA
Other RISC	0	0	6,000	0	NA	NA	NA
Total RISC (Units)	5,437	7,845	28,010	49,885	89,743	137,307	193,603
Total Unit Production	37,266	48,095	70,850	97,915	135,904	182,061	236,994
Effective Unit Production	13,081	21,045	28,830	64,065	108,723	172,958	236,971
Semiconductor Content per Unit ($)	$780.00	$740.00	$769.00	$769.00	$769.00	$769.00	$769.00
European Semiconductor Consumption ($M)	$10.20	$15.57	$22.17	$49.27	$83.61	$133.00	$182.23

NA = Not Available
Source: Dataquest (October 1990)

Over the next few years we believe that RISC-based workstations will continue to grow at a faster rate than CISC-based workstations. The higher price/performance advantage offered by RISC is strongly in demand from a growing number of technical and CAD/CAM/CAE users. In terms of unit production, we foresee a strong 72 percent CAGR for RISC-based production, and a declining 3 percent CAGR for CISC through to 1994.

This is already evidenced, we believe, by the fact that this year's sales of RISC machines closely match those of CISC. RISC has become successful mainly because support for RISC architectures has increased dramatically, and it is now clearly evident that RISC will play a central role in the workstation market. Dataquest forecasts that RISC could account for 80 percent of the total workstation market worldwide by 1994; last year it accounted for 43 percent.

EUROPEAN SALES

Workstation sales within Europe grew progressively over 1987 to 1989 from 32,275 units to 88,875 units respectively. Dataquest forecasts that the trend will continue this year, with a 51 percent growth in sales to an estimated 134,157 units.

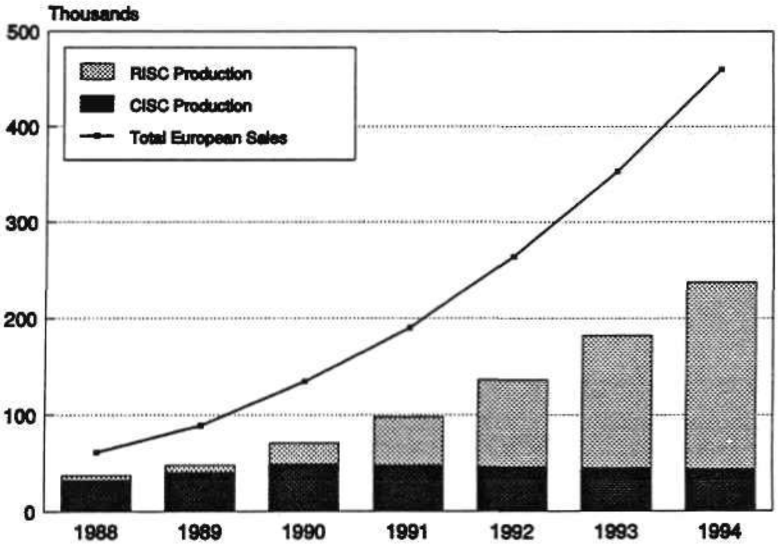
The US manufacturers indicated that they planned to increase production to meet all local demand in Europe. Currently, their target estimates for 1990 suggest that effectively 21.5 percent of units sold in Europe are produced in Europe. By 1994, we expect this proportion to have risen to above 50 percent (see Figure 1).

SEMICONDUCTOR FORECAST

To prepare estimates of the revenue from European consumption of workstation semiconductors, we have examined a typical motherboard for a midrange workstation to determine semiconductor content (see Table 4). MOS ICs represent some 82 percent of semiconductor content, with the remainder being predominantly bipolar TTL, ECL and PAL standard logic.

Our analyses of semiconductor content combined with production give a consumption forecast as seen in Table 3. While we do not forecast any growth in semiconductor content, we do forecast high growth in revenue of semiconductors in Europe (69 percent CAGR, 1990 to 1994), due to the rapid increases in effective production as discussed earlier. This year we estimate semiconductor consumption to be $22.2 million, rising to $182.2 million by 1994. In fact, the total consumption of semiconductors in workstations is expected to exceed the figures given in Table 4 as other PCBs—such as LAN, video, disk and driver

FIGURE 1
European Workstation Market and Production (Thousands of Units)



Source: Dataquest (October 1990)

cards—besides the motherboard, are needed to build a complete workstation system. In addition, peripheral units (for example, monitors, keyboards, hard disks, and so on) are not included in these estimates, consequently we believe that the total consumption for workstations exceeds Table 4 by a factor of between 1.5 and 3.

CONCLUSIONS

Today, few manufacturers procure semiconductors locally for workstation production. In our survey we discovered that, although some board tests do take place in Europe, most take place overseas.

Discussions with the manufacturers have revealed that they nearly all intend to ramp up their production markedly *and* procure locally. While many of their claims verge on the optimistic, there are clear, fundamental reasons why this might be achieved. Like PCs, the workstation market is becoming increasingly competitive; as price competition grows, so does the need to have local centers of production so that import duties can be bypassed. The need to manufacture close to their customers is another reason why these manufacturers are giving special attention to procurement in Europe.

However, this is not sufficient explanation for the transition towards local procurement among manufacturers. It may be that the unit volumes that these manufacturers are selling into Europe have not until now been high enough for them to justify investment in costly PCB assembly and test facilities. Another reason could be that recent activities by the European Commission—enforcing minimum local contents for some Japanese manufacturers of printers and photocopiers—have urged some of the workstation manufacturers to insure themselves now against further EC developments in other areas, such as PCs and workstations. However, we feel that this is unlikely as we do not foresee any "dumping" in this marketplace. It is more likely that preference rules—which give preference to suppliers with higher local content—could encourage more workstation vendors to start procuring locally.

Mike Williams
Jonathan Drazin

TABLE 4
Estimated 1990 Workstation Semiconductor Content for a Typical Midrange Workstation

	Value	Number of Parts	ASP per Part
Total Semiconductor	$769	228	$3.37
Total Integrated Circuit	$757	221	$3.42
Total Bipolar	$125	119	$1.05
Bipolar Memory	0	0	NA
Bipolar Logic	125	119	$1.05
Total MOS	$632	102	$6.19
MOS Memory	522	81	$6.45
MOS Micro	87	4	$21.73
MOS Logic	22	17	$1.31
Linear	$2	3	$0.62
Discrete	$10	4	$2.50
Optoelectronic	$0	0	NA

Note: CPU motherboard only; excludes monitor, power supply and peripheral drivers (e.g. LAN and disk controllers)
NA = Not Applicable
ASP = Average selling price
Source: Dataquest (October 1990)

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Research Newsletter

PERSONAL COMMUNICATION NETWORKS—FACT OR FANTASY?

EXECUTIVE SUMMARY

Recent technological advances in digital-radio transmission (particularly in channel modulation, speech compression, and cell reuse) will shortly make it possible for people to carry wallet-size mobile communicators, which are light and inexpensive. This is the personal communication network (PCN) concept; where calls are made between people—not places.

PCNs could become a major new driver for semiconductor demand in the 1990s: they offer flexibility of communication to a whole population—as opposed to the limited subsegment of business users presently served by cellular telephony.

Today, the PCN concept is frustrated by the absence of PCN standards and high costs of handsets. This newsletter describes how rapid progress is being made on both fronts—possibly making Europe the first continent to enter the eras of Dan Dare, Dick Tracey and Captain Kirk.

INTRODUCTION

Currently in Europe, only 1 person in a 100 has a cellular telephone handset. It is widely expected that by the end of this decade the level of penetration will have risen to as high as 1 in 4 in some parts of Europe.

TABLE 1
Existing and Emerging European Cellular Telecommunications Standards

Standards	Countries of Use
Analog	
C-450	Portugal, West Germany
NMT-450	Belgium, Denmark, Finland, France, Luxembourg, Netherlands, Norway, Spain, Sweden
NMT-900	Denmark, Finland, Netherlands, Norway, Sweden, Switzerland
Radiocom 2000	France
RTMI (discontinued 1989)	Italy
RTMS	Italy
TACS-900	Austria, Ireland, United Kingdom
Digital	
GSM (commencing late 1991)	Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom
DCS 1800 (commencing late 1992)	United Kingdom, (others may follow)

Source: Dataquest (September 1990)

Over the past decade, the development of mobile telecommunications standards in Europe has been rapid (see Table 1). However, today's networks for analog cellular telephones lack many of the qualities needed for mass mobile communication. The greatest limitation is that the networks fail to use radio spectrum efficiently enough for the needs of a whole population. Furthermore, many of these networks already experience problems serving subscribers in densely populated cities and urban areas.

PCN IN EUROPE: THE STORY SO FAR

In December 1989, the United Kingdom's Department of Trade and Industry (DTI) announced that it would award licenses to three consortia (Mercury, Microtel and Unitel) to build and operate PCNs alongside the analog TACS—and soon emerging digital Groupe Speciale Mobile (GSM)—services operated by Cellnet and Vodaphone. The DTI's objective in granting these licenses is to introduce mass-market competition for British Telecom, the main network operator in the United Kingdom.

All three UK consortia are scheduled to offer PCN services by the end of 1992 or early in 1993. At service launch they claim to be able to cover 25 percent of the UK population between them, rising to 75 percent by 1995. When granted, their licenses will stipulate that: by December 31, 1999, each operator must separately cover 90 percent of the UK population—amounting to a total infrastructure bill of about $5 billion. Special clauses have been built into their licenses to encourage this investment. These are as follows:

- The option to share infrastructure between the PCN operators
- The freedom to use their own microwave links to connect base-station sites with switching centers, and to bypass the normal BT/Mercury duopoly on such services
- The ability to sell services directly, via retail or service providers

Market projections from the three consortia suggest that, in total, there will be in excess of 10 million UK subscribers for PCN by the year 2000, a figure which, if true, may not be far short of the total number of subscribers for GSM across all Western Europe in the same year.

Earlier this year, the European Telecommunications Standards Institute (ETSI) based in southern France agreed to collaborate with the DTI-licensed consortia to develop a new PCN standard: Digital Cellular System 1800 (DCS 1800). In view of the short time to service launch, it was decided to base PCN on ETSI's new digital cellular GSM standard to commence service in cellular networks across Western Europe from the end of next year. Work on DCS 1800 is being untertaken by the same ETSI subcommittees that developed GSM, with the first stable version of DCS 1800 planned for January 1991. While this first release should lead to a marketable PCN network, subsequent refinements will be made when it has to cater for very dense voice traffic patterns and offer true ISDN compatibility.

Unlike for CT2 or GSM, no Memorandum of Understanding (MOU) exists between European states governing DCS 1800's adoption across Europe. Presently, DCS 1800 is being considered for adoption in Italy and Germany, with the probability that other countries will review its adoption at a later stage in DCS 1800's development. Work is also in progress in Europe on PCN standards that are not derivatives of the existing GSM and Digital European Cordless Telecommunications (DECT) air interfaces (particularly work on spread-spectrum techniques by AT&T and Alcatel). It is probable that several other candidates besides DCS 1800 will be considered by ETSI before a European consensus and MOU finally emerge on PCN.

DCS 1800 AND GSM—THE KEY DIFFERENCES

The advent of DCS 1800 has caused many arguments—particularly from cellular operators—that PCNs offer little beyond that which GSM is about to provide. Both types of network are likely to offer similar services to subscribers: smart card billing, call transfer, forwarding, conferencing and storage. So, what is DCS 1800's unique selling point? The answer lies in how it differs from GSM:

- Bandwidth allocation for DCS 1800 (in the United Kingdom) is three times greater than the EC allocation for GSM.
- The higher 1.8 GHz frequency band (compared to 900 MHz for GSM) allows for smaller cells to be used and greater reuse of spectrum.
- The DCS 1800 standard will permit infrastructure sharing using a new concept of "hosted" and "unhosted" cells that permit subscribers belonging to one operator to be temporarily connected to another when coverage is not available.

The above points, combined, form the basis of a mobile communications network with massively greater capacity than that available from the analog and digital cellular networks added together.

PCN IN THE UNITED STATES—MUCH INTEREST, BUT A LONG WAIT?

There is much interest in PCN in the United States: last June, the Federal Communications Commission (FCC) issued a Notice of Inquiry (NOI) calling for comment on development of a mass-market personal communication "service" (PCS). Already, some 22 experimental licenses have been requested for testing proposed services by companies including Millicom, Motorola, Nynex and BellSouth. Two to three years from now, the FCC is expected to announce its findings on PCS and declare its intentions for standards and spectrum allocation in a Notice of Proposed Rule Making (NPRM).

However, US spectrum allocation is a lengthy process. Several years are expected to elapse between the FCC's issue of the NPRM on PCS and its final ruling. In the case of the US analog cellular network (AMPS), five years passed before allocation was granted—this is largely why the new digital system (US Digital) uses the same frequencies as AMPS.

To overcome the frequency allocation problems in the United States, two companies—Millicom and Nynex—have proposed that the FCC use PCN services based on spread-spectrum techniques that employ a code division multiple access (CDMA) standard. Although CDMA uses a very wide bandwidth, it is spectrally efficient in the sense that there would be no need to clear spectrum because CDMA can be laid on top of other services. CDMA products, such as wireless LANs and very small aperture terminals, are already on sale in the United States and Europe. However, CDMA's feasibility for use in PCN environments (where received signal strengths are highly variable) is questionable. Consequently, widescale adoption of PCN services in the United States is not seriously expected for at least another five years—more than three years after DCS 1800 has entered service in the United Kingdom.

WHAT IMPACT FOR SEMICONDUCTORS?

The DCS 1800 standard is intended for use in cell diameters from about 50 meters to 1 kilometer—much smaller than the diameters used by GSM. Transmit powers (1W or 0.25W, depending on the power class) are also lower than for GSM, resulting in lighter, more compact handsets.

There will be no significant extra semiconductor cost from shifting the air interface to 1.8 GHz from 900 MHz for GSM. In fact, the overall semiconductor cost for DCS 1800 handsets will be lower than for GSM because no separate power-amplifier module is required. The move to smaller cell sizes also brings simplifications to the channel-equalizer and baseband codec ICs. Other functions, such as the GSM 13/6.5 kbit/s speech codec, are likely to remain unchanged.

Table 2 shows our estimates for the semiconductor content of a DCS 1800 handset in 1995. The total semiconductor content should be around $43, consisting of about four ICs. Chip-and-wire technology will allow the RF and IF stages (if any) to be mounted in a single, small package—we have already seen working prototypes from two European vendors. Simplifications to the channel modulator and equalizer circuits will allow them to be combined for PCN. The speech and controller ICs are likely to be used for GSM handsets (see ESAM newsletter 1990-5, "GSM in Europe—Cellular Turns Digital"), although possibly with minor modifications to the mask ROM codes in each.

Advances in cost reduction and compaction will leave the RF and IF stages accounting for less than a fifth of total semiconductor content. The remaining 80 percent by value consists of roughly 200,000 gates of CMOS. Consequently, we expect PCN handset semiconductor costs to fall roughly in line with high gate count CMOS for the remainder of the decade.

WHAT IS THE FUTURE FOR PCN?

So how will GSM and PCN coexist? In the first years of service, we expect the PCN operators to face a tough uphill battle. The fact that PCN uses smaller cells than GSM, makes the PCN cost of infrastructure per unit-area considerably higher. Further, up until the point when the GSM networks approach full capacity, there will be little to differentiate PCN from GSM. From this point onwards, service quality on the GSM networks will diminish, especially in the cities, clearing the way for PCN to take on new subscribers.

Although DCS 1800 is "mobile" (in the sense that it provides handover between cells and permits communication at speeds up to 125 km/h) we do not believe it will become a major rival to GSM for in-car mobile use. This is because PCN's coverage will first be limited to inner cities and later will expand to urban and rural areas. While coverage of major highways is envisaged, the operators are not likely to extend coverage to all rural roads for many years—if at all. Consequently, we foresee that GSM, not PCN, will become the chosen form of access for most automotive users.

We believe DCS 1800 in its present form has other limitations. Possibly the most severe of these is that time pressure (as a result of PCN's UK launch by 1992), has been one reason for ETSI selecting GSM, not DECT, to form the basis of DCS 1800. However, GSM is less spectrally efficient compared to DECT in small cells (for which DECT was designed). More fundamental is that, unlike DECT, neither GSM nor DCS 1800 can carry Basic Rate ISDN data traffic. This is not an issue today but by the mid-1990s, when both PCN *and* ISDN take off, this will become embarrassing. GSM and DSC 1800 are said to have problems in the short term too—one being that Group 3 facsimile machines cannot be connected to these networks.

DATAQUEST CONCLUSIONS

The implication of PCN for the semiconductor industry over the coming decade will be no less profound than the impact the personal computer had in the last decade. For Western semiconductor manufacturers the challenges will be particularly great. This is because personal communicators will have more in common with low-margin miniature consumer products like camcorders and Walkmans (into which they sell few parts) than they have with desktop PCs.

Dataquest is convinced that the PCN concept is set to commence across Europe within the next three to five years. What is less clear, is how Europe's first experience of PCN will fare in the United Kingdom. While DCS 1800 will lead to cheaper and more compact handsets (two vital conditions for mass adoption) than is possible with GSM, we are not convinced that it will have sufficient flexibility to ensure its adoption as the PCN standard for Europe. Much further work is needed to include DECT functionality into it before it will satisfy data users.

TABLE 2
Semiconductor Content Estimation for a DCS 1800PCN Handset in 1995

Component	Technology	Cost
Front-End IC	Chip-and-wire	$7.00
Filters	SAW	
Receive amplifier	Bipolar or GaAsFET	
Transmit amplifier	Bipolar	
Synthesizer/PLL	Bipolar	
Baseband conversion	CMOS	
Channel IC	Monolithic CMOS	$13.00
Channel Codec		
Channel equalizer		
Speech IC	Monolithic CMOS	$13.00
Speech Codec		
Mike/Speaker circuits		
Controller IC	Monolithic CMOS	$10.00
Keyboard/LCD controller		
Card controller		
Supplementary functions		
Memory		
Total Semiconductor Content:		$43.00

Source: Dataquest (September 1990)

We see stormy weather ahead for the PCN pioneers in the United Kingdom. They face strong competitors (Cellnet and Vodaphone) who, in the short term (1992 to 1994), have fully developed analog TACS networks with spare capacity—capable of carrying double the amount of subscribers than they have at present. Over the longer term (1993 to 1996) the same competitors will deploy GSM networks that are expected to at least triple their present capacities. Winning market share from these players will be an expensive exercise. Only when capacity runs short on GSM can PCN demonstrate clear leadership.

This is not to imply that PCN will be totally excluded from the UK market until the mid-1990s; niches will start to appear from the outset. These niches are likely to be in city areas: with professional users who value the quality of service that PCN will offer. Many of these will use PCN handsets in multiple environments: at home, while commuting, and around the office. But here, again, PCN will find itself pitted against two rival cordless technologies—CT2 and DECT.

Jonathan Drazin

Dataquest
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Research *Bulletin*

EUROPEAN COMMISSION ORIGIN RULE FOR PCBs

SUMMARY

Over the last 12 months, the European Commission has been debating the pros and cons of defining a rule of origin for assembled printed circuit boards (PCBs), primarily to aid import controls. Currently there is no standard method employed by the Commission, and each case is determined on its merits. Commission regulation 802/68, article 5, dated 27 June 1968 is the only reference point in this respect. This is a general regulation which defines the origin of the goods as: the country "in which the last substantial process or operation, that is economically justified, was performed."

In the case of a PCB, there is usually no appropriate manufacturing process which determines its origin, and so the country in which the last substantial element of value was added is used instead. The term "substantial" is arbitrarily interpreted to mean greater than 45 percent of the ex-works value, while "added value" can include raw materials, assembly costs, sales costs and profit. Raw materials are the board and component costs. When the added value has been spread across more than one country, it is the country that contributed the greatest part which earns the label of origin. A standard definition would eliminate the ambiguity and subjective interpretation of regulation 802/68, making the country of origin of a PCB a legal certainty.

However, the Commission has now abandoned its proposal for a rule of origin on PCBs based on this interpretation. A Dataquest analysis of this issue is presented in this bulletin.

THE PRESENT SYSTEM

When products cross a national border, it is a requirement to know their country of origin in order to apply any relevant import duty. In the case of a PCB being imported to the European Community, the duty is generally 4.9 percent. PCBs originating from EFTA countries and certain other regions may have this duty waived due to preferential trade arrangements with the EC. The origin of the PCB is determined by interpretation of Commission regulation 802/68, using the added value principle in most cases. The proposed rule of origin for PCBs would have formalized the use of the added value principle, with no real change in the present procedure. However, this proposal has been met with resistance from many sources, the reasons for which will now be discussed.

Use in Anti-dumping Action

The Commission has found some foreign exporters guilty of dumping certain types of equipment in the European market. Some of these exporters subsequently circumvented anti-dumping regulations through so-called European "screwdriver" operations, which assembled equipment from imported components. This related to photocopiers, dot-matrix printers, electronic typewriters, and electronic weighing machines. The Commission ruled that these manufacturers may continue to trade without penalty (in the form of anti-dumping duty) only if they keep the proportion of parts sourced from their home country below 60 percent by value. As a PCB cannot easily be taken apart and reassembled in working order, the Commission has ruled that a PCB is a single element in this equation. PCBs can account for as much as 50 percent of the final equipment cost, so it is important for the manufacturer to minimize the proportion of PCBs labelled as being sourced from their home country in order to avoid anti-dumping duty. Since only Japanese companies have been subject to this ruling so far, this actually means minimizing PCBs labelled as Japanese.

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One way to begin to overcome the Japanese origin label is to purchase the bare board locally and assemble locally. But to ensure that proprietary and competitive Japanese technology is used in the equipment, a significant proportion of Japanese components are incorporated. When the added value principle is used to determine origin, this places the board in danger of being labelled as Japanese, so, it is important to boost the parts value from another region to exceed that sourced from Japan. This can be achieved most effectively by adding more European added value, as the locally sourced bare board and local assembly has already provided a significant base to build on. Adding parts value from any other country would only dilute the non-Japanese added value without making any single country dominant over that of Japan. This has conceivably put European component suppliers at an advantage, and has provoked US component suppliers to complain that they are denied access to this new market. This also provides the basis for US resistance to the Commission's proposal of a value added rule of origin for PCBs.

Assembling Views

In the US, and many other world regions, the country in which assembly takes place is regarded as the origin of the PCB, the origin of raw materials is therefore irrelevant. This allows relatively low-cost entry as a "local" supplier of PCBs. The US has been lobbying the Commission to adopt this rule of origin instead of the value added definition. The Commision, on the other hand, does not regard assembly as a sufficient indicator of origin. It has already demonstrated its stand on this issue by introducing a rule of origin on semiconductors which takes diffusion rather than assembly as the substantial process. This has also been met with criticism.

DATAQUEST ANALYSIS

The news that the Commission has dropped its proposal of a value added rule of origin on PCBs, including raw materials, is seen in some quarters as a step toward the assembly origin rule. As such, some press reports on the subject have declared this development a major compromise by the Commission. However, the procedure followed by the Commission will not change, as the proposed origin rule on PCBs would only formalize the process to hasten decisions and minimize disputes.

Clearly, one of the reasons why the Commission continues to resist the assembly rule of origin is that it does not attract the same level of investment, and therefore commitment, to the European Community. The announcements of new European semiconductor fabrication facilities by foreign manufacturers may have some relation to the Commission's position on this matter.

The real test will occur when the General Agreement on Tariffs and Trade (GATT) round of talks is completed at the end of this year. It is then that the Commission will know whether its anticircumvention regulations on equipment parts value is ruled illegal. If this occurs, then the Commission will truly need to consider its stance on PCB rules of origin, as it will no longer be able to discriminate against "screw-driver" operations. The simplest option in this case would be to adopt the assembly rule of origin for PCBs, in line with the US, although this would not be compatible with the Commission's rule of origin on semiconductors.

In any case, due to the strategic nature of building a semiconductor fabrication facility, Dataquest does not expect any plans for such investment to be curtailed. The benefits of a local manufacturing presence go beyond the issue of PCB origin rulings. The opportunities presented by a single European market and the opening up of Eastern Europe are far more powerful incentives.

Byron Harding

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Research Newsletter

ESTIMATED 1989 EUROPEAN SEMICONDUCTOR MARKET SHARE RANKINGS BY APPLICATION SEGMENT

SUMMARY

Dataquest estimates that overall semiconductor market growth in 1989 over 1988 was 14.9 percent. Strongest growths were seen in the segments of consumer (20.8 percent), data processing (19.9 percent), and transportation (17.5 percent). The military (1.2 percent), industrial (6.5 percent) and communications (13.3 percent) segments grew below the market average. The data processing segment continues to drive the European semiconductor market with an increased share (31.2 percent) of the total market in 1989 (compared to 29.9 percent in 1988 (see Table 1).

This newsletter presents the results of Dataquest's survey of semiconductor vendor market shares by application segment in Europe.

SURVEY RESULTS

Data Processing

The data processing segment (Table 2) has remained the largest segment with sales up 19.9 percent to $3,045 million. European suppliers showed the strongest growth (57.2 percent) followed by Rest of World (ROW) companies (39.1 percent), Japanese companies (19.8 percent), and last, North American companies (1.7 percent). The strong overall growth reflects a trend toward increased European production to meet the demands of the European data processing market. Over the last year, we have witnessed ramp-ups in production from a number of computer companies (Sun, Tandon, Digital, IBM and Apple). Printer output from companies like Epson and NEC is also believed to have grown dramatically.

Siemens made the most rapid ascent through the rankings. Its performance is largely attributable to its rapid growth in the 1M DRAM market throughout 1989. Siemens' 189 percent growth in this segment has somewhat moderated the growth of the other players.

Newcomers in the top ten league this year are SGS-Thomson (which now includes Inmos) and AMD. National Semiconductor and Philips were displaced from the top ten league (please refer to ESAM newsletter 1989-21 for 1988 ranking). Sales

TABLE 1
Estimated 1988 and 1989 European Semiconductor Market by Application Segment (Millions of US Dollars)

	1988		1989	
Segment	Revenue	Percent of Total	Revenue	Percent of Total
Data Processing	$2,540	29.9	$3,045	31.2
Communications	1,736	20.4	1,967	20.2
Industrial	1,625	19.1	1,731	17.8
Consumer	1,526	18.0	1,844	18.9
Military	505	5.9	511	5.2
Transportation	559	6.6	657	6.7
Total	$8,491	100.0	$9,755	100.0

Source: Dataquest (September 1990)

within Philips was affected by lower demand from their data processing businesses.

Of the top ten vendors: three were Japanese, three North American, two European and one was South Korean.

Communications

Semiconductor consumption in communications (Table 3) came to 20.2 percent of the total market, making this segment the second largest market for semiconductors in Europe.

Overall, Japanese companies, historically weak in the European telecommunications market, have shown the most significant growths: 32.2 percent compared to 16.6 and 2.6 percent respectively for North American and European companies.

The top five supplier ranking remained unchanged, although both SGS-Thomson and Motorola now closely rival Philips. SGS-Thomson's growth (19 percent) was particularly healthy, this is attributed to strong sales of line cards and other switching ICs into France, Italy and West Germany. We believe that uncertainty over Plessey's future during 1989 (GEC/Siemens acquisition) played a large part in its fall from the top ten table. Note also that Plessey sold its discrete business during the year to the newly formed Zetex Semiconductor based at Oldham in England, and divested its optoelectronics business to its management.

Siemens was unable to do as much business in 1989 as it did in 1988 due to the fact that this segment is influenced by national government contracts—German communications in 1989 showed some decline internally. Thus, Siemens moved down two places from sixth to eighth position in 1989. ITT moved up one position to fill in the number ten slot.

Of the top ten vendors in data processing: seven were North American, two were European, and one was Japanese.

Industrial

Semiconductor vendors overall indicated that this segment has declined. Industrial semiconductor demand represented 17.8 percent of the total market (Table 4) compared to 19.1 percent in 1988. Revenue growth by the company's region of origin showed a 900 percent growth for ROW companies, 26.4 percent by Japanese companies, 17.9 percent by North American companies and a negative 13.3 percent growth by European vendors.

SGS-Thomson emerged as number one supplier from number two position in 1988, but, poor industrial sales through Philips' North American Signetics subsidiary caused it to slip from first to fourth place behind TI and Motorola. The split-up of ASEA Brown Boveri to ABB-IXYS and ABB-HAFO paved the way for Telefunken as a newcomer in the top ten rankings.

Japanese and North American vendors gained market share from European companies as European vendors' market share declined from 41.7 percent in 1988 to 33.9 percent of the total market in 1989. Of the top ten vendors: four were European, five were North American and one was Japanese.

Consumer

Whereas the consumer semiconductor segment grew at an overall 20.8 percent rate, Japanese vendors grew by 89.8 percent.

The rapid level of investment by Japanese consumer electronics manufacturers in European production is the main reason for the strong performance of the Japanese vendors, many of whom are forward-integrated in consumer electronics production in Europe (see ESAM Volume 1, section 8.3).

However, Philips continues to retain leadership in this segment, although we estimate that their share of the total consumer semiconductor market fell from 28.6 percent in 1988 to 27.7 percent in 1989. Other Western vendors—National Semiconductor and Plessey—were displaced from the top 10 league altogether, being replaced by Toshiba and Mitsubishi.

Of the top ten vendors: four were European, three Japanese and three North American. (See Table 5).

Military

The slow-down in the military segment to a meagre 1.2 percent growth in 1989 over 1988, is directly attributed to *Perestroika* and the relaxation in East–West military tension. Key changes to military semiconductor vendors' rankings (Table 6) are the descent of Philips and Siemens from the top ten. Motorola maintained its number one position and Plessey displaced SGS-Thomson from number two vendor position. Newcomers in the league are Thomson Composants Militaires et Spatiaux (TMS) and Intel. Overall, North American vendors supplied 61.8 percent of this segment and the remainder went to European vendors.

No Japanese or ROW companies showed revenues in this segment. Of the top ten vendors: five were European and five were North American.

Transportation

Transportation semiconductor consumption (see Table 7) grew 17.5 percent to $657 million making it 6.7 percent of the total market. European companies' revenues showed the strongest growth of 27.5 percent followed by Japanese companies with 25.9 percent and North American companies with 4.6 percent.

We attribute this strong overall European performance to the unique procurement policies in the automotive industry; car manufacturing was one of the first industries to make the transition toward requiring zero inventory just-in-time delivery. This has placed considerable logistic strains on remote vendors to this segment. In addition, very high degrees of vendor-customer participation favor local vendors with local manufacturing.

Equipment growth was strongest in areas influenced by higher safety and environmental awareness: ABS (antilock braking systems), airbags, fuel emission control units and engine management systems. Motorola was displaced in this segment by Siemens, SGS-Thomson and NEC to take fourth position. Siemens enjoyed a strong growth in 1989 as a result of increased consumption from captive sales to their own Siemens Automotive Group as well as to their local West German customers. European vendors now hold the majority of the transportation semiconductor market share (45.8 percent), with North American vendors supplying 37.9 percent and Japanese vendors 15.2 percent.

There were no new suppliers in the top ten European semiconductor league. Of the top ten vendors: four were European, five were North American and one was Japanese.

CONCLUSIONS

Inspection of how individual companies performed in each application segment gives valuable insight into how they are adjusting their market strategy. Although Philips declined 5.3 percent in terms of overall sales, its consumer semiconductor sales have remained strong (albeit underperforming the consumer segments 20.8 percent average), and this is consistent with Philips' overall strategy of concentrating on the consumer electronics markets. Philips' greatest declines are believed to have occurred in areas which are not related to this central strategy. One prime example of this is believed to be Signetics' poor performance in the North American industrial market.

In contrast, Siemens made its advances almost exclusively in data processing with strong DRAM sales to computer companies. Sales in the transportation segment also proved successful as captive sales to Siemens Automotive Group increased.

With weaker links between SGS-Thomson and the systems divisions of it parents—STET and Thomson—compared to those in Philips or Siemens, it is not surprising to see that SGS-Thomson's major gains are therefore less confined to a single segment: with growth spread fairly evenly between data processing, communications and transportation.

No one company leads in all application segments. Each tends to have focused on one or two application markets. Similar tendencies to specialize on individual applications are evident by origin of vendor (see Table 8). Overall, European companies took more than half the market (52.3 percent) for consumer semiconductors last year; 15.7 percent higher than their average market share (36.5 percent) in Europe. Strong European performance was also evident in transportation (45.8 percent market share).

Continued strong performance by European and Japanese vendors in data processing has forced North American market shares in this segment down to a point where their performance in this segment (39.1 percent) is slightly lower than their overall market share (41.3 percent). However, North American vendors have continued to make increasing inroads into industrial applications at the expense of European vendors.

North American companies (Table 8) hold the largest market share in all segments except transportation and consumer segments, although Japanese vendors are swiftly challenging positions here.

Jonathan Drazin
Mike Williams

TABLE 2
Data Processing Category

1988 Rank	1989 Rank	Change in Rank	Ranked Companies	1988 Sales ($M)	1989 Sales ($M)	1988-89 Annual Growth (Percent)	1989 Cum. Sum ($M)	1989 Market Shares (Percent)	1989 Cum. Sum (Percent)
5	1	4	Siemens	$172	$497	189.0	$497	16.3	16.3
3	2	1	Intel	270	302	11.9	799	9.9	26.2
2	3	(1)	Texas Instruments	275	259	(5.8)	1,058	8.5	34.7
1	4	(3)	Toshiba	278	208	(25.2)	1,266	6.8	41.6
4	5	(1)	NEC	175	193	10.3	1,459	6.3	47.9
6	6	0	Motorola	163	178	9.2	1,637	5.8	53.8
10	7	3	Samsung	112	155	38.4	1,792	5.1	58.9
9	8	1	Hitachi	116	143	23.3	1,935	4.7	63.5
12	9	3	SGS-Thomson	96	135	40.6	2,070	4.4	68.0
11	10	1	AMD	111	118	6.3	2,188	3.9	71.9
			Application Splits						
			Total Europe	507	797	57.2		26.2	
			Total North American	1,172	1,192	1.7		39.1	
			Total Japanese	733	878	19.8		28.8	
			Total Rest Of World	128	178	39.1		5.8	
			Total All Companies	$2,540	$3,045	19.9		100.0	

Columns may not add to totals shown because of rounding
Source: Dataquest (September 1990)

TABLE 3
Communications Category

1988 Rank	1989 Rank	Change in Rank	Ranked Companies	1988 Sales ($M)	1989 Sales ($M)	1988-89 Annual Growth (Percent)	1989 Cum. Sum ($M)	1989 Market Shares (Percent)	1989 Cum. Sum (Percent)
1	1	0	Philips	$195	$193	(1.0)	$193	9.8	9.8
2	2	0	SGS-Thomson	158	188	19.0	381	9.6	19.4
3	3	0	Motorola	154	171	11.0	552	8.7	28.1
4	4	0	Texas Instruments	144	130	(9.7)	682	6.6	34.7
5	5	0	Intel	99	106	7.1	788	5.4	40.1
8	6	2	National Semiconductor	72	103	43.1	891	5.2	45.3
9	7	2	Toshiba	71	85	19.7	976	4.3	49.6
6	8	(2)	Siemens	97	84	(13.4)	1,060	4.3	53.9
7	9	(2)	AMD	77	80	3.9	1,140	4.1	58.0
11	10	1	ITT	57	70	22.8	1,210	3.6	61.5
			Application Splits						
			Total Europe	700	718	2.6		36.5	
			Total North American	788	919	16.6		46.7	
			Total Japanese	230	304	32.2		15.5	
			Total Rest Of World	18	26	44.4		1.3	
			Total All Companies	$1,736	$1,967	13.3		100.0	

Columns may not add to totals shown because of rounding
Source: Dataquest (September 1990)

TABLE 4
Industrial Category

1988 Rank	1989 Rank	Change in Rank	Ranked Companies	1988 Sales ($M)	1989 Sales ($M)	1988-89 Annual Growth (Percent)	1989 Cum. Sum ($M)	1989 Market Shares (Percent)	1989 Cum. Sum (Percent)
2	1	1	SGS-Thomson	$149	$165	10.7	$165	9.5	9.5
4	2	2	Motorola	110	138	25.5	303	8.0	17.5
3	3	0	Texas Instruments	122	123	0.8	426	7.1	24.6
1	4	(3)	Philips	182	116	(36.3)	542	6.7	31.3
8	5	3	National Semiconductor	70	95	35.7	637	5.5	36.8
5	6	(1)	Siemens	106	94	(11.3)	731	5.4	42.2
7	7	0	Intel	72	74	2.8	805	4.3	46.5
10	8	2	Hitachi	62	67	8.1	872	3.9	50.4
11	9	2	Telefunken	60	60	0.0	932	3.5	53.8
9	10	(1)	Harris	65	55	(15.4)	987	3.2	57.0
			Application Splits						
			Total Europe	677	587	(13.3)		33.9	
			Total North American	739	871	17.9		50.3	
			Total Japanese	208	263	26.4		15.2	
			Total Rest Of World	1	10	900.0		0.6	
			Total All Companies	$1,625	$1,731	6.5		100.0	

Columns may not add to totals shown because of rounding
Source: Dataquest (September 1990)

Table 5
Consumer Category

1988 Rank	1989 Rank	Change in Rank	Ranked Companies	1988 Sales ($M)	1989 Sales ($M)	1988-89 Annual Growth (Percent)	1989 Cum. Sum ($M)	1989 Market Shares (Percent)	1989 Cum. Sum (Percent)
1	1	0	Philips	$437	$510	16.7	$510	27.7	27.7
3	2	1	Siemens	118	150	27.1	660	8.1	35.8
2	3	(1)	SGS-Thomson	137	143	4.4	803	7.8	43.5
4	4	0	ITT	108	103	(4.6)	906	5.6	49.1
5	5	0	Telefunken	86	84	(2.3)	990	4.6	53.7
16	6	10	Toshiba	9	75	733.3	1,065	4.1	57.8
9	7	2	NEC	27	73	170.4	1,138	4.0	61.7
7	8	(1)	Texas Instruments	41	58	41.5	1,196	3.1	64.9
6	9	(3)	Motorola	49	46	(6.1)	1,242	2.5	67.4
32	10	22	Mitsubishi	3	46	1,433.3	1,288	2.5	69.8
			Application Splits						
			Total Europe	871	964	10.7		52.3	
			Total North American	441	485	10.0		26.3	
			Total Japanese	196	372	89.8		20.2	
			Total Rest Of World	18	23	27.8		1.2	
			Total All Companies	$1,526	$1,844	20.8		100.0	

Columns may not add to totals shown because of rounding
Source: Dataquest (September 1990)

TABLE 6
Military Category

1988 Rank	1989 Rank	Change in Rank	Ranked Companies	1988 Sales ($M)	1989 Sales ($M)	1988-89 Annual Growth (Percent)	1989 Cum. Sum ($M)	1989 Market Shares (Percent)	1989 Cum. Sum (Percent)
1	1	0	Motorola	$57	$59	3.5	$59	11.5	11.5
3	2	1	Plessey	45	50	11.1	109	9.8	21.3
2	3	(1)	SGS-Thomson	48	45	(6.3)	154	8.8	30.1
6	4	2	National Semiconductor	40	42	5.0	196	8.2	38.4
5	5	0	Texas Instruments	40	39	(2.5)	235	7.6	46.0
NA	6	NA	TMS	NA	38	NA	273	7.4	53.4
7	7	0	Analog	32	32	0.0	305	6.3	59.7
8	8	0	AMD	32	26	(18.8)	331	5.1	64.8
9	9	0	Matra MHS	19	26	36.8	357	5.1	69.9
14	10	4	Intel	12	16	33.3	373	3.1	73.0
			Application Splits						
			Total Europe	205	195	(4.9)		38.2	
			Total North American	286	316	10.5		61.8	
			Total Japanese	14	0	(100.0)		0.0	
			Total Rest Of World	0	0	0.0		0.0	
			Total All Companies	$505	$511	1.2		100.0	

NA = Not Applicable
Columns may not add to totals shown because of rounding
Source: Dataquest (September 1990)

TABLE 7
Transportation Category

1988 Rank	1989 Rank	Change in Rank	Ranked Companies	1988 Sales ($M)	1989 Sales ($M)	1988-89 Annual Growth (Percent)	1989 Cum. Sum ($M)	1989 Market Shares (Percent)	1989 Cum. Sum (Percent)
4	1	3	Siemens	$60	$112	86.7	$112	17.0	17.0
2	2	0	SGS-Thomson	64	75	17.2	187	11.4	28.5
3	3	0	NEC	64	73	14.1	260	11.1	39.6
1	4	(3)	Motorola	83	66	(20.5)	326	10.0	49.6
5	5	0	ITT	47	55	17.0	381	8.4	58.0
7	6	1	Texas Instruments	25	39	56.0	420	5.9	63.9
6	7	(1)	Philips	37	29	(21.6)	449	4.4	68.3
8	8	0	Telefunken	25	28	12.0	477	4.3	72.6
9	9	0	National Semiconductor	21	19	(9.5)	496	2.9	75.5
10	10	0	Harris	18	16	(11.1)	512	2.4	77.9
			Application Splits						
			Total Europe	236	301	27.5		45.8	
			Total North American	238	249	4.6		37.9	
			Total Japanese	85	107	25.9		16.3	
			Total Rest Of World	0	0	0.0		0.0	
			Total All Companies	$559	$657	17.5		100.0	

Columns may not add to totals shown because of rounding
Source: Dataquest (September 1990)

TABLE 8
Semiconductor Application Market Share Analysis by Region—1988 Sales
(Millions of US Dollars)

	Total	EDP	Comms.	Ind.	Cons.	Mil.	Trans.
European Companies	$3,196	$507	$700	$677	$871	$205	$236
North American Companies	3,664	1,172	788	739	441	286	238
Japanese Companies	1,466	733	230	208	196	14	85
Rest of World Companies	165	128	18	1	18	NA	NA
Total All Companies	$8,491	$2,540	$1,736	$1,625	$1,526	$505	$559

Semiconductor Application Market Share Analysis by Region—1988 Sales
(Percentages)

	Total	EDP	Comms.	Ind.	Cons.	Mil.	Trans.
European Companies	37.64%	19.96%	40.32%	41.66%	57.08%	40.59%	42.22%
North American Companies	43.15	46.14	45.39	45.48	28.90	56.63	42.58
Japanese Companies	17.27	28.86	13.25	12.80	12.84	2.77	15.21
Rest of World Companies	1.94	5.04	1.04	0.06	1.18	0.00	0.00
Total All Companies	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

(Continued)

TABLE 8 (Continued)
Semiconductor Application Market Share Analysis by Region—1989 Sales
(Millions of US Dollars)

	Total	EDP	Comms.	Ind.	Cons.	Mil.	Trans.
European Companies	$3,562	$797	$718	$587	$964	$195	$301
North American Companies	4,032	1,192	919	871	485	316	249
Japanese Companies	1,924	878	304	263	372	NA	107
Rest of World Companies	237	178	26	10	23	NA	NA
Total All Companies	$9,755	$3,045	$1,967	$1,731	$1,844	$511	$657

Semiconductor Application Market Share Analysis by Region—1989 Sales
(Percentages)

	Total	EDP	Comms.	Ind.	Cons.	Mil.	Trans.
European Companies	36.51%	26.17%	36.50%	33.91%	52.28%	38.16%	45.81%
North American Companies	41.33	39.15	46.72	50.32	26.30	61.84	37.90
Japanese Companies	19.72	28.83	15.46	15.19	20.17	0.00	16.29
Rest of World Companies	2.43	5.85	1.32	0.58	1.25	0.00	0.00
Total All Companies	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

NA = Not Applicable
Columns may not add to totals shown because of rounding
Source: Dataquest (September 1990)

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Research *Newsletter*

EUROPE—REDRAWING THE COMPETITIVE BORDERS
EUROPEAN SEMICONDUCTOR INDUSTRY CONFERENCE

SUMMARY

Dataquest's ninth annual European Semiconductor Industry Conference was held in Geneva, Switzerland, from June 6 to 8. The theme of the conference, "Europe—Redrawing the Competitive Borders," focused on how economic, commercial, technological and political changes were affecting the semiconductor industry, its users and suppliers.

Along with discussions on the current situation in the European semiconductor scene and forecasts for the future, with reference to Eastern Europe, and developments in memory chips, the attendees had a choice of two concurrent panel sessions:

- "Made in Europe"—What does it mean?
- Has the ASIC market matured?

SPEAKER HIGHLIGHTS

This newsletter highlights the information presented at the conference by the invited speakers in the following extracts.

JESSI and the European Semiconductor Industry

Raimondo Paletto
President, JESSI Board

Whereas Sematech is aimed only at manufacturing science, JESSI covers the total "food chain" of electronics from research to applications. JESSI's budget of $4 billion over eight years is as much as all the other Eureka projects combined. The aim in process technology is to go from 0.8 µm to the 0.3 µm needed to make a 64-Mbit DRAM. In April an agreement was reached on industrial property rights which "ensures the success of JESSI." Spurred on by the IBM/Siemens alliance, all JESSI targets for memory chip development have been accelerated by one year (1994 for the 64-Mbit DRAM). These chips will give European companies access to a $70 billion plus market by 1995.

Mega-Technologies for the '90s

Dr. Horst Fischer
Vice President and Chief Operating Officer
Siemens Semiconductor Group

The world market share of the European electronics industry has been stagnant for ten years. The three "legs" on which the industry stands are proprietary architectures, efficient software and innovative chips. Europe can supply only half its chip consumption. Siemens is producing 4 million 1-Mbit DRAMs a month and is ramping the 4-Mbit. It can supply 20 percent of the European requirement for 1-Mbit and 5 percent of the requirement for 4-Mbit. First silicon of the 16-Mbit was developed in April and its production ramp will start in the second half of 1992. The 64-Mbit being developed with IBM is expected in 1994. The continual improvements in process technology are feeding through into Siemens' logic products.

Economic Overview

Dr. Yuri Levine
Senior Research Fellow, Institute of World Economy and International Relations, USSR

The drive towards market-oriented economies and political pluralism is both underway and irreversible in the Eastern bloc. By the end of 1990 legislation is expected in Russia and Eastern

Europe to allow the purchase of real estate. A stock market has opened in Budapest. Legislation to set up a stock market has been adopted in Poland. Similar legislation is being enacted in Czechoslovakia and is being prepared in Russia. The transfer to market prices has happened in Hungary where government subsidies are nil, and in Poland where prices are rising steeply. Market prices are being introduced in Czechoslovakia where subsidies are diminishing, and in East Germany where prices are soaring while some subsidies remain. In Russia, large price subsidies are continuing but reform is expected. In the Eastern bloc as a whole, foreign capital does not play any substantial role as yet.

Technology for the Next Century

Manny Fernandez
President, Dataquest Incorporated

DRAM generations are coming closer together which will entail a revision of Moore's Law. Driving that will be the PC for which the market will more than double over the next four years to 239 million units in 1994 from the 1989 level of 94 million units. There are two possible pitfalls to this growth:

- Software, which is lagging behind the introduction of the hardware to such an extent that a whole silicon cycle could be wasted with new machines merely offering the capability to run old software faster.
- Marketing, which has to learn how to address a 240 million user market.

Pen and Paper—The New Revolution

Dr. Hermann Hauser
Chairman, Active Book Company

The 1990s will be the age of the book computer—the fourth wave in computing after mainframes, minicomputers and PCs. Dr. Hauser has invested $1 million of his own money in producing a notebook computer which is accessed via a stylus using handwriting rather than a keyboard. The machine simulates the working of a book with chapters, pages and an index, adding to it voice and animation. It will open up computing to computer illiterates. The first models are expected to be on the market in the first quarter of 1991 and will cost around £1,000.

East European Perspective

Mitja I. Tavčar
Vice President, Iskra Commerce

Iskra is a group of Yugoslavian manufacturing companies with combined sales of 1.4 billion ECU and exports of 350 million ECU in telecommunications, automation, electronics and components including semiconductors. Iskra's exports to COMECON have grown from 50 million ECU to 110 million ECU in the last 15 years. A huge but unquantifiable market for electrical and electronic products exists in Eastern Europe. Among the problems in opening it up are: CoCom regulations, poor distribution, the low profile of companies, the lack of hard currency, and the chaos caused by sudden decentralization after years of central planning. One way of trading is to swap manufactured Western goods for Eastern bloc components including semiconductors.

Trends in Consumer Electronics

Dr. Jean Caillot
Senior Vice President
Thomson Consumer Electronics

Semiconductors and consumer electronics depend on each other for survival. The Japanese built their semiconductor industry on the back of their consumer electronics industry; so must Europe. While the United States has mostly withdrawn from consumer electronics, Europe has two companies—Philips and Thomson—in the top six worldwide. A constraint to the success of European companies is the fact that the second largest consumer market—the Japanese market—is effectively closed to outsiders; for example, 77 percent of the big Japanese stores with 45 percent of the sales are controlled by the top nine electronics manufacturers (other stores are pressured into not taking foreign goods).

Multimedia—Converging Technology

Ray Burgess
Business Segment Director
Motorola European Semiconductor Group

Multimedia is the convergence of one or more of the characteristics of consumer electronics (still pictures, audio, motion video) with one or more of the characteristics of the computer (text, graphics, interactivity). In education it can provide interactive books and language learning. In entertainment it makes possible video games and simulated experience like armchair holidays. For training it can provide "How to ... " manuals, the "expert-in-the-corner," and situational simulation. For presentations it can help in point-of-sale promotions, conference addresses and visualization. Software will drive the market, which should reach $16.4 billion by 1994.

New Trends in Semiconductor Memories

Dr. Tsugio Makimoto
Director and General Manager, Semiconductor Design and Development Centre
Hitachi

The 1990s are the submicron decade when the world moves from the Mega to the Giga—from the 0.8 µm 1-Mbit DRAM in 1990 to the 0.1 µm 1-Gbit DRAM in the year 2000. MOS remains the technology driver. MOS memory is a quarter of the total semiconductor market and will increase to a third by 2000. On average, each person on the planet consumes 160 Kbits of MOS memory a year; in 2000 that will rise to 8 Mbits. Logic and memory are merging to the extent we will have to talk about "memory and logic" chips. Flash technology provides an approach to the ultimate memory chip, a high-density, cost-effective nonvolatile RAM. Gigabit technology should make possible portable translation machines—a powerful aid to world communication.

Semiconductors: Rationale for a Community Strategy

Gérald Santucci
Principal Administrator
European Commission—DG XIII

Is it justified to provide special support for the semiconductor industry? The semiconductor industry is becoming a crucial element in the world economy—its small size must not hide its broader significance—and its inescapable importance to the European economy means that EC policies must be adopted accordingly. Concern centers on the increasing domination of the market by Japanese producers. European producers have "at best a modest position" but EC efforts to maintain a European semiconductor industry will determine whether the EEC stays in the rest of the electronics industry. That is because it is unlikely that systems design and software will be sufficient to stay in the electronics industry because of the increasing integration of intelligence into the chips themselves. Although managed trade in semiconductors would lead to ossified trade, there is a case for forming a multilateral consultative forum on semiconductors, maybe with the OECD.

PANEL SESSION 1: "Made in Europe"—What does it mean?

Michael F. Phillips
Director, European Corporate Affairs
Motorola Inc.

The November 1989 report by the US National Advisory Committee on Semiconductors stated that semiconductors were a strategic industry for the United States as the foundation of the information age. So it is for Europe. A product is usually said to have the nationality of where it is made, but a chip can be diffused on one continent, assembled on another and put into equipment on a third. Where a product is made in two or more countries, it takes on the nationality of the country in which the last substantial process which is economically justified was performed. With chips that process is the diffusion stage, which is accepted by the EC as the "last substantial transformation."

Bruno Lamborghini
Vice President
Corporate Strategic Analysis and Planning
Olivetti Group

To be competitive the European electronics industry needs to get supplies of semiconductors at the right time and the right place. Europe has become too dependent on the Japanese for DRAMs and on the Americans for microprocessors—the most critical devices for computer manufacturers. Other areas like TV—particularly HDTV—printers and workstations need increasing quantities of DRAM. Olivetti has supported JESSI and antidumping actions but is concerned at the artificial price limitation measures, especially at the delicate stage of the introduction of a new device such as the 4-Mbit DRAM. Tariffs should not be used as a protectionist measure. The competitiveness of the European IC industry should come through the positive action of the manufacturers and not by creating an artificial market. We need alternative high-quality sources in a competitive environment.

Albert Maringer
Director Strategic Planning
Siemens AG

The undertaking extracted by the EC from the Japanese manufacturers on the pricing of DRAM was fair. The case took too long to settle, but it ended in a voluntary agreement. A monopoly in the supply situation is not and never will be in the interest of the European user industry. The reference price mechanism is in place for five years for existing and future products.

Sadru Nanji
Manager, Components Products Centre,
Purchasing Division, ICL

We need an electronics industry in Europe that is competitive against the world. Any action taken by the EC that makes us uncompetitive in the market is very serious. The 14 percent tariff is punitive and damaging—the United States has zero duty. But the Europeans have matured over the last two years and have tried to communicate and make all our positions clear.

Question from the Floor: Is the European semiconductor industry able to supply the 4-Mbit DRAM?

Maringer: it is too far-reaching to say we are leading the Far East—what we're trying to achieve is an open market. If there is no European supply then we are completely in the hands of others. If we say we're going to supply everything, that's nonsense.

Question: We are running into disaster. In a year or two there will only be Japanese suppliers of flat screens. It is almost too late.

Santucci: We have established a forum where representatives of the suppliers and users can meet to discuss common issues. Since 1988 tremendous work has been done in narrowing the gap between users and suppliers, which has to be the first thing. That's what happened with the DRAM. But this is wasted if the industry lacks the will—both from the suppliers and users.

Enrico Villa
Vice President of Government Affairs
SGS-Thomson Microelectronics

There are misconceptions about the ability of semiconductor vendors to become competitive. We should be competitive with the best in the world but it is not easy. Take the cost of money in Europe compared to Japan, and take the cost of R&D. But if companies leave commodity memory manufacturing, they have no chance of becoming competitive.

Question: How will the EC deal with possible oversupply by newly created fabs in Europe?

Santucci: There are two basic rules in the Community:

- There must be neutrality in the treatment of domestic and inward investment.
- There must not be a sectoral approach to investment.

Because of 1992, the European market has become attractive. We're not going to encourage or discourage inward investment. We can trust those deciding to invest Europe that they know what they're doing.

Maringer: The hype about 1992 forces inward investment on people who think there's a big market coming. But in electronics, 1992 is already here. Nothing will happen to change things between now and 1992. The market size won't change; there will still be the same number of people spending the same amount of money.

Question: How is the 14 percent tariff helping the indigenous semiconductor industry?

Maringer: The tariff has little effect on the final price of equipment (for instance, 0.6 percent on a TV, 1.7 percent on a PC) and there are many expectations from tariffs altogether. Tariffs help to manage the trade in semiconductors to stop Europe becoming dependent on imports.

PANEL SESSION 2: Has the ASIC market matured?

Jean-Pierre Liebaut
President and Chief Executive Officer
Mietec Alcatel

Maturity in the digital ASIC market, if not already achieved, is not far off. However the market for mixed-mode ASIC has not reached maturity. According to Dataquest the mixed-mode ASIC market will grow from $361 million in 1988 to $1,603 million in 1993.

Dieter Mezger
President, Europe
VLSI Technology Inc.

MOS ASIC has grown in line with the overall semiconductor market since 1985. MOS full-custom has been a static market, but MOS semicustom has increased its share of the overall logic TAM from 7.2 percent in 1985 to 26.5 percent in 1989. Traditional ASIC products may be addressing mature markets, but ASIC technology for systems integration will be increasingly needed.

Jörgen Hjert
Manager Custom Circuit Design Centre
Ericsson Telecom AB

The ASIC market has not matured. Complexity will increase by a factor of 5 or 10 compared with today's chips, but the CAE tools are not powerful enough to cope with the available process technology. It is said that CAE tools a thousand times more effective are needed. Programmable logic will be used mainly for fast prototyping.

John C. East
President and Chief Executive Officer
Actel Corporation

This year there will be more design starts for field programmable gate arrays (FPGA) than there will be for conventional gate arrays. FPGA revenue will grow at a compound annual rate of 50 percent through 1994. By contrast bipolar gate array design starts have been, and are expected to stay, static through 1994, and MOS gate array design starts, which increased from around 8,000 worldwide in 1987 to nearly 10,000 in 1989, may increase to 12,000 in 1992 but thereafter are expected to be a static market.

Hisashi Izumi
Managing Director
Toshiba Electronics (UK) Ltd

A limited number of major suppliers with stable market shares dominate the market, with a handful of small companies supplying niches. The growth rate of the market is moderate, market penetration is high, there is little product differentiation and slow product evolution. The US market is more mature than the market in the UK and Japan. Europe has the potential to grow faster than the other two main trading blocks, becoming the largest semiconductor market in the world.

End of Panel Sessions

Global Procurement Strategies: A European Perspective

David Miller
Manager, Supply Management Group
Bull HN Information Systems Ltd

The 1990s are not like the 1960s—Europe is now becoming a major player in the computer and semiconductor industries. It has three companies in the top 12 computer firms worldwide, and two of the three fastest-growing semiconductor companies in the 1988 to 1990 timeframe. Bull intends to be in the top five by 1995. Having no semiconductor capability, Bull has to rely on semiconductor vendors and was disappointed last year when it was let down in memory supplies by vendors with whom Bull thought it had established close relationships. Europe has to establish a true pool of technology like the United States and Japan.

Europe's Silicon Supply—In Shape for the '90s

Hans-Jürgen Giffhorn
Executive Vice President, Marketing and Sales
Wacker-Chemitronic GmbH

Wacker is third out of the six companies (two German, four Japanese—the Americans are no longer in it) left in the silicon supply business. Profitability is poor. The silicon supply industry is worth $33 billion compared to the $60 billion of the semiconductor industry and the $733 billion worth of the equipment industry. The market is growing at 10 percent a year and the largest growth area is the rest of the world (Korea, Taiwan and Singapore), which is expected to grow at 19 percent per year between 1988 and 1993. Eight inch wafer processing is still rare. IBM is using 8-in. wafers in three locations. One other company is also using 8-in. Three Japanese companies start this autumn and Samsung starts shortly. (Since this presentation, Samsung has moved to using 8-in. wafers.)

Wafer Scale Integration

Peter Cavill
Chief Executive Officer
Anamartic Ltd

A high-volume market for intermediate storage—between semiconductor memory and magnetic media—is developing and Anamartic is shipping wafer product into it. Its current product is a 40-megabyte stack of wafers which sell at $45 per megabyte. Next year should see a 100-megabyte stack selling at $35 per megabyte and 1994 a 250-megabyte stack will offer $20 per megabyte intermediate memory. Applications include relational databases, network file servers, high-end UNIX machines and CAD/CAM workstations. In two years' time the company expects 16-Mbit flash EPROM technology to provide nonvolatile storage; 16-Mbit technology will also allow Anamartic to put 2,000 transputers on a wafer providing 25,000 mips (if the yield is 50 percent) at a cost of $3,000, or 12 cents per mip.

Time to Redraw Europe's Semiconductor Borders

Philippe Geyres
Corporate Vice President, Strategic Planning
SGS-Thomson Microelectronics

Europe has woken up to the fact that it doesn't have to lose. It has 4 electronics companies in the world top 12, and 6 in the top 20. Europe is moving towards self-sufficiency in semiconductors and can internally source 80 percent of its needs. Before year-end it will have developed 16-Mbit DRAMs and EPROMs. JESSI will give Europe products which command access to a $70 billion market in 1996, and an equipment market 15 times bigger.

The Expertise in Integration

Michel Desbard
Managing Director
Matra MHS

Mid-size vendors can do a better job than giant companies when they have excellence in particular specialities. Matra MHS is making microprocessors, static RAMs and ASICs all on the same process, from the same wafer fab with the same methodology and the same people. No other manufacturer can say that. Of Matra's wafer starts 50 percent are for 1 µm processing compared with the 19 percent norm for Europe and the 9 percent norm for the USA. Taking European vendors only, Matra MHS is fourth in MOS ICs, third in gate arrays, fourth in micros, third in memories and second in SRAM.

Semiconductor Computing in Europe

Bernard Giroud
Vice President, Intel Corporation
President, Intel Europe

The decline of Europe is over. Although Europe currently has a $20 billion trade deficit in semiconductors, telecommunications and information technology, it is now looking for recognition as innovatory with strong business leaders and companies which compare with the leading US and Japanese companies. Europe needs access to the driving technologies in a secure fashion. A key one is semiconductor processing which JESSI is funding. Europe has not been strong in the computer business but its growth in PCs is such that the European market could outstrip the US market by the mid-1990s. The "new computer industry" is a very open, competitive and international business in which the key to success is continually identifying bottlenecks that impede the flow of technology from the technology engine (PC, workstation, etc.) to the end user, removing them, and going on to the next bottleneck.

Winning in the '90s

Jim Hubbard
Senior Vice President, Semiconductor Group
General Manager, Texas Instruments Europe

The electronic equipment market will be a $2 trillion market by the year 2000—close to being the world's largest market. At that time the semiconductor market will be worth $200 billion, but "it's not for the faint-hearted." The Far East is able to "productize" technology (that is, get new technology to market in the form of products) faster than the United States can. The West has to concentrate on reducing product development cycle times, support customers locally with globally available products ("local globalization"), and bring down the total cost of ownership of its products. This needs leadership which requires "human resources excellence." One way of achieving this is to improve the "communications yield" inside a company, by eliminating such destructive practices as preformed opinions, "rebuttal preoccupation" and unclear use of English.

FOOTNOTE

At the end of the conference, delegates were asked their opinion on holding the 10th annual European Semiconductor Industry Conference in Hungary. Opinion was mixed on this issue and, due to logistic reasons, an Eastern bloc conference in 1991 will not be possible. The conference is likely to be held in Spain or Portugal, but any suggestions you have will be welcome.

Mike Williams

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Research *Newsletter*

ABS IN EUROPE—FEET OFF THE BRAKES

SUMMARY

The antilock braking systems (ABS) equipment market in Europe is estimated this year to be $963 million. Currently 9.5 percent of the 13.8 million cars produced in Europe contain ABS. Dataquest expects a rapid further penetration of this application in Europe over the next five years, as car manufacturers broaden the ranges of models offering this feature. We believe that by the mid-1990s the equipment revenue for ABS systems will have grown to $1,992 million, representing a 15.6 percent compound annual growth rate (CAGR) between 1990 and 1995. In terms of semiconductor consumption, we estimate that ABS production in Europe is driving an $81 million semiconductor market in 1990. This is forecast to more than double within the next five years, reaching $184 million by 1995. Two players, Bosch and ITT-Teves, currently account for 80 percent of ABS semiconductor demand in Europe.

This newsletter explains ABS technology, looks at the semiconductor content of ABS and forecasts its consumption by the European automotive industry.

INTRODUCTION

Antilock braking systems (ABS) are one of the most important safety systems in a car, giving safer braking in all road conditions.

An antilock braking system consists of a hydraulic module and an electronic control unit, which complement the conventional car braking system. ABS continuously monitors wheel speed and automatically releases brake pressure each time sensors detect wheel lock during braking. This gives greater steering control and stability. Effectively, the braking system does what an experienced motorist should do before the car begins to skid.

Lucas developed Girling, a mechanical system, in the 1970s—but the electronic developments of the 1980s have been the most significant and reliable basis for safer braking. Electronic ABS applications in cars first became popularly adopted by car manufacturers in 1986.

The imminent growth of ABS installations in Europe has been pioneered by two German car manufacturers, Mercedes-Benz and BMW, who already offer ABS as standard equipment on their top-range models.

Our discussions with a number of key car manufacturers in Europe lead us to believe that there will be a rapid uptake of ABS in midrange, and to a lesser extent, low-range cars over the next three to five years. The European manufacturers are following the Japanese approach of shifting value into electronic features such as ABS, as opposed to trim and body features such as upholstery and paintwork.

The prospect of legislation to extend ABS's mandatory use from articulated lorries and trailers to certain sizes and types of car is another major factor that will drive the growth of ABS in Europe. Already in the US State of California, legislation exists to enforce the inclusion of ABS into all cars sold from mid-1992. Similar legislation is looming in Europe and, within the next five years, we can expect to see near full penetration of ABS's applications in European car manufacturing.

INSIDE AN ABS

Typically, an antilock braking system has three major types of components: wheel speed sensors, an electronic control unit (ECU) and a hydraulic modulator/impulse ring. These components are attached to the car's conventional braking system, and are shown in Figure 1.

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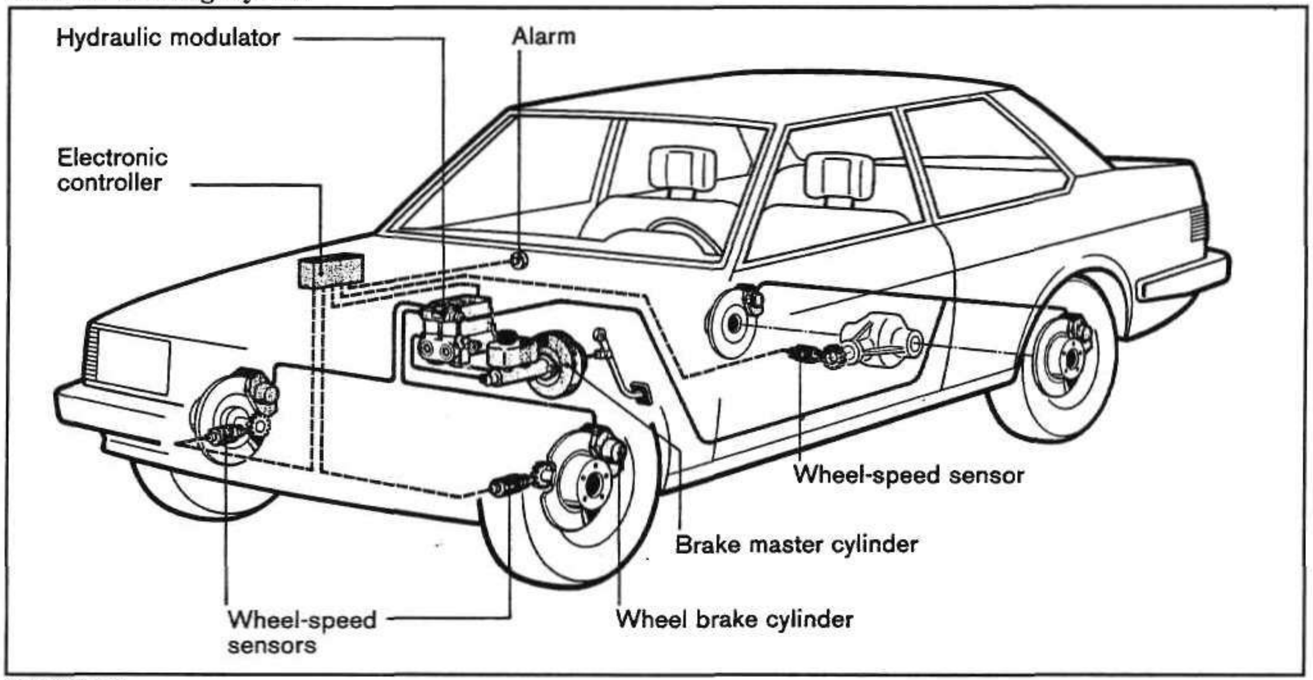
FIGURE 1
Antilock Braking System



Source: Bosch

Wheel Speed Sensors

The wheel speed sensors are attached to the chassis of the car, usually on the front steering knuckle and the rear axle body, while the impulse ring is fitted to the wheels, and in the case of a three-channel system (as illustrated) to the rear wheel axle. The sensors are connected to the ECU and positioned to monitor the rate of revolution for each impulse ring. When the brakes are applied, the controller computes tolerable wheel slip for optimum braking by eliminating wheel lock.

Electronic Control Unit (ECU)

The ECU processes signals and computes the permissible wheel slip for safe braking. It also regulates the pressures in the wheel brake cylinders by means of solenoid valves that convey pressure

TABLE 1
Semiconductor Content of a Typical ABS

Component Function	Technology	Units	Cost/Unit	Total Cost
Voltage Regulator	Bipolar (Analog)	1	$1.00	$1.00
Input Amplifier	Bipolar/BiCMOS	1	$2.00	$2.00
Microcontroller 1	MOS/ASIC	1	$5.00	$5.00
Microcontroller 2	MOS/ASIC	1	$5.00	$5.00
Valve Drivers 1-4	Bipolar/MOSFET	4	$0.50	$2.00
Valve Drivers 5-8	Bipolar/MOSFET	4	$0.50	$2.00
System Fault Diagnostics	MOS ASIC	1	$3.00	$3.00
Memory	EEPROM	1	$1.00	$1.00
Solenoid Valve Driver	Bipolar Power Darlington	3	$1.00	$3.00
Total Semiconductor Content:		17		$24.00

Source: Dataquest (July 1990)

information to it via an amplifier and A/D converter. Typically, the amplifiers and A/D converters reside on one bipolar or BiCMOS IC. The control outputs from the ECU to the hydraulic modulator are amplified by either discrete Darlington pairs or by power MOSFETs.

Hydraulic Modulator

The hydraulic modulator is the electromechanical interface to the braking system and is fitted to the car master brake cylinder. This unit consists of solenoid valves that are activated by the ECU.

Semiconductor Content

Table 1 shows the semiconductor content for a typical ABS system.

THE ABS PLAYERS

Table 2 lists the main ABS manufacturers in Europe by activity and location. Altogether, we estimate that these companies satisfy the bulk of ABS demand from car manufacturers in Europe, with imports of US and Japanese systems accounting for less than 5 percent of the total market.

Robert Bosch is the leading supplier of ABS systems both in Europe and worldwide. Bosch has manufacturing facilities in Anderson, South Carolina, USA and has a joint-venture company with Nippon-Denso developing ABS in Japan for cars and motorcycles. In Europe, ITT-Teves (West Germany), which also has a plant in Asheville, North Carolina, USA, and Lucas (UK) are also key ABS suppliers to the automotive industry.

One of the key issues facing semiconductor vendors and car manufacturers is to reduce the total cost of ABS by driving down the cost of the semiconductors they contain. Conceivably, this will happen through economies of scale as ABS continues to proliferate. The most popular type of ABS has been the ABS-2S supplied by Bosch which originally incorporated an ASIC chip but, for safety reasons, is now replaced by two microcontrollers. The second microcontroller is employed for standby purposes and acts as the diagnostic system monitor in case of system failure.

To gain an understanding of how ABS will evolve, ABS needs to be considered in conjunction with the other emerging electronic automotive applications. Inevitably, ABS will be integrated into other car systems. However, before integration,

TABLE 2
ABS Manufacturers in Europe by Location and Activity

Company	Location	Country	Status
BBA	Cleckheaton, W. Yorks.	UK	Developing ABS
Bendix France	Drancy	France	Car and truck antilock braking systems
Clayton Dewandre/Wabco Automotive Group	Rugby, Warwicks.	UK	Car antilock braking systems
Delco-Moraine	Gennevilliers Cedex	France	Developing antilock braking system: a new product, ABS-IV (with electronic motor instead of hydraulic unit) for GM
Fatec Fahrizeugtechnik GmbH	Alzenau/Unterfranken	WG	Developing antilock braking system
ITT-Teves	Frankfurt	WG	Car antilock braking systems (ATE ABS Mk IV)
Lucas	Kenfig Hill, Wales	UK	Car and truck antilock braking systems
	Koblenz	WG	Car and truck antilock braking systems
Magneti Marelli	Crescenzago	Italy	Developing antilock braking system (sold to Siemens/Bendix)
Motorola	Frankfurt	WG	Developing antilock braking system
Robert Bosch	Ansbach, Brodswindon	WG	Car antilock braking systems
TRW Messmer GmbH	Radolfzell	WG	Developing antilock braking system

Source: Dataquest (July 1990)

ABS will be connected to other car systems using "multiplexing" (the replacement of the existing wiring harness with a common communications bus). Some manufacturers (BMW and Mercedes) are already involved in multiplexing. The integration of ABS into other systems such as traction control, engine speed control, active suspensions, engine management and drive-by-wire concepts will follow.

At present, much of the semiconductor content in ABS systems consists of standard commercial, not military or high-reliability, parts. Further, there are no mandatory standards currently in place governing the use of semiconductors in automotive applications.

However, in Germany, the VDA (Association of the German Automobile Industry) is making provision for legislation. This draft legislation will mandate rigorous testing of automotive components, and their identification using serial numbers. Currently each car manufacturer has its own procedures for evaluating ABS reliability and quality testing.

Whereas, in most applications, semiconductor vendors are rarely liable for more than replacement of a defective part, the situation for semiconductors that go into ABS is likely to be very different, because the consequences of component failure are potentially catastrophic.

Automotive manufacturers are very wary of competitive espionage. Virtually all forms of car product development and prototyping occurs in highly secretive environments. Semiconductor vendors planning to do business with automotive manufacturers must be prepared to win the confidence of automotive manufacturers through close and exclusive cooperations.

Growing demand for lower-cost ABS has led to the development of hybrid ABS. The key features of hybrid ABS are their compactness and the lower entry-level costs. Hybrid ABS integrate together the controller unit and the hydraulic modulator, reducing system size, weight and cost. The introduction of hybrid ABS is permitting further penetration of ABS from high-end to midrange cars.

SAFETY—HEIGHTENED CONSUMER AWARENESS

A precedent already exists for EC legislation to require that ABS be fitted as standard in passenger cars in the same way that seat belts have become obligatory today. ABS is mandated in heavy-duty vehicles by EC legislation. This specifies for a given truck category what type of ABS equipment is required. ABS in trucks typically involve the use of hybrid systems which have the two major components described earlier. Trailers also have to be fitted with ABS units to meet EC requirements.

The factors driving increased penetration of ABS application in vehicles are largely a consequence of increased consumer awareness of the same safety issues that led to car seat belt regulations in Europe over the past 20 years. In North America, for example, GM and Ford have quietly announced plans to fit ABS as standard on virtually all cars by 1995. Similar plans are echoed in their operations here in Europe, and also by Mercedes and BMW. Car manufacturers in Europe are already beginning to standardize ABS in top-range cars—in preparation for mandatory regulations. Although such legislation is not yet fully defined for brake safety, the EC is currently working on a proposal to effect mandatory measures in this direction.

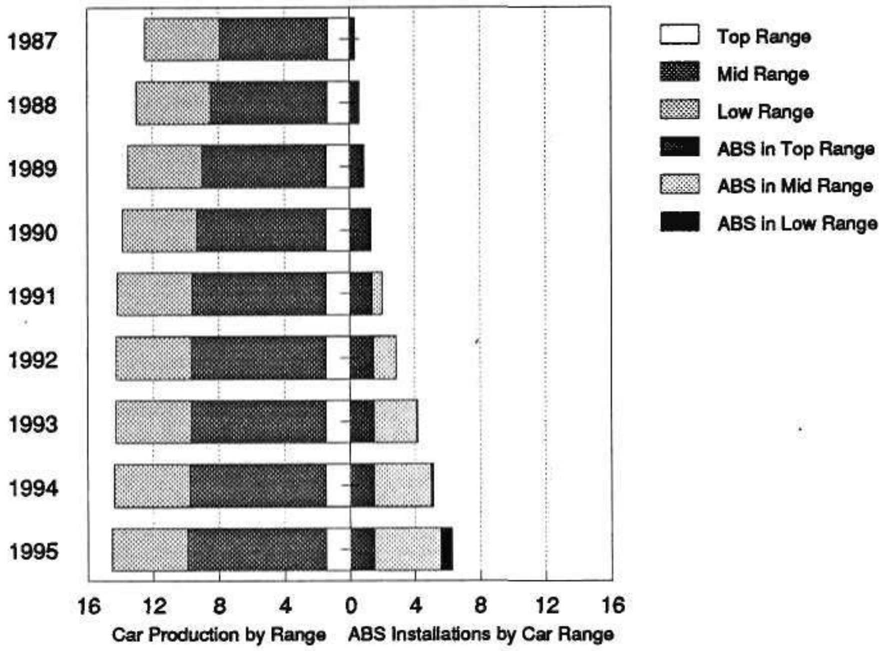
DATAQUEST ANALYSIS

ABS Proliferation

Table 3 shows ABS penetration in cars manufactured in Europe. Europe produces the largest number of cars in the world, estimated to be 13.8 million units in 1990. Of this total 10.5 percent fall in the top-range category, 56.8 percent are midrange and 32.7 percent low-range cars. Figure 2 shows European car production for 1987 to 1995 and ABS installations over that period.

We estimate that ABS has already achieved greater than 80.0 percent penetration into top-range cars. The next major opportunity for growth lies with its penetration of shipments into the midrange segment, which we currently estimate to have a penetration of only 1.2 percent (90,000 units). In anticipation of moves to reduce ABS cost, heightened consumer awareness on safety, and probable EC legislation, we believe that manufacturers will include ABS as standard (as opposed to optional) on most midrange models within the next two to four years. By 1995, ABS will become standard on all midrange cars, with some penetration into low-range cars. This leads us to a forecast of 6.25 million units sold in Europe in 1995 over the 1.32 million ABS units sold today.

FIGURE 2
ABS Production in Cars: History and Forecast (Millions of Units)



Source: Dataquest (July 1990)

By 1995, we expect ABS will have achieved 100.0 percent, 48.0 percent and 15.1 percent penetration into top-, mid- and low-range cars respectively. This will represent a total ABS equipment market of $1.9 billion.

We forecast total ABS semiconductor consumption will rise to $184 million in 1995 from an estimated $59 million in 1989, representing 21.0 percent CAGR.

Conclusions

The key trend for ABS in Europe is clearly its strong growth in sales. Our analysis of the marketplace indicates that Europe is a net exporter of ABS to the United States and Japan. The main suppliers in Europe are Bosch, ITT-Teves and Lucas. Two players account for 80 percent of ABS semiconductor demand in Europe. Of the 1.95 million units produced in Europe during 1989, we estimate that Robert Bosch accounted for 55 percent and ITT-Teves nearly 25 percent. In addition to their European operations, both companies are expanding their production strongly in the United States and Japan.

Recent announcements from GM's Delco-Moraine subsidiary of a low-cost ($250) ABS based on electronic motors, instead of hydraulic units, is further indication that ABS is set for a rapid move into volume mid- to low-range cars.

However, the price erosion expected for complete ABS will not be matched by the same levels of erosion in the prices of semiconductors they contain. Several emerging factors—safety standards, fault tolerance, testability, serial numbering—could maintain costs at present-day levels for some years.

Mike Williams

TABLE 3
Estimated European ABS Production and Semiconductor Consumption Forecast

	1987	1988	1989	1990	1991	1992	1993	1994	1995
Total Car Production									
Top-range cars (units M)	1.34	1.39	1.44	1.46	1.46	1.47	1.48	1.49	1.50
Midrange cars (units M)	6.58	7.10	7.55	7.87	8.17	8.20	8.21	8.31	8.44
Low-range cars (units M)	4.53	4.48	4.51	4.53	4.56	4.56	4.57	4.57	4.58
Total production	12.44	12.96	13.49	13.86	14.20	14.23	14.26	14.38	14.53
Percentage ABS Penetration									
Top-range penetration	24.00%	41.00%	58.00%	84.00%	95.00%	100.00%	100.00%	100.00%	100.00%
Midrange penetration	0.00%	0.09%	0.60%	1.20%	7.30%	17.00%	32.00%	41.80%	48.00%
Low-range penetration	0.00%	0.00%	0.00%	0.00%	0.00%	0.10%	0.80%	3.00%	15.10%
Total ABS penetration	2.6%	4.5%	6.5%	9.5%	14.0%	20.2%	29.0%	35.5%	43.0%
ABS Equipment Production									
ABS consumption (units M)	0.32	0.58	0.88	1.32	1.99	2.87	4.14	5.10	6.25
Dollar revenue ($M)	$283	$493	$680	$963	$1,202	$1,431	$1,690	$1,847	$1,992
% Local consumption	53.9%	55.6%	45.0%	46.2%	54.4%	68.4%	81.9%	84.2%	81.6%
ABS production (units M)	0.60	1.05	1.95	2.85	3.65	4.20	5.05	6.06	7.65
Dollar value ($M)	$525	$887	$1,512	$2,085	$2,208	$2,090	$2,063	$2,193	$2,439
ASP Breakdown									
ASP for top-range cars	$875	$850	$800	$765	$740	$700	$650	$600	$550
ASP for midrange cars	$360	$340	$325	$300	$290	$285	$275	$265	$250
ASP for low-range cars	$340	$315	$270	$250	$245	$235	$230	$225	$220
Unit ASP (US$ ex-factory)	$875	$844	$776	$732	$605	$498	$409	$362	$319
Semiconductor content	$35.0	$32.4	$30.0	$28.5	$26.6	$25.8	$25.4	$24.9	$24.0
Semiconductor consumption ($M)	$21	$34	$59	$81	$97	$108	$128	$151	$184

Source: Dataquest (July 1990)

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Research *Newsletter*

REDRAWING THE APPLICATIONS BORDERS FOR THE 1990s

The following speech was presented on behalf of Dataquest's European Semiconductor Applications Markets (ESAM) service at the European Semiconductor Industry Conference in Geneva, on June 7, 1990.

The full text is reprinted here for the benefit of ESAM clients who could not attend the Conference. Copies of the slides are shown at the end of the newsletter.

Redrawing the Applications Borders
for the 1990s
European Semiconductor Industry Conference
June 7, 1990
Geneva, Switzerland

Jonathan P. V. Drazin
Industry Analyst
European Semiconductor Applications Markets
Service

SLIDE 1: AGENDA

The theme of our Conference this year is about redrawing the competitive borders. These borders may be geographical—or they may be borders that divide markets in other senses, such as the set of borders that divide one application from another. Will the border between the television and the personal computer disappear? ... And will new borders *appear* to form new territories like "personal communications land" which are splinters from the land of the "plain old telephone?"

I do not propose to answer these questions directly. However, I *do* propose to put some of the most promising applications emerging in Europe on the map and leave you, in true *perestroika* fashion, to put the borders where *you* want them to be!

I will look at the new GSM standards, and the pan-European digital cellular telephone. I will then turn to look at smart cards, and some of the many smart card applications now appearing. Finally, I shall end with a little insight on the common threads between the various applications and technology issues we will have covered.

SLIDE 2: SEMICONDUCTOR CONSUMPTION

But first, let us stand back to see how we expect the overall applications borders of Europe to change. This table is based on analysis of semiconductor demand across the top 90 existing electronics segments we cover in Europe. We have condensed these into the six main categories, and shown them for three points in time: 1986, today and four years from now.

The most dramatic transformation has come from electronic data processing applications, and it is easy to forget that back in 1986 its consumption was comparable to telecoms, consumer or industrial. This has been dramatically changed by strong computer hardware growth, OEMs switching to European production, and memory price inflation; so that, today, data processing is 35 percent of the semiconductor market.

The emergence of the personal computer has played a large part in this change over the last few years. Today, we estimate this one application accounts for 35 percent of all data processing semiconductor consumption—and both my colleague, Gregory Nelson and our guest speaker, Dr. Hermann Hauser, will look at the PC in much more detail shortly—and you can safely expect data processing will continue to remain a fertile environment for many new applications in the near future. One example is X.terminals ...

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SLIDE 3: X. TERMINALS

X.terminals are very intelligent graphics and text terminals, with window management. Typically, they are based on a Motorola 68020 microprocessor, a Texas Instruments graphics processor, a LAN controller and somewhere between 2 and 8 Mbytes of DRAM.

X.terminals are being offered by companies like Digital, IBM, NCR, Network Computing Devices (NCD) and many others. Their significance is that they rival traditional workstations in terms of the interface they present to the end user—but at a much lower price.

The key issue here is whether these low-cost terminals could reverse the trend of having computation centralized in one big mainframe to having it distributed across several workstations? Watch this application very closely over the next few years, not just for its own potential, but for the implications it may have on the workstation and, possibly, the PC markets.

Next, I would like to turn to a data processing application which *has* been with us for some years, but has yet to make a major impact on semiconductor demand in Europe.

SLIDE 4: LASER PRINTER

The laser printer is an exciting opportunity for future semiconductor sales in Europe ... for good reason.

First, there is massive pressure to provide faster page rates and computationally intensive features like PostScript—particularly at the low end of the laser printer market. In turn, this is driving semiconductor content up, favoring powerful 32-bit controllers, like those offered by National Semiconductor or Intel.

Second, only 20 percent of Europe's $3 billion laser printer market is satisfied by local production. However, strong competition and having to meet local content rules *may* encourage many Japanese manufacturers, already making dot matrix printers in Europe, to switch to making page printers as well.

This combination of a growing end-user market, growing content and the outlook of increased local production *may* lead to very *rapid* semiconductor growth in this area, from the relatively small $39 million consumed last year. I say "may" because the key factor here is local content and, as I am sure you all know, the European Commission's policies have been hotly contended at GATT. Any deviation from present policies will cause major revisions to future plans, not just for production of laser printers, but for a long list of other segments as well.

Next, I would like to turn to transportation which, if you recall from my first main slide, will match data processing in overall revenue growth over the next four years.

SLIDE 5: TRANSPORTATION

In most transportation applications, the main semiconductor issues are *cost* and *reliability*, because these components must compete with well established rival electromechanical systems.

However, whereas features like ABS, fuel-injection and engine control are, today, fast becoming standard, the cumulative replacement of electromechanical by electronic will have largely ended by the mid-1990s. Five years from now, the opportunities for car manufacturers to differentiate by adding refinements to these applications will have faded. New applications will be needed to fill this differentiation gap—and we expect the mid-1990s to herald the era of in-car navigation, traffic control, noise reduction and, of course, the digital cellular telephone.

For the semiconductor industry the issues will no longer be cost reduction and reliability but, instead, ones where it will be crucial to both *lead* and *follow*. To lead through innovation ... but to follow through close attention to developing standards from European programmes like Eureka, Esprit and Drive, which each contain many transportation projects scheduled to mature in the mid-1990s.

Recalling again my first slide, you see that while transportation takes second place in terms of long-term semiconductor growth, telecommunications will continue to rank second after data processing in absolute revenue.

SLIDE 6: TELECOMMUNICATIONS

The most dramatic trend here is the swing away from the production of public telecoms equipment (like switches, line cards and transmission systems) towards customer premise equipment (such as modems, local area networks, facsimile machines and cellular phones).

In the spirit of our theme, it is the applications borders which are being redrawn. The picture in 1986 was one where the premise telecom and public telecom segments were comparable in size. Today, we estimate that production in Europe of the many customer premise applications outnumber public telecoms equipment by nearly 2 to 1; and, as you see here, this gap will widen further in the coming years.

A clear understanding of emerging applications is crucial for predicting the future of today's mature ones. This is particularly so for telecoms, where all telecoms hardware, from phones to fax machines, seek to satisfy the same basic end-user need: namely, to communicate.

SLIDE 7: THE APPLICATIONS OVERLAP

In the Europe of the 1990s, where the X's are marked on this chart, battles will be fought and borders will be crossed. Some battles mark the end of border disputes started in the 1980s, like the decline of telex to new applications like facsimile.

But other battles are just around the corner. One such example sits in the middle of this map: namely, the inevitable collision between modems and ISDN terminal adaptors. Over the last year, ISDN adaptors have been launched by a large number of companies like IBM, Matra Communication, Siemens, Sagem and Systec. These adaptors mainly allow PC users to connect either to a PBX or to the public network.

However, in the move from modems to ISDNs, we see no stampedes—only a gentle but irreversible plod. Today, these adaptors and other ISDN hardware are confined largely to communication within the national borders of France or West Germany; there is still no common standard for international communication using ISDN.

The standards issues could be resolved in months, but ISDN's implementation across the whole of the public networks in Europe will take years to achieve. For these reasons, there is a lot of life in the modem yet, with double-digit growth in modem semiconductor demand continuing into 1992.

Turning to the top left corner of this diagram, we see other instances of the telecom overlap characteristic—between cordless, cellular and standard telephones.

SLIDE 8: CT2

Last year, we predicted there would be between 4 and 16 million cordless phones in use in Europe by 1995. We still hold to this forecast but, since that time, several major events have occurred ... or not occurred.

First, at the beginning of this year, the United Kingdom's Department of Trade and Industry, the prime mover behind CT2, licensed three consortia to build and operate a new type of network called PCN, the personal communications network. This will be largely based on the European cellular GSM standard, which I shall come to shortly. Second, CT2 products suitable for office use, as opposed to consumer or telepoint use, have yet to reach the market. Third, the CT2 Memorandum of Understanding between the European PTTs was not signed until spring this year, instead of last summer as originally planned.

So, what is the picture for CT2 now? Many argue that the greatest threat to CT2 is the imminence of superior systems like PCN or DECT. However, at a time when most of the PTTs are under threat themselves from cellular and other services, CT2 is widely regarded as the "PTT's friend" because the telepoint services it supports complement their existing wire-based telephone networks.

However, at CT2's present prices, no amount of investment in, or promotion of, telepoint services can guarantee its success. Few are going to pay in excess of $300 for a CT2 handset to do what they can already do from a public payphone ... unless the same handset can satisfy some other need as well. One such is the need for a roaming office telephone which, like the normal office worker, is not permanently tethered to the desk.

We shall have to wait a few more months to see whether CT2 technology can satisfy users in the office. If it does, then there is a far stronger probability that it will satisfy the same users *outside* the office—as subscribers to telepoint services. If it does not, then CT2 will leave a vacuum that will take the emerging DECT, GSM and PCN technologies at least two years to fill.

This leads me to the first of the two applications I want to mention today: namely, the new pan-European digital cellular telephone. First a few words of explanation: in Europe both the new digital cellular phone, and the network infrastructure that will support it, are based on the so-called "GSM" standards.

These networks are scheduled to enter service from the middle of next year. Looking round Europe, we see West Germany as the largest and most eager potential market for GSM. However, we also expect prompt take-up of GSM throughout the rest of Europe, even in countries like the United

Kingdom where analog services are already established.

We recently surveyed several R&D labs to determine what ICs will go into a GSM handset, and to uncover some of the more crucial technology constraints. These are some of our findings.

SLIDE 9: GSM COMPONENT BREAKDOWN

These two bar charts sum up how the components in a GSM handset split out by technology, and by function. The handset in question is a first-generation 2w hand-portable.

The left bar splits out only semiconductor components by their process type. The right bar identifies the main electronic components in the handset. The "others" block consists of a variety of electronic components, both semiconductor and non-semiconductor.

One striking point is that the total electronic content for GSM handsets will be about $190 when they are launched next year, of which 80 percent will be semiconductor.

From the semiconductor viewpoint, the GSM telephone has more in common with a laptop personal computer than it has with a normal telephone. Its large CMOS content includes, among other things, three big DSP ICs: the speech and channel CODECs, and a channel equalizer. *Each* of these has a computational capacity in the range 2 to 5 mips—somewhat *more* than your average laptop!

The other 20 percent of non-semiconductor is taken up mainly by costly SAW and ceramic filters.

Altogether, we expect the first digital cellular phones to have a semiconductor content about three times higher than that of a typical analog handset today.

SLIDE 10: GSM HANDSETS

Let us not forget the key design objectives for the handset manufacturers. They are aiming to sell compact, light, but affordable digital handsets—ideally, as small as the lightest 300 gram analog cellular handsets on the market today, This is what *their* customers want, and new mass-market derivatives of GSM, like PCN, will fail if this cannot be offered.

Besides component cost, the critical issues affecting IC designers are power consumption and bulk. The two are inextricably linked in that additional power means more battery ... which means more bulk.

Ironically, a major source of power dissipation in a GSM transportable is not through the antenna, but from the costly DSPs I mentioned earlier. There will be an enormous push to raise yield and conserve power from these ICs over the next few years.

Mastery of this CMOS logic will go ultimately to those mainline vendors with high-yielding submicron processes. I am thinking here of companies like Motorola, NEC and Texas Instruments.

The analog RF front end is another area where progress must be made. The challenges are a little different in the sense that the synthesizer, mixer and amplifier ICs are each quite small and do not present yield problems ... But power remains a big problem because, although these parts consume considerably less power than the DSPs I mentioned earlier, they remain on standby mode—when calls are not being made.

Besides power reduction, the other main drive is to reduce bulk and component cost by minimizing the number of IF stages, and discarding as many discrete filter components as possible.

You don't need powerful CAD suites, high yields and to be able to make big chips to be in this business. Instead, the crucial factors are a reasonably fast bipolar process, an inspired radio design group and strong capabilities in RF packaging, which is where vendors like Philips, Plessey, Siemens, SGS-Thomson and STC all excel.

SLIDE 11: GSM MARKET FACTORS

Picking up from what I said earlier about the comparatively high semiconductor content in these handsets, you might conclude that they will be expensive to buy, and have problems selling alongside today's analog handsets.

In fact, we expect the GSM telephone will carry only a marginal price premium over existing equipment. Two factors support this: first, the fact that any GSM handset will work anywhere in Europe will bring greater economies of scale. More significantly, this will give greater freedom for subscribers to buy equipment where they want, and at the most competitive price. Second, the powerful speech compression ICs used by GSM allow it to cram in more subscribers compared to analog systems, and this will eventually lead to lower call charges.

We predict an aggressive rollout for digital cellular in Europe, with 2.4 million telephones shipped in 1994, equivalent to a semiconductor market of nearly $300 million—although not all of this will be consumed in Europe.

Returning one moment to the laptop computer comparison, these GSM handset shipments are 40 percent higher than what we forecast for *laptop PC* sales in Europe in the same year. This comparison with the laptop market is not an entirely idle one, for cordless laptop modems may be one potential major spin-off for GSM semiconductor sales in the mid-1990s.

Every GSM handset will need a smart card inserted into it before it will work. Smart cards themselves will make very promising applications for semiconductor sales in Europe this decade.

But the smart card is not *one* application but *several* ... in fact, hundreds. However, we are fortunate in the belief that the bulk of the market over the next few years lies with just a handful of key applications.

First, a few words of explanation: there are two broad forms of smart card in use today. The first, the token card, is not a smart card in the strict sense of the word; it contains no microprocessor and only a small amount of memory ... and then there are true smart cards, like the French health card you see here, which contain microprocessor, memory and other logic—all on a single IC.

SLIDE 12: SMART CARDS

We estimate that $16.3 million of semiconductor sales went into smart cards or token cards in Europe last year, mainly into token cards for payphones in France.

So far, the majority of true smart card issues have gone to a handful of bank applications—like those of Carte Bancaire in France and Eurocheque in West Germany.

Three vendors hold the majority of semiconductor supply to this market. SGS-Thomson and Texas Instruments account for the bulk of ICs into token cards, with Motorola the leading supplier for ICs into smart cards.

SLIDE 13: SMART CARDS—KEY FACTORS

Strong recent support for token cards has come from the West German, Spanish, Finnish and Irish PTTs, with their decision to follow France in the use of token cards for payphones.

Pay TV has recently become a major new application for smart cards. This year we estimate that nearly 3 million smart cards will be issued for pay TV, with most of these being made in Scotland by a venture between New International and the smart card company, Gemplus, for viewers of Sky television. Sky will be followed by other smart card pay channels, including Canal Plus and the new D2-MAC channels.

However, by far the *greatest* demand for smart cards will come from the banks, who need the smart card concept to differentiate their services from their competition. When the time is right, there will be an avalanche of bank smart card issues across Europe. The first signs have already appeared in France, Norway, West Germany and here, in Switzerland, with the Migros banking and shopping card.

What will be the final trigger to this avalanche? Arguably the greatest determining factor will be the European Commission, which is presently formulating policies on the rights and roles of consumers in relation to the banks, retailers and national institutions like health and social security.

The Commission has two groups developing standards and policy for the whole Community, one working on card authentication and the other on standards. Both are known to be in favor of the smart card as a universal transaction device for the whole population, not just for consumer purchases ... but for *everything* from medical records to passports.

SLIDE 14: SMART CARDS—THE MARKET

Even when we restrict ourselves to the few applications I have mentioned, the prospects for IC sales into smart cards look very bright. The revenues you see here are for token and smart cards combined. For just the applications mentioned, we forecast total semiconductor consumption in Europe to reach $139 million—for some 200 million cards in 1994.

The trend will be towards secure and sophisticated multipurpose cards which will drive an increase of semiconductor content above the jellybean levels typical in the popular telephone token cards of today—so that by 1994, we expect IC content to have at least doubled from the 35 cents per card average today.

At this point, I would like to stand back to make some brief remarks about what all these applications have in common from the semiconductor viewpoint.

SLIDE 15: CLOSING REMARKS

My first observation is that there are many emerging applications where custom IC design is a very large part of the total systems development cost. This is particularly true for the digital cellular telephone, where companies like Motorola and NEC must surely benefit from having their whole production effort under one roof.

These applications tend to be at the leading edge of what is technologically possible. High-definition television is another example, where the close involvement of companies like Philips, Thomson and Sony at every level of development, from semiconductors to systems, should give them each a strong advantage.

Vertical integration is certainly a key factor in determining the *rate* at which new applications will emerge. If the companies that developed CT2 handsets had the benefit of larger and better resources at the silicon level, I am sure CT2 would be a mass market today.

My second point is that it is important not to underestimate the benefit of hindsight when assessing the future for new applications. It is easy to forget that the application consuming the largest volume of semiconductors today, some 10 percent of the *total* market in Europe, is also the youngest.

The personal computer is the quintessence of why it is essential to watch emerging applications with care. In less than ten years, these boxes have upturned market shares, not only in the computer business but also in semiconductors, with their enormous demands for memory, microprocessors and chip sets.

Finally to my last point—on where to draw the application borders of the 1990s.

SLIDE 16: REDRAWING THE BORDERS

In redrawing the borders of the '90s, an appreciation of which technology has its fingers in which application will be *crucial.*

On this table, I have separated some basic technologies, shown along the top, from a number of major applications down the left. For good measure I have thrown in a few other promising technologies and standards in addition to GSM and smart cards. I have put crosses where each technology might have the potential to appear in each application.

When you sum up each column, you see that GSM does pretty well. So do smart cards for that matter—particularly when there are literally hundreds of applications for smart cards not written in.

There is a third, and vital, dimension on this graph for *you* to fill in when you get back to the office: how will your companies' individual strengths fit with these technologies and these applications?

At Dataquest we will, of course, be delighted to help and work with you to answer this question!

Ladies and Gentlemen, thank you.

Jonathan Drazin

Erratum

There have been two ESAM newsletters issued with the code 1990-10. Please change the code on the newsletter "Smart Cards in Europe—from Telephones to Consumers" to 1990-11.

AGENDA

- Overview
- Digital Cellular
- Smart Cards
- Conclusions

EUROPEAN SEMICONDUCTOR CONSUMPTION AND GROWTH

BY APPLICATION

	Percent Consumption			Annual Growth	
	1986	1990	1994	86-90	90-94
EDP	20.2%	35.7%	40.5%	36.0%	24.5%
Telecoms	23.2%	19.1%	18.5%	12.2%	19.8%
Industrial	21.0%	17.7%	15.3%	13.0%	16.4%
Consumer	22.6%	15.5%	14.4%	7.3%	18.4%
Military	6.8%	5.0%	3.5%	9.4%	10.5%
Transportation	6.3%	7.0%	7.8%	21.2%	24.0%
Total	100.0%	100.0%	100.0%	17.9%	20.7%
Revenue ($B)	5.5	10.7	22.7		

Source: Dataquest

X. TERMINALS

- Same screen capabilities as workstations
- Lower cost
- What impact on the workstation market?
- A re-birth for centralized computing?

LASER PRINTERS

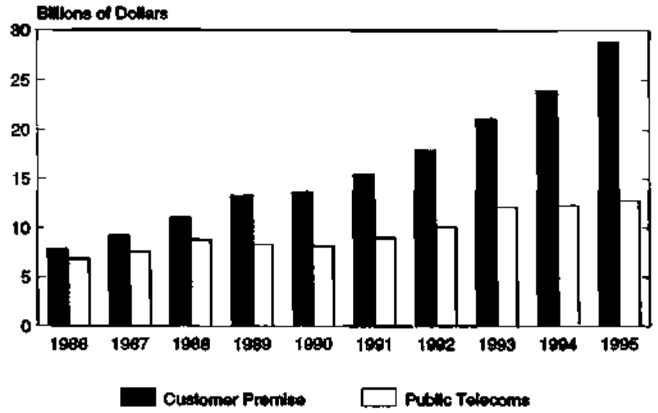
- Increasing semiconductor content
  - push to faster page rates
  - new features (e.g. PostScript)
- European production accounts for 20 percent of market
- Local Far Eastern producers to switch to laser printers
- Strong semiconductor growth

TRANSPORTATION

SEMICONDUCTOR ISSUES

- Today: Cost and Reliability
- Manufacturers will look to new *applications for differentiation*
  - in-car navigation
  - traffic control
  - noise reduction
- Tomorrow: Innovation and Standards

Estimated Customer Premise and Public Telecoms Equipment Production in Europe



Source: Dataquest

TELECOMS
THE APPLICATIONS OVERLAP

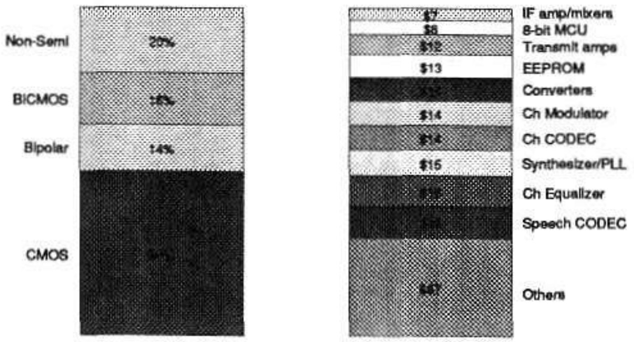
	STANDARD PHONES	CORDLESS PHONES	CELLULAR PHONES	MODEMS	ISDN TAs	LANs	TELEX	VIDEOTEX	FACSIMILE	
STANDARD PHONES	■	X	X							VOICE
CORDLESS PHONES	X	■	X							
CELLULAR PHONES	X	X	■							
MODEMS				■	X		X			DATA
ISDN TAs				X	■		X	X	X	
LANs						■				
TELEX				X	X		■	X	X	TEXT & IMAGE
VIDEOTEX					X		X	■	X	
FACSIMILE					X		X	X	■	

Source: Dataquest

CT2

- Strong preference by PTTs for telepoint
- Slow acceptance in U.K. - so far
- CT2 must satisfy office users
- Future rival technologies:
  - DECT
  - GSM
  - PCN

Electronic Component Breakdown
for 1st Generation Class IV GSM Handset
by Technology and Type



Total Content = $190

Source: Dataquest

GSM HANDSETS

- High component cost
- Critical issues:
  - power consumption
  - bulk
- CMOS logic - big ICs, many challenges:
  - 50,000 gates per IC
  - <1 um, double level metal
  - 1cm x 1cm ⟶ yield critical
- RF front-end - small ICs
  - minimize IF stages and filters

GSM - MARKET FACTORS

- Reasonable handset prices:
  - scale economies
  - price competition
  - bandwidth efficiency ⟶ lower tariffs
- Aggressive rollout:
  - 2.4 million handsets shipped in 1994
  - $300 million semiconductor consumption
- Spin-offs...cordless modems for laptop PCs?

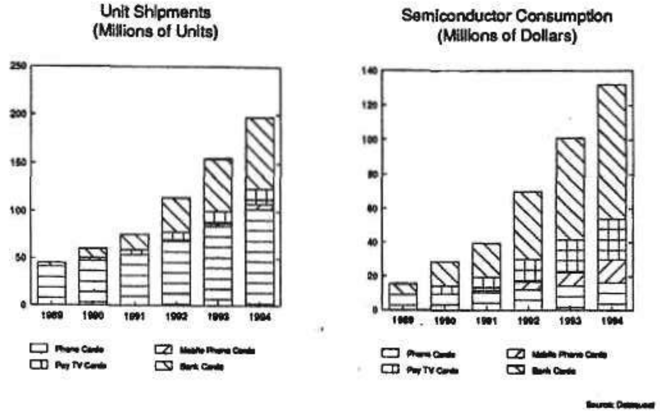
SMART CARDS

- Awaiting mass-adoption by banks
- $16.3 million semiconductor consumption in 1989
- Key vendors
  - Token: SGS-Thomson, Texas Instruments
  - Smart: Motorola, SGS-Thomson
- Emerging applications:
  - pay phones, mobile phones
  - pay TV
  - medical, passports, social security

SMART CARDS - KEY FACTORS

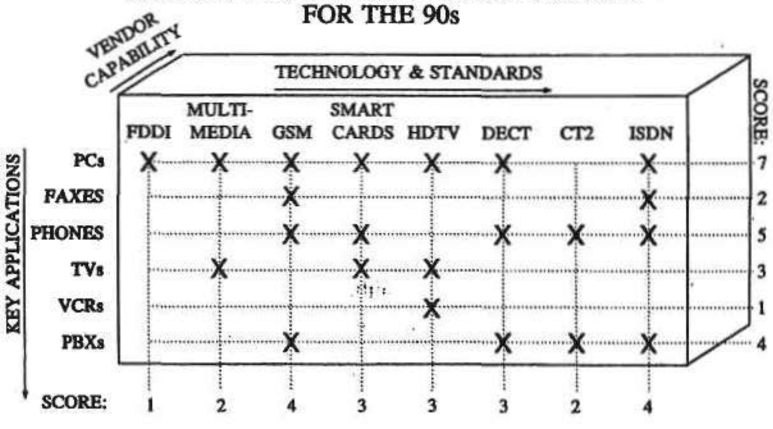
- Payphones - renewed PTT interest
- Pay TV - a new application:
  - 3 million smart cards for Sky TV this year
  - Canal Plus and D2-MAC demand will follow
- Bank cards:
  - smart cards permit differentiation
  - EC studies in progress
  - multi-applications - attractive to banks
- Smart cards - the universal transaction device

Smart and Token Cards - The Market



Source: Dataquest

DRAWING THE APPLICATIONS BORDERS FOR THE 90s



	FDDI	MULTI-MEDIA	GSM	SMART CARDS	HDTV	DECT	CT2	ISDN	SCORE:
PCs	X	X	X	X	X	X		X	7
FAXES			X					X	2
PHONES			X	X		X	X	X	5
TVs		X		X	X				3
VCRs					X				1
PBXs			X			X	X	X	4
SCORE:	1	2	4	3	3	3	2	4	

Source: Dataquest

CLOSING REMARKS

- Complex new systems (GSM, HDTV) need vertical integration
- 1980s: The decade of the PC
- 1990s: The decade of ?
- Essential to separate out:
  - technology
  - standards
  - end-user needs

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Research *Newsletter*

SMART DRIVE ELECTRONICS: IF YOU'VE SEEN ONE . . .

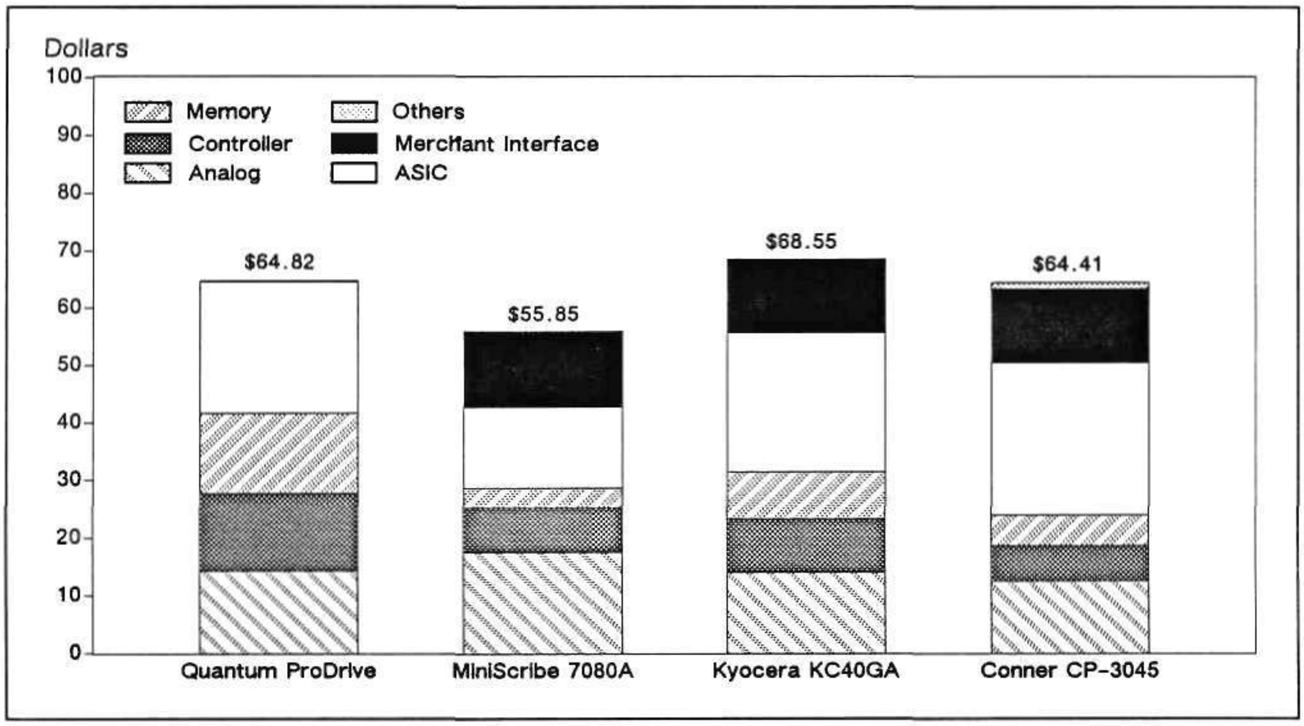
SUMMARY

When it comes to embedded controller design, rigid disk drive manufacturers face a tough challenge: to differentiate their product without sacrificing profit margins. This newsletter provides a detailed look at the semiconductor content of several recently announced 3.5-inch rigid disk drives. The models examined here were selected not only as representative of current embedded control implementations, but also as illustrative of the ongoing trends and constraints that face controller designers today.

INTRODUCTION/OVERVIEW

Figure 1 shows the estimated component cost of the Quantum ProDrive 80S, the MiniScribe 7080A, the Conner Peripherals CP-3045, and the Kyocera KC40GA. The pricing data contained in this analysis are based on Dataquest's Semiconductor User Information Service (SUIS) pricing study, assuming a 100,000-piece contract buy. Because manufacturers enjoy varying degrees of purchasing leverage and may secure greater quantity discounts for certain components, these cost figures should be used for comparison purposes only.

FIGURE 1
System Component Cost Breakout



Source: Dataquest (June 1990)

ESAM Newsletters 1990-12

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DESIGN CONSTRAINTS AND THEIR IMPLICATIONS

Cost, performance, interface, and form factor issues are placing severe constraints on the controller design equation, causing manufacturers to converge on what is essentially the same embedded controller solution. With product differentiation and the attendant gross margins becoming harder and harder to achieve, drive manufacturers face the prospect of losing the ability to set themselves apart through controller design and IC selection.

The next step in this analysis will sound all too familiar to chip industry veterans: Standardization leads to price erosion. As is often the case, the tremendous size of this industry is proving to be a double-edged sword for semiconductor suppliers, with a steady stream of new suppliers bringing pin-compatible products to market. As a result of this strong price pressure, Dataquest forecasts slowing growth for this application market. A detailed analysis of this market and our five-year forecast by semiconductor type will be provided in upcoming SAM newsletter number 1990-5, entitled "System Semiconductor Content Trends: Rigid Drives Learn Self-Control."

Table 1 compares the system specifications of these drives. Both AT and SCSI interface drives have been included, as these are by far the most common interface standards among intelligent drives today (vendors typically offer both versions). Aside from switching interface chips, there is virtually no difference in the semiconductor content of the respective versions of a given drive design. AT and SCSI interface devices are available on the merchant market at approximately the same price.

DRIVE DISCUSSION

The Quantum ProDrive 80S

Quantum is probably the best example of a drive manufacturer trying to achieve differentiation through chip selection. By using proprietary interface and buffer controller ASICs, Quantum is able to implement a unique design solution while keeping component costs under control. (There are indications that current pricing on merchant interface and buffer controller devices is slightly *higher* than the corresponding cost for certain in-house design solutions.) The current trend toward declining merchant ASPs threatens this cost edge, however.

In addition to using proprietary ASICs, Quantum also seeks differentiation through its own patented head positioning technique. Although this

TABLE 1
Drive Comparison

	Quantum ProDrive 80	MiniScribe 7080A	Conner CP-3045	Kyocera KC40GA
Interface	SCSI	AT	SCSI	AT
Platters	3	2	1	1
Surface Capacity (MB/s)	14.0	20.2	21.4	20.3
Drive Capacity (MB)	84.0	80.7	42.8	40.5
Access Time (msec)	19	19	25	28
Head Positioning	Servo	Servo	Servo	Stepper
Cache (KB)	64	-	-	-
Buffer (KB)	8	8	8	32
1:1 Interleave	Yes	Yes	Yes	Yes
TPI	1,000	1,387	NA	1,309
BPI (Maximum)	22,050	30,625	NA	29,589
RLL	2, 7	1, 7	2, 7	1, 7
Areal Density (Mb per sq. in.)	22.05	42.48	43.00	38.73

NA = Not available

Source: Dataquest
June 1990

gives Quantum some unique benefits, it also increases controller requirements—the ProDrive has the most sophisticated, and expensive, microcontroller of any of these drives.

Table 2 shows the semiconductor content of the ProDrive 80S.

Although the ProDrive appears to have a substantially higher semiconductor cost, it is worth noting that this cost figure is skewed by the inclusion of three cache DRAMs. This cache is largely responsible for the ProDrive's fast access time and higher component cost. None of the other drives examined feature a data cache.

The ProDrive also illustrates the cost/technology trade-offs related to media technology. The ProDrive has the lowest level of head-media technology (areal density), which reduces the cost per platter, but this savings must be balanced against the cost of the additional platter required.

The MiniScribe 7080A

Never mind that MiniScribe's books look like the accounting version of the old "shell game"; the 7080A is a competitive product with a viable controller design. Like the ProDrive, the 7080A achieves faster access times through the use of a servo loop to control head positioning. Unlike the ProDrive, the 7080A takes advantage of much higher media technology (nearly double the areal

Table 2
Semiconductor Content—Quantum ProDrive 80S

		Vendor	Part Number	Quantity	Function	Estimated Cost	Comments
Controller Card							
	Data Path	Si Systems	32P541-CH	1	Pulse detector	$ 3.26	Read data processor
		Si Systems	32D5321-CH	1	Data separator	6.07	Data synchronizer/ ENDEC
	Controller	NEC	D78312G	1	8-bit MCU	10.25	64-pin spider-leg DIP
		Hitachi	HA13441	1	Driver	3.05	Spindle motor driver
	Memory	NEC	D27C256AC-20	1	OTP EPROM	2.03	256K, 200ns
		Fujitsu	81464-10	3	DRAM	8.58	64Kx4, 100ns
		Sharp	LH5164LN-10	1	SRAM	3.34	8Kx8, 100ns
	ASICs	Plus	NM	1	SCSI interface	12.00	68-pin PLCC
		Quantum	NM	1	Buffer controller	11.00	68-pin PLCC
	Std Logic	Mitsubishi	LS365A	1	Buffer	0.19	
	Analog	SGS-Thomson	L2722	1	Op amp	0.22	Dual-power op amp
			C324G	1	Quad op amp	0.45	
			C339G	1	Quad comparator	0.22	
			3771	1	Op amp	0.22	8-pin DIP (M93)
			HCT08	1	DAC	0.45	14-pin DIP
Drive							
		Si Systems	32R 501-6CH	1	R/W preamp	2.75	28-pin PLCC
			C324G	2	Quad comparator	0.44	
		National	LM78L	1	Voltage regulator	0.30	8-pin DIP
	Total			21		$64.82	

NM = Not meaningful

Source: Dataquest
June 1990

density of the ProDrive) to squeeze 80 megabytes onto two platters rather than three.

This aggressive technology strategy, although initially risky, has its rewards. By committing to a higher density and then pushing that technology to improve yields and costs, MiniScribe elects to push down a more advanced technology learning curve.

From a control electronics standpoint, the biggest difference between these drives lies not so much in the basic controller design itself but in the selection of proprietary versus standard ICs. Table 3 shows the semiconductor content of the 7080A.

MiniScribe's lack of interest in differentiating through chip selection is evident in the observation that, with the exception of two ASICs, all of the ICs in the 7080A are off-the-shelf merchant products.

The Kyocera KC40GA

Unlike the other drives, the KC40GA uses a stepper motor for head positioning which leads to a significantly higher access time. To offset this performance degradation, KC40GA offers a larger (32KB) data buffer.

As a relative newcomer to this business, a general lack of product differentiation works to Kyocera's favor as it reduces the customer loyalties and switching costs that otherwise would form formidable barriers to entry. Volume manufacturing cost, not differentiation, is the key criterion in this design. Table 4 shows the semiconductor content of the KC40GA.

In implementing this design, Kyocera seems to be minimizing cost *in the long term*. This is

TABLE 3
Semiconductor Content—MiniScribe 7080A

	Vendor	Part Number	Quantity	Function	Estimated Cost	Comments
Controller Card						
Data Path	SSI	32D536-CH	1	Data synchronizer	$ 6.07	28-pin PLCC
	NA	NA	1	Pulse detector	3.26	28-pin PLCC
Controller	Motorola	68HC11	1	Controller	6.15	
	Philips	TDA 514 OT	1	Motor driver	1.45	Spindle motor controller
Memory	Sony	CXK58257M-12L	1	64K SRAM	3.50	8KB buffer
Interface	Cirrus	CL-SH260-15PC-D	1	AT I-face adapter	13.00	SCSI version uses Adaptec
ASICs	MiniScribe	NM	1		3.50	28-pin PLCC
	NCR	NM	1	NA	10.50	68-pin PLCC
Analog	Motorola	LM324	1	Quad op amp	0.54	14-pin DIP
	SGS-Thomson	LM324 D1	1	Quad op amp	0.54	14-pin DIP
	National	LM258M	1	Dual op amp	0.44	8-pin DIP
	SGS-Thomson	L2726	1	Quad op amp	0.54	14-pin DIP
	Siliconix	DG211	1	Quad switch	0.99	16-pin DIP
	Maxim	AD7628KCWP	1	Dual 8-bit DAC	2.38	20-pin DIP
	RCA	ACT10 RCAH485	1	NA	0.24	14-pin DIP
Drive						
	SSI	32R510AR-4CL	1	R/W preamp	2.75	4-channel, 24-pin SO DIP
Total			16		$55.85	

NA = Not available
NM = Not meaningful

Source: Dataquest
June 1990

evident in the selection of a high-density ASIC, which can be quite expensive initially, in order to minimize component count and long-run high-volume production costs.

This long-term focus is evident in Kyocera's media density as well. With virtually the same areal density as MiniScribe, Kyocera takes a similar approach in minimizing the number of platters in the KC40GA and then pushing that technology to improve yields and cost.

The KC40GA also is interesting in that it points out one of the competitive weaknesses of lower density drives. With the same controller cost spread over fewer megabytes, lower-density drives eventually will have a higher cost per megabyte than drives with similar media costs and a greater number of platters.

Another way of looking at it is to consider that the primary cost difference between the KC40GA and the 7080A is MiniScribe's second platter. For the incremental cost of that second platter, the end user can have 40 additional megabytes!

The Conner Peripherals CP-3045

Conner Peripherals, well on its way to becoming the fastest-growing start-up ever, has made its mark by taking the lead in the small, lightweight product segment of the market. In a market where many of its competitors searched fruitlessly for effective product differentiation to protect their profit margins, Conner looked past the challenges associated with the smaller form factors and saw opportunity in the portable PC boom.

Conner also has benefited greatly by focusing on key OEM relationships such as Apple, Compaq, and Sun. Not surprisingly, we found a CP-3045 while dissecting a Macintosh Portable.

Table 5 shows the semiconductor content of the CP-3045.

Although the 3045 uses an Adaptec interface chip and a Cirrus buffer controller, it nevertheless has a very high ASIC content. This high content is partly explained by the lack of standard logic components in this design. In addition, the lack of any motor driver/control devices, along with the

TABLE 4
Semiconductor Content—Kyocera KC40GA Teardown

	Vendor	Part Number	Quantity	Function	Estimated Cost	Comments
Controller Card						
Data Path	Si Systems	X3P544-CHX	1	Pulse detector	$ 3.26	Pulse detection
	Si Systems	32D535-CW	1	Data synchronizer	6.07	Data separator/ ENDEC
Controller	Motorola	MC68HC11AO	1	8-bit MCU	6.15	
	Hitachi	HA13426	1	Driver controller	3.05	Spindle motor controller/ driver
Memory	Sony	CXK58257M-10L	1	SRAM	8.12	256K, 100ns, low power
Interface	Cirrus	CL-SH260-15QC-D	1	AT I-Face Adapter	13.00	100-pin quad flatpack
ASICs	Sanyo	CMM-8716	1	ASIC	5.25	
	NA	PBL3770A	2	ASIC	7.00	28-pin PLCC
	Fujitsu	NM	1	ASIC	12.00	96-pin quad flatpack
Analog		5247	2	A/D	1.90	8-pin DIP
Drive	Sony	NA	1	R/W preamp	2.75	R/W preamp
Total			13		$68.54	

NA = Not available
NM = Not meaningful

Source: Dataquest
June 1990

unusually large number (11) of power transistors present, suggests that the motor control function has been implemented in a mixed-mode ASIC, using power transistors as motor drivers.

Given Conner's superior product positioning, there is little incentive to differentiate in controller hardware. Therefore, one might expect this drive to have a very generic look to its controller design; however, power and form factor considerations have pushed this design into this relatively nonstandard, highly integrated condition. Indeed, the high level of integration present in the 3045 should make the job of adapting this design to a 2.5-inch form factor much more manageable.

DATAQUEST CONCLUSIONS

Figure 2 shows the IC cost distributions of these drives by semiconductor type. In this figure, Dataquest classifies the R/W preamp, the pulse detector, and the data synchronizer as analog components.

When compared with other electronic equipment types, these drives have a rather high analog component content. This is not surprising, given that the motor control functions are analog in nature and that the data is stored magnetically, and therefore must be read in analog form.

The memory content of these drives is surprisingly high because of increasing use of buffer

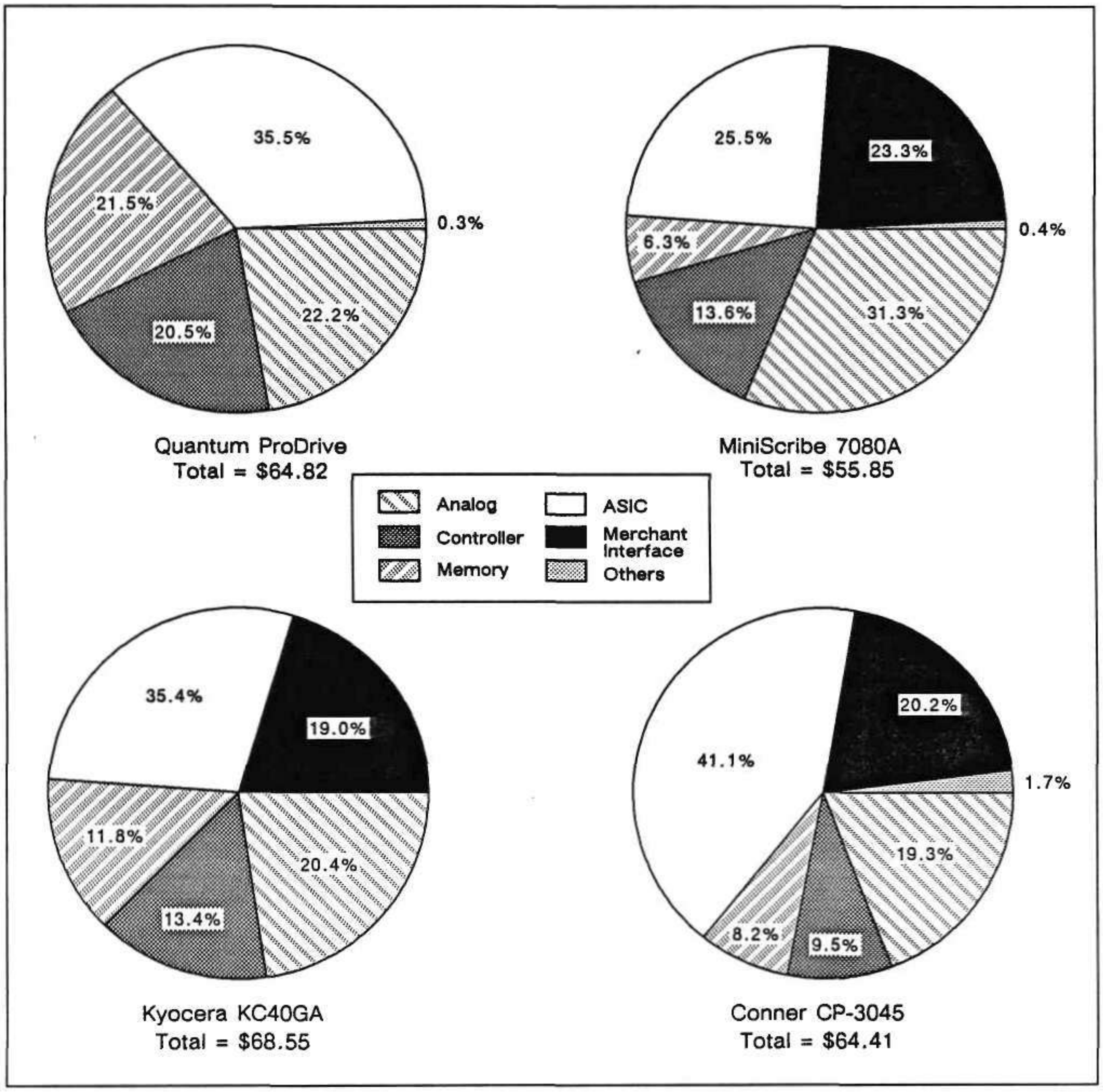
Table 5
Semiconductor Breakdown—Conner Peripherals CP-3045

	Vendor	Part Number	Quantity	Function	Estimated Cost	Comments
Controller Card						
Data Path	Microlinear	ML8464C-1CQ	1	Pulse detector	$ 6.07	28-pin PLCC
	NA	NA	1	Data separator	3.26	28-pin PLCC
Controller	Motorola	SC80566FN	1	Microcontroller	6.15	52-pin PLCC (ROM-less)
Memory	Atmel	AT27C256	1	OTP EPROM	1.95	256KB (32Kx8), 150ns
		SRM2264LM10	1	Buffer SRAM	3.34	100ns 8Kx8 (28-pin DIP)
Interface	Adaptec	AIC-610FL	1	SCSI interface	13.00	68-pin PLCC
	Motorola	61038-002	1	Standard cell	10.50	68-pin PLCC
ASSP	Cirrus Logic	SH110-00PC	1	Buffer controller	2.75	28-pin PLCC
ASICs	Motorola	S38AC004PK01	1	Gate array	6.25	44-pin PLCC
	Conner	GC27C	1	Mixed mode	6.95	44-pin PLCC
Analog	NA	MOG3586A	1	NA	0.35	16-pin DIP
Standard Logic	Fujitsu	74AC00	1	Quad 2-in. NAND	0.23	14-pin advanced CMOS
	Fujitsu	74AC02	1	Quad 2-in. NOR	0.23	14-pin advanced CMOS
	Fujitsu	74AC373	1	Octal 3-state	0.52	20-pin advanced CMOS transceiver
	Motorola	LS01D	1	Quad 2-in NAND	0.11	14-pin DIP
Drive						
	NA	NA	1	R/W preamp	2.75	
Total			16		$64.41	

NA = Not available

Source: Dataquest
June 1990

FIGURE 2
Semiconductor Cost Distributions



Source: Dataquest (June 1990)

and cache memories. In addition, the high ASIC and application-specific standard product (ASSP) content can be attributed to the elimination of virtually all standard logic and interface chips.

With controller designs settling into a predictable, almost standard implementation, component vendors face a tough challenge in sustaining healthy ASPs. This challenge is exacerbated by widespread second-sourcing within the semiconductor industry, which clearly enhances drive manufacturers' already considerable bargaining leverage.

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Mike Williams
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Research Newsletter

FLAT-PANEL DISPLAY: TRENDS AND DIRECTIONS

INTRODUCTION

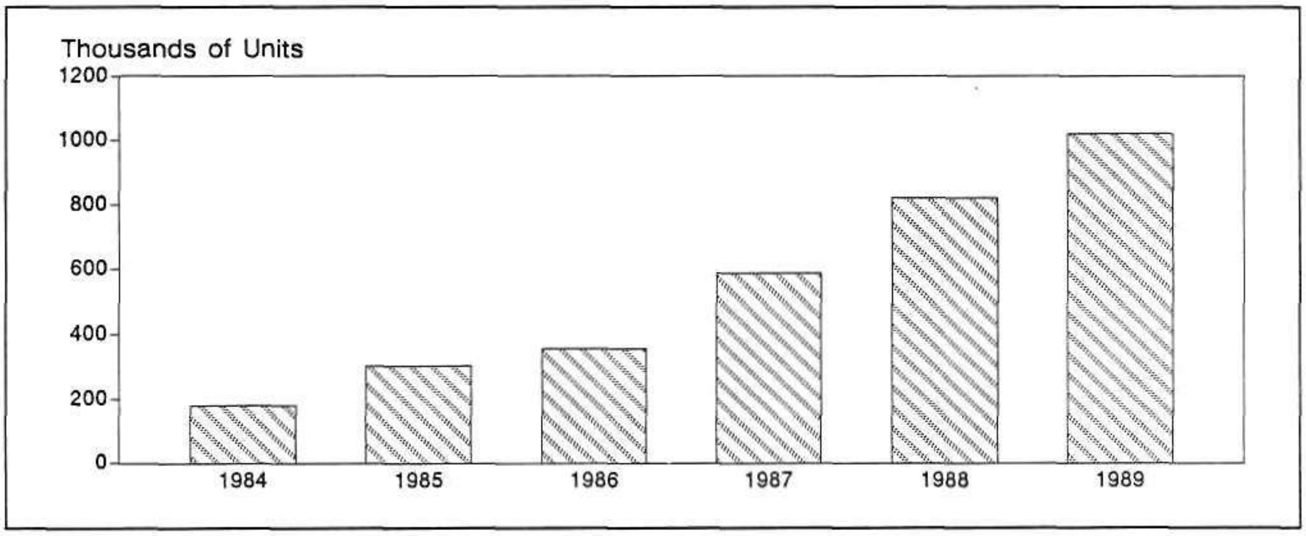
Display technology has witnessed exciting progress in the past decade. Although the traditional cathode-ray tube (CRT) display remains dominant in most applications, its future has never looked so doubtful. Replacing the vacuum tube CRT with some other "flat" technology has been anticipated ever since the vacuum tube triode was replaced by the solid-state transistor.

Ten years ago, liquid crystal display (LCD) development was driven by consumer electronics applications using small-area LCDs; few expected this technology to develop into a replacement for CRTs. Today, LCD technologies have emerged as the leading candidates to replace CRTs. Laptop computers are the current technological driving force for LCDs; however, LCD manufacturers also hope that their technology will play a major role in tomorrow's high-definition TVs (HDTVs). Screen manufacturers currently are demonstrating working prototypes of large-area color LCD displays at trade shows and are creating a frenzy of excitement. Market trends in laptop computers extrapolate to rapid growth with an even faster displacement of traditional machines being limited only by the lack of a high-contrast, reasonably priced, flat-panel display. Figure 1 shows the worldwide portable computer market.

LCD MARKET GROWS

Although many manufacturers have demonstrated impressive working models of color LCD displays, the major problems with bringing these

FIGURE 1
Worldwide Portable Computer Market



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products to market are manufacturing in nature. Specifically, obtaining a high yield from large-area display production is a monumental problem that roughly parallels the challenges of producing the next generation of DRAM products. Whereas DRAMs involve placing a larger number of working transistors on a chip, thin-film display (TFT) LCDs must make their transistors work over a larger physical area of material that is fundamentally less uniform (i.e., nonsingle crystal). Corporate efforts toward solving DRAM and TFT LCD manufacturing problems are very similar; massive investments by major manufacturers are being augmented by strategic alliances and membership in various consortia.

Last August, IBM and Toshiba announced the establishment of a new joint venture company, Display Technology Corporation (DTC). At the press conference, one of the DTC company officers predicted that TFT display panels would completely take over CRT displays. At an Osaka, Japan, electronics trade show last October, DTC demonstrated its new product, an 11.2-inch diagonal color TFT LCD fabricated on amorphous silicon. The DTC display had a pixel count of 720 x 480 and an intensity of 120 cd/m^2 with a contrast ratio of between 20:1 and 40:1. At the same trade show, comparable color TFT LCDs were shown by Hitachi, Seiko-Epson, and others.

Many Japanese electronics companies have begun funneling large investments into their LCD production facilities. Sharp, a leading LCD manufacturer, announced plans to invest ¥140 billion ($970 million) in LCD production by 1994. The company currently has two factories under construction. As well as its joint venture with IBM, Toshiba will spend ¥3 billion ($21 million) to strengthen its existing LCD production facilities during 1990. Toshiba executives have been quite explicit in their expectations that LCDs will play a key role in future corporate product strategy. Current goals at Toshiba are to fabricate 10- to 14-inch color TFT panels with one megapixel of resolution to be produced concurrently with its 4-Mbit generation of DRAM products. Hitachi, Matsushita, Mitsubishi, and Seiko-Epson all announced intentions to invest heavily—approximately ¥10 billion to ¥30 billion ($70 million to $210 million) apiece—in LCD manufacturing capacities. In 1990 alone, total investment in LCD technology by major electronics companies should exceed ¥100 billion. Even a relatively small company, Alps Electric of Tokyo, is planning to build a ¥5 billion ($35 million) color LCD facility that should be operational this spring. Other Japanese players include Hoshiden Electronics, NEC, and Sanyo. Most companies have relatively lofty goals, taking direct aim at color panels with dimensions greater than 10 inches, employing TFT technology, and scheduling mass production in 1990 or by early 1991.

Japanese market projections forecast a ¥1 trillion LCD business by 1995. As a large contribution to this growth, industry observers forecast a tenfold increase in the laptop computer industry from its current level until the end of 1993. In the long term, HDTV is expected to be the next bonanza for the electronics industry, with many gambling that LCD will be the primary display technology for HDTV implementation. Present Japanese domestic CRT production is approximately ¥500 billion ($3.5 billion) per year.

JAPANESE GOVERNMENT CONSORTIA

Because LCD development clearly is resource intensive, private enterprise in the display arena is being complemented by several government-sponsored efforts in Japan. In 1989, the Japanese government established two consortia related to LCD research. Table 1 gives the background on these two recently formed consortia, which were assembled by the Japan Key Technology Center (Japan Key-TEC), the Ministry of International Trade and Industry's (MITI's) research organizer.

Giant Technology Corporation (GTC) has the charter to develop various fundamental technologies needed to realize a 1-square-meter (about 40 x 40 inches) color TFT LCD display, thereby attempting to leap over at least one generation of LCD displays. Participants include a diverse group of traditional electronics companies and printing, glass, and vacuum technology companies. At press time, the project appears to be progressing smoothly.

High Definition Television Engineering Corporation (HDTEC) is primarily studying HDTV technology. HDTEC currently is pursuing four objectives simultaneously; one objective is the improvement of projection-type LCD displays.

OTHER TECHNOLOGIES: DOWN WITH THE BLUES

Professor Akazaki and a team of semiconductor engineers at Japan's Nagoya University recently developed a high-intensity blue light-emitting diode

TABLE 1
Japanese Display Technology Consortia

	Giant Electronics Technology Corporation (GTC)
Established:	March 23, 1989
Objectives:	R&D of advanced technologies for large-area TFT circuitry
Project Term:	7 years
Budget:	¥13 billion ($90 million)
Participants:	Japan Key Technology Center (Japan Key-TEC), Asahi Glass, Casio, Chisso, Dainippon Printing, Fujitsu, Hitachi, Hoechst Japan, Japan Sheet Glass, Japan Synthetic Rubber, NEC, Sanyo, Sharp, Seiko-Epson, Semiconductor Energy Research, Thomson Japan, Toppan, Ulvac
	High Definition Television Engineering Corporation (HDTEC)
Established:	March 27, 1989
Objectives:	R&D of HDTV technologies such as computer graphics, high-speed digital information transfer systems, LCD projection type display, and evaluation of display quality
Project Term:	5 years
Budget:	¥3.5 billion ($24 million)
Participants:	Japan Key Technology Center (Japan Key-TEC), JR Research, Meitec, NEC, NHK, Seiko-Epson

Source: Dataquest
May 1990

(LED). Red and green LEDs have been available for some time, but blue LEDs have long eluded researchers, creating the primary barrier to the successful implementation of a flat-panel color display based on LED technology. It is likely that the first LED display products will be hybrids, i.e., discrete or small-scale devices bonded together that will not require the high manufacturing yield of monolithic devices. Because one-dimensional bonded LED arrays of page-size dimensions now are being used as imaging arrays in commercial high-resolution printers (in competition with laser printers), it is clear that this type of packaging already exists to some degree. LED displays should offer superior contrast, color, and viewing angle when compared with LCD displays. Sanyo already has made progress toward the development and commercialization of blue LEDs.

Although gas plasma and electroluminescent screens are not as well publicized as LCD displays, their contrast and response time are considered their traditional strong points. At the Osaka electronics show, Matsushita revealed a 17-inch color plasma display that it plans to sample-ship by the end of 1990. Matsushita's display had an output intensity specification of only 25 cd/m^2 at a 640 x 480 pixel resolution, but it possessed a contrast ratio of 150:1. The only other non-LCD products shown at this show were a fast 12-inch monochrome plasma display from Oki and a 10-inch monochrome electroluminescent screen from Sharp. As with displays based on LEDs, progress in the development of color electroluminescent screens has been hindered by the lack of a high-intensity blue phosphor.

DATAQUEST ANALYSIS

Dataquest believes that further erosion of the CRT market is inevitable. Although many technologies compete with the CRT in monochrome applications, the LCD is positioned to be the first to compete directly with the CRT in applications requiring color displays. The TFT LCD manufacturing learning curve will determine the price-time progression and thus define both how quickly laptop computers displace desktop machines and, more generally, how rapidly LCD panels penetrate traditional CRT markets. However, several competing technologies should not be discounted, including plasma discharge, electroluminescence, and LEDs, all of which probably will evolve to the level needed to create a usable color, flat-panel display. In the past decade, LCDs have benefited numerous advances such as the so-called supertwist technology and the advent of thin-film transistors on amorphous silicon. However, if a comparable innovation or breakthrough occurs in one of the less publicized technologies, such as those based on gas plasmas, electroluminescence, or even cold cathodes, it could once again change the complexion of the display market. We could conceivably see a renewed interest in such a technology in the same way that there has been resurgence of interest in bipolar transistors in the digital VLSI arena.

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Mike Williams
Junko Matsubara

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Research Newsletter

SMART CARDS IN EUROPE—FROM TELEPHONES TO CONSUMERS

SUMMARY

Smart card technology has progressed to a stage where, while on cost grounds it cannot surpass the magnetic stripe card, it does offer powerful new functions that pave the way for the smart card to ultimately play many roles in most peoples' lives.

With a few exceptions, the smart card has failed so far to make major inroads into the existing mass-market banking and credit applications of Europe. Widescale adoption by the banks will not happen until *all* the issues concerning its adoption (authentication, reliability, cost, patent liability, etc.) have been fully addressed. We believe this to be one to two years away.

On a more positive note, smart card technology has already spawned many existing (pay telephone cards) and emerging mass-market applications (mobile telephone, pay TV and health cards). The fact that the smart card is so rich in applications, so early in its development, is a very positive indicator for its future.

Dataquest forecasts a strong 35 percent compound annual growth rate (CAGR) for total smart card issues in Europe: from 45 million units in 1989 to 199 million units in 1994. We foresee a swing away from simple prepaid telephone cards, widely in use today, to true smart cards for banking, TV and mobile telephone applications. Indeed, all segments will show healthy growth. As a consequence of increasing card sophistication, we expect smart card IC revenue growth to exceed unit growth: rising from $16.3 million in 1989 to $139 million in 1994, a 54 percent CAGR.

This newsletter explores some of the many applications, existing and new, to which smart card technology is being applied and assesses the prospects for semiconductor vendors to sell ICs into these markets.

SOME CARDS ARE SMARTER THAN OTHERS

The smart card is one of a number of existing and emerging card technologies. These technologies divide into two broad types: those that contain semiconductors, known as IC cards, and those that do not (see Table 1).

Table 1
The Card Technologies

Type of Card	Key Card Manufacturers	Cost per Card
IC Cards		
Memory Cards	Fujisoku, Macro, MIPS, Mitsubishi, Oki,	$20 to $1,000
Token Cards	Bull, Gemplus, Schlumberger, Sligos	80 cents to $8
Smart Cards	Bull, Citizen, Dai Nippon, Gemplus, Philips, Schlumberger, Sligos	$3 to $10
Smart Contactless	ADE/Valvo, AT&T, GEC	$15 to $30
Super Smart Cards	SCI, Toshiba	Over $50

Source: Dataquest
May 1990

Table 1
The Card Technologies (Continued)

Type of Card	Key Card Manufacturers	Cost per Card
Non-IC Cards		
Magnetic Stripe	(too numerous to include)	30 to 60 cents
Laser Optical	Canon, Drexler	$3 to $5
IR Optical	Landis & Gyr	80 cents

Of the non-IC cards, the most ubiquitous are magnetic stripe cards, extensively used for consumer credit and banking since the mid-1970s. More than 1.6 billion of these cards have been issued worldwide but, although cheap to use, they are susceptible to fraudulent copying and are less reliable than IC cards. Above all, magnetic stripe cards lack the flexibility to offer multiple services, or higher levels of service, that are needed for one application vendor to *differentiate* itself from another.

Of the cards that contain ICs, only those that contain a central processor unit (CPU) are commonly known as "smart cards." Consequently memory cards, widely used to hold games software, character fonts and as solid-state disks for laptops, do not qualify as smart cards. Tables 2 and 3 list the major IC card and reader manufacturers in Europe. In this newsletter, we look at the applications markets for "token" and "smart" cards only, with or without contacts. These are defined below.

Token Cards

We define as "token" those IC cards which do not contain a CPU but whose data flow to or from a card reader is more complex than a basic memory read or write. These cards are often referred to as "prepaid" cards.

Token cards presently account for the greatest proportion of the IC card market. Typically, they contain a fusible programmable logic array (PLA) with a small amount (16 to 256 bytes) of EPROM or EEPROM. Their main applications are as prepayment cards for public payphones, vending machines, car parks and movie theater admission. They offer little more functionality than a magnetic stripe card, except that they are less easily recopied and reused. Like most other IC cards, they are about 10 times more reliable than magnetic stripe ones.

Table 2
European IC Card Fabricaters

Country	Manufacturer
France	Adventure, Bull, Citizen, Gemplus, Grundig, Hello, IBSI Electronique, Logicam, Mustang Technologies, Ordicam, RTIC, Ruwa Bell, Schlumberger, Sligos, Télécash, Télématique Finance, TRT, Vak
Netherlands	Philips
United Kingdom	De La Rue, Fortronic, GEC Card Technology, McCorquodale, News Gem Ltd
West Germany	Datacard, GAO, Giesecke & Devrient, Maxell, Oldenbourg, ORGA, Rexroth Electronic, ADE/Valvo

Source: Dataquest
May 1990

Table 3
European IC Card Reader Manufacturers

Country	Manufacturer
Austria	Voest Alpine
France	A&S, ACS, Bull, Camp, Ceicom, CGE, CKD, CSEE, EIN, ESD, FAAS, Gemplus, Générale des Eaux, Gilbarco, Grundig, G3S-Infodif, Hello, Ingenico, ITT-Sealectro, Logicam, Matra, NSI, Ordicam, Radiotel, Recitel, Réseaumatique, RTIC, Sagem, Satam, Satelcom, Schlumberger, Secre, Sedri, Sepia, Sextant/ Crouzet, SF2E, Silec, Sinfa, Smart Ingénière, SMT-Goupil, Sofrel, TBS, Télémedicartes, Transtel, TRT, Unidel, Vak
Netherlands	Philips
United Kingdom	De La Rue, Fortronic, GEC Card Technology, Zergo
Switzerland	Clairinter
West Germany	Bosch-Telenorma, GAO, Giesecke & Devrient, IBM, ORGA, Rexroth Electronic, Siemens

Source: Dataquest
May 1990

We estimate that Gemplus, Schlumberger and Silgos manufactured 41 million token cards in Europe in 1989. More than 95 percent of these were purchased by France Telecom for use as prepaid public telephone cards, using ICs supplied by SGS-Thomson and Texas Instruments.

The market for token cards is expected to grow strongly despite their limitations. The telephone card has spread recently to Finland, Ireland, Luxembourg, Norway and West Germany – with trials also underway in Spain. These countries lag France Telecom's early adoption but, five years from now, we expect comparable levels of penetration to be achieved in these, and possibly other, countries as in France today.

Smart Cards

Smart cards are so named because they include a CPU to perform complex data processing tasks. Most smart cards conform to the ISO 7816 standard, and usually contain a single IC with an 8-bit CPU based on the 6805, 8048 or S9 architectures.

The DES, RSA and other proprietary algorithms, needed for encryption and cardholder authentication, place the greatest demands on both the CPU and the memory. These algorithms require high-speed CPUs with large amounts of ROM and RAM. The need for greater computational speed will eventually result in the introduction of cards with 16-bit CPUs. IBM's recent adoption of Hitachi's H8-310 smart card IC for security access systems is one example.

The following types of memory are also included within the IC:

- Mask ROM (1 to 10 Kbytes) memory to store the operating system and application program.
- EEPROM or EPROM (1 to 8 Kbytes) memory to store personalized card data. This area is programmed by the card issuer, as opposed to the IC supplier, and is often used to hold security routines to complement the card's operating system. EEPROM is gaining increased popularity over EPROM because of its ability to be erased and re-written.
- Volatile SRAM (36 to 256 bytes) used as fast scratch memory to hold intermediate results of calculations.

Semiconductor cost is a critical factor for smart cards because the IC represents a high proportion (15 to 60 percent) of their total cost. A vendor that can supply an IC which closely matches an application's needs is at a strong advantage. The mainstream smart card IC vendors (Motorola and SGS-Thomson) offer ICs with multiple size mixes.

SMART CONTACTLESS CARDS

Most of the token and CPU-based smart cards in use today employ a set of 6 to 8 gold-flashed contacts to make connection between the card and the card reader. Initially there were several proprietary positions and protocols for these contacts, but now ISO standards exist to define these.

Two European companies, GEC and ADE (manufacture contracted to Valvo), have developed smart cards without contacts. These use an RF loop around the card perimeter to draw power and communicate with the card reader. In other respects they resemble normal smart cards.

Today, there are no ISO standards to define the communications protocol, or "air interface," between a contactless card and its reader – although work is in progress. Until these standards appear, we expect contactless cards to be restricted mainly to small niche applications where regular smart cards cannot perform, such as in inflammable, corrosive or dirty environments. Their extra cost over regular smart cards will also strongly limit their uptake.

SUPER SMART CARDS

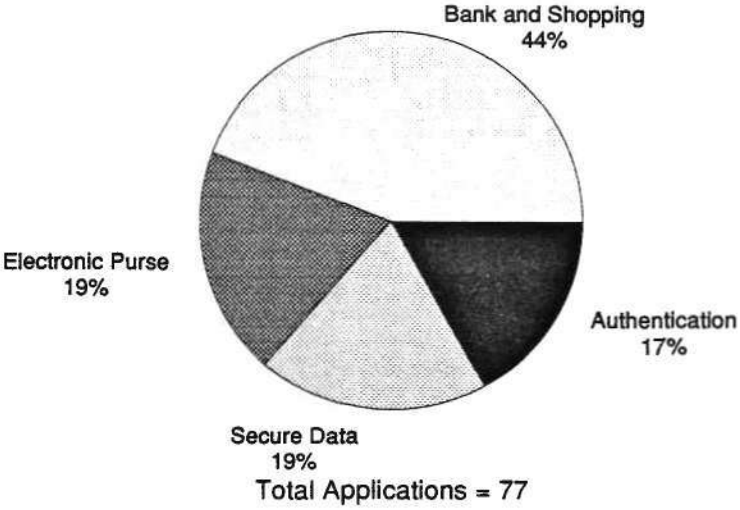
In view of the fact that the term "SuperSmart" is now a Visa International trademark, super smart cards might more appropriately be called "augmented smart" cards. They contain additional features such as a keyboard and LCD, and resemble slim calculators. Three trials are currently underway in Japan by Visa (using Toshiba's card), by Sumitomo Bank (Omron) and by Fuji Bank (Oki).

High component and assembly costs are expected to make these cards expensive compared to smart cards, even in mass production. For this reason, we expect them to remain a curiosity for some years. Trials by one global credit card company and two major Japanese banks is *not* an indication that these cards will receive early adoption by the European financial community, or for other smart card applications.

MANY DIVERSE APPLICATIONS

France accounts for about half of the 67 established smart card applications we have counted in Europe, with this total more than doubling if card trials and experiments are also included. Figure 1 divides out the established applications in Europe by type. These types are defined below.

FIGURE 1
Existing Smart Card Applications in Europe Counted by Class



Source: Dataquest
May 1990

Electronic purse applications use token cards for prepayment. Examples are the payphone systems of France Telecom, Deutsche Bundespost and Televerket, numerous vending machine and car parking systems and Pathe's movie admission card.

Banking, shopping and credit applications use smart cards to perform PIN verification, authentication and, occasionally, to record transactions. Ultimately smart cards will replace magnetic stripe bank and credit cards. There have been many experiments, but only one has resulted in mass issue — Carte-Bancaire (16.5 million Bull and Philips smart cards) — and the Norwegian Bank card is commencing this year. The Eurocheque smart bank card, presently offered in Regensburg (West Germany), is another major and growing application.

Authentication covers a wide range of non-banking applications from pay TV, home shopping, PC security, to computer network and secure area access systems.

Pay TV became a major application following the scrambling of Sky's movie channel last February. This year, we expect about 50 percent of Sky's 1.3 million viewers (satellite and cable) to purchase prepaid viewing on disposable Gemplus smart cards every four months — 2 million cards. Large-scale card sales into the emerging French and West German D2-MAC Eurocrypt pay-per-view networks are less favorable since only one reusable smart card is issued per subscriber. There are no smart cards currently planned by BSB for its D-MAC channels.

Secure Data applications use smart cards as portable, secure data stores. The most promising applications, so far, are those taken up by the French medical insurance companies: Biocarte, Santal and Transvie. Many dental, pharmaceutical and hospital trials are also in progress. Other applications include industrial batch monitoring, electoral voting (Norway) and electronic lotteries (Loto, France).

Although potentially representing one of the largest markets, medical applications are characteristic in their need for high data capacities. Consequently, non-semiconductor laser card technologies with 2- to 3-Mbyte capacities may prove more suitable in the long term.

WHAT'S HOLDING UP THE SMART BANK CARD?

Replacement of the magnetic stripe credit or bank card is one of the greatest opportunities for the smart card. Overall, there has been scant uptake by the financial community because the savings from prevention of fraud are not sufficient justification alone for migration away from the magnetic stripe card.

We believe the two most significant European advances so far in smart card banking have occurred largely as a consequence of factors which are *atypical* for Europe as a whole:

- The recent decision by Carte Bancaire to expand its card issues to Paris and the rest of France should be viewed in the light of the fact that Carte Bancaire is a group of French banks which works in close harmony with the strategic initiatives in information technology advocated by the French government.
- The full-scale launch of the smart Norwegian Banking Card allows banks to perform secure off-line transaction processing, not previously possible using magnetic stripe cards. However, we believe the key economic factor behind this move is the abnormally high cost of fixed lines needed for on-line processing in Norway compared to the rest of Europe.

Waiting for Biometrics and Better Authentication

Easily forgotten and often uncovered by fraudsters, the personal identification number (PIN) is a less than ideal way to check identity. A "biometric" technique, that cross-matches a cardholder's characteristics with a metric stored in the card would be preferable. Possible metrics are written signature, finger prints, hand contours and face recognition. For use with existing smart card technology, the signature appears to be the most feasible. Dynamic signature verification trials by Midland Bank using the GEC contactless card are about to commence in the United Kingdom.

A smart card using biometric authentication would entail fitting biometric sensors to ATMs and POS terminals, at considerable cost. Consequently, the banks may be unlikely to opt for smart cards until they can all agree that one biometric is clearly superior to the others — not likely for some years.

The Sleeping Patents

Currently about 450 patents cover smart card technology in Europe. Bull, historically the leading innovator in smart cards, holds about half of these and administers them collectively. The others are owned by many different companies and private individuals. Consequently, a total assessment of patent liability by card manufacturers and issuers is difficult, and could become a major factor inhibiting the smart card's future generally.

Multiapplication Cards—The Snags

Recent smart card designs permit many different applications to reside on one card, with ISO standards passed to facilitate this. Potentially, this might make cards more affordable and reduce the number that have to be kept by cardholders. It would also allow the banks to sell services on behalf of other applications that reside on their cards (pay TV, for example).

There are two hurdles to overcome: first, no mechanism presently exists to prevent one application reading the memory space of another. To counter this limitation, each application is obliged to encrypt all data residing in it if security against being spied upon by another application is to be ensured. Second, there is value in having a brand logo printed on the card face, suggesting that many application vendors may be reluctant to share the same card with other vendors.

MOBILE TELEPHONES—A NEW CHAMPION

The GSM pan-European mobile telephone is set to become a champion for smart card market development, as was the payphone for the token card following France Telecom's adoption of it in 1983. (For an introduction to GSM, readers should refer to the ESAM newsletter "GSM in Europe —Cellular Turns Digital," March 1990.)

All GSM mobile phones will be fitted with smart card readers. Standard credit-card-sized cards will be used for in-car mobiles, with smaller plug-in modules intended for hand portables. Unlike today's cellular networks, call charges will be billed to the cards, not to the handsets. This opens the way to several smart cards being issued per handset.

Dataquest predicts a rapid uptake of GSM in Europe. In 1994, we forecast that 2.4 million handsets will be shipped into Europe. A reasonable assumption is that each handset will drive a demand for between one and two smart cards, leading to approximately 6 million GSM smart card issues and reissues in 1994.

THE MARKET

The smart card has not one market, but several. However, the emergence of just one mass application could dramatically transform the total market from what it is today. With much smart card technology, software and standardization already in place, such innovations can easily appear. With this qualification in mind we believe that, over the next five years, the bulk of the smart card IC market will lie with the following key applications:

- Payphone (prepaid and subscriber) cards
- Mobile telephone cards
- Banking and credit cards
- Pay TV cards
- Smart card readers and terminals (for the above applications only)

Inevitably, the emergence of other applications (particularly health, cordless telephone and transportation cards) will cause the total smart card consumption to exceed the total shipments of Figure 2.

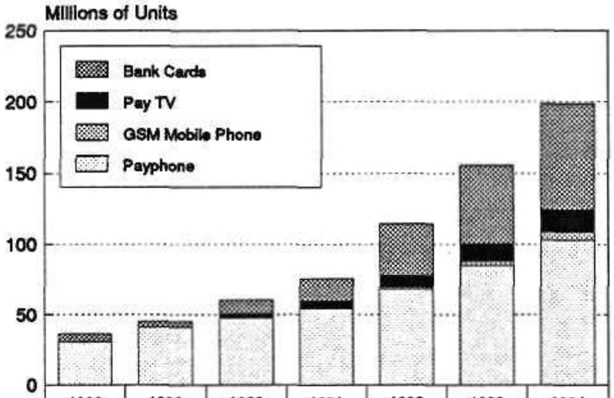
1989—The Year of the Payphone

We estimate that total token and smart card IC consumption (cards and terminals) amounted to $16.3 million in 1989 (Figure 3). ICs for payphone cards accounted for 57 percent ($9.3 million) of total semiconductor consumption, with smart bank cards taking most (38 percent, $6.3 million) of the remainder.

In 1989 we estimate that altogether 45 million IC cards were produced in Europe, of which 44.1 million were token cards consumed in the French market.

Telephone applications currently dominate. In units, the vast bulk of telephone cards were token cards with low IC value (25 cents). We estimate that smart cards for pay telephone applications accounted for only 250,000 units last year, but had a significantly higher semiconductor content ($1.40). Token cards offer limited services and, in principle, are susceptible to fraud — both factors will push payphone card demand from token to smart cards over the coming years.

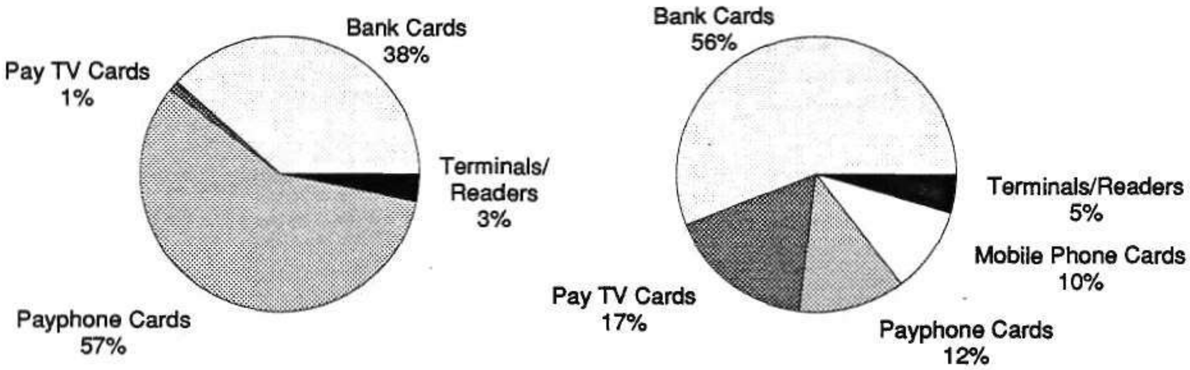
FIGURE 2
Estimated European Smart Card Production by Application Type



	1988	1989	1990	1991	1992	1993	1994
Bank Cards	6.1	3.9	10	16	36.5	55.2	74.24
Pay TV	0	0.1	2.8	4.8	8.3	12.6	16
GSM Mobile Phone	0	0	0	0.42	1.53	2.97	5.55
Payphone	30.25	41	47.6	54.41	68.1	85	103

Source: Dataquest
May 1990

FIGURE 3
Estimated European Smart Card IC Consumption Split by Application



1989
Total = $16.3 Million

1994
Total = $139 Million

Source: Dataquest
May 1990

1994—The Year of the Consumer

Two key European Commission (EC) studies are presently being conducted by CEN (the European standards body) and the European Payment Systems Council (EPSC) to evaluate the future roles between the consumers and retailers, bankers and other European institutions. It is known that these bodies are strongly in favor of the smart card as a universal transaction device for the consumer.

We forecast total production in Europe will rise to 199 million cards in 1994, showing a 35 percent CAGR in unit shipments since 1989. Interestingly, we predict that IC revenue growth will markedly outstrip unit growth over the same period: 54 percent CAGR, rising from $16.29 million in 1989 to $139 million in 1994. As applications appear that require smart card, as opposed to token card, ICs we expect the average semiconductor content to rise from an estimated 35 cents in 1989 to 67 cents by 1994.

The rapid emergence of banking, pay TV and mobile phone applications will cause today's scene to change dramatically, reducing payphone applications to 12 percent of total IC consumption, although nearly doubling its revenue. We expect IC revenue from banking smart cards to overtake payphone IC revenue this year (1990). In 1994, we expect them to account for IC revenue worth $78 million with 74 million cards shipped.

As pay satellite and cable TV find increasing acceptance in Europe, so will smart cards. Currently the main application is Sky TV, with others opening up as Canal+ moves to card-based decoders and D2-MAC EuroCrypt channels emerge in Europe. We forecast that 16 million pay TV smart cards will be issued in 1994, equivalent to an IC revenue of $24 million.

The number of smart card units shipped will in future depend on the extent to which multiple applications can share a single card. However, we expect IC revenue to be less sensitive to this outcome because the success of multiapplication cards would result in fewer cards — but more costly ICs.

CONCLUSIONS

The smart card IC will be one of the most critical products of the 1990s. The probability is that, by the end of this decade, at least one smart card will be used by every man, woman and child in Europe, for whatever purpose. In terms of uptake worldwide, smart card developments in the Far East at least parallel and probably exceed those in Europe.

The main implication for the European IC market is not the prospect of rapid growth, but that there will be an *irreversible* trend toward high-end smart cards containly increasingly sophisticated smart ICs. The ergonomics of a single powerful multiapplication smart card will eventually be compelling.

We expect to see many new entrants from the Far East in this market. The existing IC vendors must be prepared to put as much technology and investment into smart card ICs as they do into PCs and other main-line applications today because, one day, the smart card could become a PC.

Jonathan Drazin

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Research Newsletter

FLAT-PANEL DISPLAY: TRENDS AND DIRECTIONS

INTRODUCTION

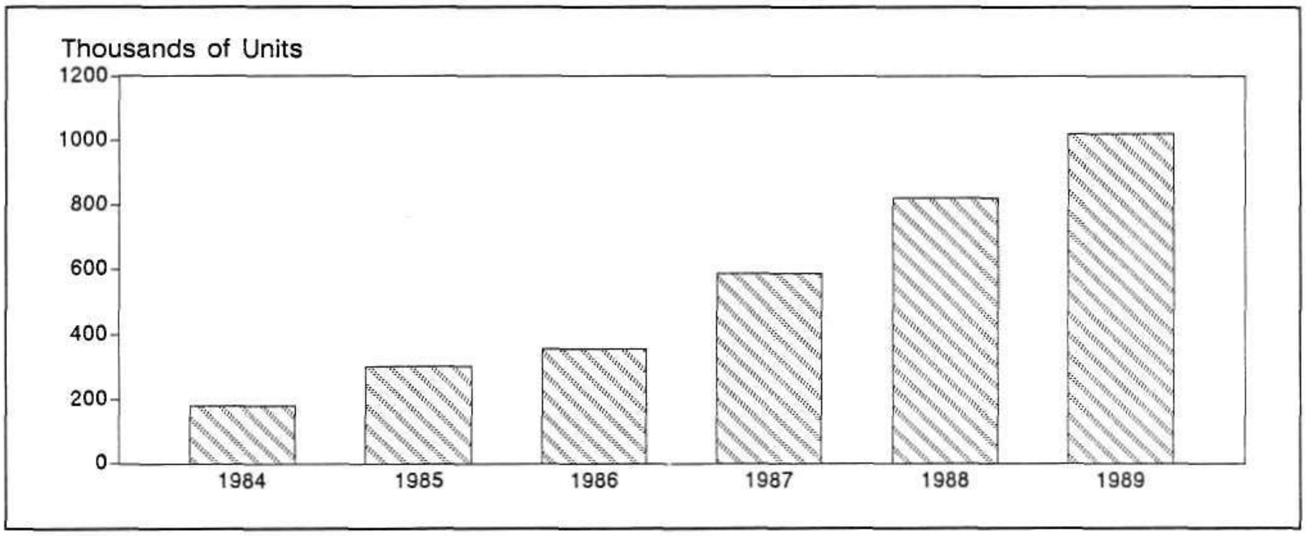
Display technology has witnessed exciting progress in the past decade. Although the traditional cathode-ray tube (CRT) display remains dominant in most applications, its future has never looked so doubtful. Replacing the vacuum tube CRT with some other "flat" technology has been anticipated ever since the vacuum tube triode was replaced by the solid-state transistor.

Ten years ago, liquid crystal display (LCD) development was driven by consumer electronics applications using small-area LCDs; few expected this technology to develop into a replacement for CRTs. Today, LCD technologies have emerged as the leading candidates to replace CRTs. Laptop computers are the current technological driving force for LCDs; however, LCD manufacturers also hope that their technology will play a major role in tomorrow's high-definition TVs (HDTVs). Screen manufacturers currently are demonstrating working prototypes of large-area color LCD displays at trade shows and are creating a frenzy of excitement. Market trends in laptop computers extrapolate to rapid growth with an even faster displacement of traditional machines being limited only by the lack of a high-contrast, reasonably priced, flat-panel display. Figure 1 shows the worldwide portable computer market.

LCD MARKET GROWS

Although many manufacturers have demonstrated impressive working models of color LCD displays, the major problems with bringing these

FIGURE 1
Worldwide Portable Computer Market



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Source: Dataquest
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products to market are manufacturing in nature. Specifically, obtaining a high yield from large-area display production is a monumental problem that roughly parallels the challenges of producing the next generation of DRAM products. Whereas DRAMs involve placing a larger number of working transistors on a chip, thin-film display (TFT) LCDs must make their transistors work over a larger physical area of material that is fundamentally less uniform (i.e., nonsingle crystal). Corporate efforts toward solving DRAM and TFT LCD manufacturing problems are very similar; massive investments by major manufacturers are being augmented by strategic alliances and membership in various consortia.

Last August, IBM and Toshiba announced the establishment of a new joint venture company, Display Technology Corporation (DTC). At the press conference, one of the DTC company officers predicted that TFT display panels would completely take over CRT displays. At an Osaka, Japan, electronics trade show last October, DTC demonstrated its new product, an 11.2-inch diagonal color TFT LCD fabricated on amorphous silicon. The DTC display had a pixel count of 720 x 480 and an intensity of 120 cd/m^2 with a contrast ratio of between 20:1 and 40:1. At the same trade show, comparable color TFT LCDs were shown by Hitachi, Seiko-Epson, and others.

Many Japanese electronics companies have begun funneling large investments into their LCD production facilities. Sharp, a leading LCD manufacturer, announced plans to invest ¥140 billion ($970 million) in LCD production by 1994. The company currently has two factories under construction. As well as its joint venture with IBM, Toshiba will spend ¥3 billion ($21 million) to strengthen its existing LCD production facilities during 1990. Toshiba executives have been quite explicit in their expectations that LCDs will play a key role in future corporate product strategy. Current goals at Toshiba are to fabricate 10- to 14-inch color TFT panels with one megapixel of resolution to be produced concurrently with its 4-Mbit generation of DRAM products. Hitachi, Matsushita, Mitsubishi, and Seiko-Epson all announced intentions to invest heavily—approximately ¥10 billion to ¥30 billion ($70 million to $210 million) apiece—in LCD manufacturing capacities. In 1990 alone, total investment in LCD technology by major electronics companies should exceed ¥100 billion. Even a relatively small company, Alps Electric of Tokyo, is planning to build a ¥5 billion ($35 million) color LCD facility that should be operational this spring. Other Japanese players include Hoshiden Electronics, NEC, and Sanyo. Most companies have relatively lofty goals, taking direct aim at color panels with dimensions greater than 10 inches, employing TFT technology, and scheduling mass production in 1990 or by early 1991.

Japanese market projections forecast a ¥1 trillion LCD business by 1995. As a large contribution to this growth, industry observers forecast a tenfold increase in the laptop computer industry from its current level until the end of 1993. In the long term, HDTV is expected to be the next bonanza for the electronics industry, with many gambling that LCD will be the primary display technology for HDTV implementation. Present Japanese domestic CRT production is approximately ¥500 billion ($3.5 billion) per year.

JAPANESE GOVERNMENT CONSORTIA

Because LCD development clearly is resource intensive, private enterprise in the display arena is being complemented by several government-sponsored efforts in Japan. In 1989, the Japanese government established two consortia related to LCD research. Table 1 gives the background on these two recently formed consortia, which were assembled by the Japan Key Technology Center (Japan Key-TEC), the Ministry of International Trade and Industry's (MITI's) research organizer.

Giant Technology Corporation (GTC) has the charter to develop various fundamental technologies needed to realize a 1-square-meter (about 40 x 40 inches) color TFT LCD display, thereby attempting to leap over at least one generation of LCD displays. Participants include a diverse group of traditional electronics companies and printing, glass, and vacuum technology companies. At press time, the project appears to be progressing smoothly.

High Definition Television Engineering Corporation (HDTEC) is primarily studying HDTV technology. HDTEC currently is pursuing four objectives simultaneously; one objective is the improvement of projection-type LCD displays.

OTHER TECHNOLOGIES: DOWN WITH THE BLUES

Professor Akazaki and a team of semiconductor engineers at Japan's Nagoya University recently developed a high-intensity blue light-emitting diode

TABLE 1
Japanese Display Technology Consortia

	Giant Electronics Technology Corporation (GTC)
Established:	March 23, 1989
Objectives:	R&D of advanced technologies for large-area TFT circuitry
Project Term:	7 years
Budget:	¥13 billion ($90 million)
Participants:	Japan Key Technology Center (Japan Key-TEC), Asahi Glass, Casio, Chisso, Dainippon Printing, Fujitsu, Hitachi, Hoechst Japan, Japan Sheet Glass, Japan Synthetic Rubber, NEC, Sanyo, Sharp, Seiko-Epson, Semiconductor Energy Research, Thomson Japan, Toppan, Ulvac
	High Definition Television Engineering Corporation (HDTEC)
Established:	March 27, 1989
Objectives:	R&D of HDTV technologies such as computer graphics, high-speed digital information transfer systems, LCD projection type display, and evaluation of display quality
Project Term:	5 years
Budget:	¥3.5 billion ($24 million)
Participants:	Japan Key Technology Center (Japan Key-TEC), JR Research, Meitec, NEC, NHK, Seiko-Epson

Source: Dataquest
May 1990

(LED). Red and green LEDs have been available for some time, but blue LEDs have long eluded researchers, creating the primary barrier to the successful implementation of a flat-panel color display based on LED technology. It is likely that the first LED display products will be hybrids, i.e., discrete or small-scale devices bonded together that will not require the high manufacturing yield of monolithic devices. Because one-dimensional bonded LED arrays of page-size dimensions now are being used as imaging arrays in commercial high-resolution printers (in competition with laser printers), it is clear that this type of packaging already exists to some degree. LED displays should offer superior contrast, color, and viewing angle when compared with LCD displays. Sanyo already has made progress toward the development and commercialization of blue LEDs.

Although gas plasma and electroluminescent screens are not as well publicized as LCD displays, their contrast and response time are considered their traditional strong points. At the Osaka electronics show, Matsushita revealed a 17-inch color plasma display that it plans to sample-ship by the end of 1990. Matsushita's display had an output intensity specification of only 25 cd/m^2 at a 640 x 480 pixel resolution, but it possessed a contrast ratio of 150:1. The only other non-LCD products shown at this show were a fast 12-inch monochrome plasma display from Oki and a 10-inch monochrome electroluminescent screen from Sharp. As with displays based on LEDs, progress in the development of color electroluminescent screens has been hindered by the lack of a high-intensity blue phosphor.

DATAQUEST ANALYSIS

Dataquest believes that further erosion of the CRT market is inevitable. Although many technologies compete with the CRT in monochrome applications, the LCD is positioned to be the first to compete directly with the CRT in applications requiring color displays. The TFT LCD manufacturing learning curve will determine the price-time progression and thus define both how quickly laptop computers displace desktop machines and, more generally, how rapidly LCD panels penetrate traditional CRT markets. However, several competing technologies should not be discounted, including plasma discharge, electroluminescence, and LEDs, all of which probably will evolve to the level needed to create a usable color, flat-panel display. In the past decade, LCDs have benefited numerous advances such as the so-called supertwist technology and the advent of thin-film transistors on amorphous silicon. However, if a comparable innovation or breakthrough occurs in one of the less publicized technologies, such as those based on gas plasmas, electroluminescence, or even cold cathodes, it could once again change the complexion of the display market. We could conceivably see a renewed interest in such a technology in the same way that there has been resurgence of interest in bipolar transistors in the digital VLSI arena.

(This newsletter is reprinted with the permission of Dataquest's Japanese Semiconductor Application Markets service.)

Mike Williams
Junko Matsubara

Dataquest
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The Dun & Bradstreet Corporation

Research *Newsletter*

EXCHANGE RATE QUARTERLY NEWSLETTER

FINAL 1989

Dataquest exchange rate tables involve data from many countries, each of which has different and variable exchange rates against the U.S. dollar. As much as possible, Dataquest estimates are prepared in terms of local currencies before conversion (when necessary) to U.S. dollars. Dataquest uses International Monetary Fund (IMF) average foreign exchange rates; but all exchange rates quoted after final 1989 will be sourced from the *Wall Street Journal* in line with standard Dun & Bradstreet practice.

All forecasts are prepared assuming no changes in any exchange rate from the last complete historical year—in this case, 1988. During the course of the current year, as local currency exchange rates vary, the appropriate U.S. dollar value changes accordingly. To maintain consistency across all its analyses, Dataquest does not make ongoing adjustments to its forecasts for these currency changes during the current year. As a result of this policy, as the year progresses the forecast numbers could become distorted, in dollars, should the European currencies deviate substantially from the previous year's rates.

Dataquest monitors the exchange rates on a weekly basis using IMF exchange rates, supported by *Financial Times* exchange rates when IMF data are not yet available. (*Financial Times* is the accepted U.K. newspaper giving daily updates.) Effective exchange rates for the current year are calculated each month. This information is then used to assess the local currency's impact on U.S. dollar forecasts.

The purpose of this newsletter, which will be updated quarterly, is to record these changes, and thus allow the reader to make any necessary adjustments when interpreting regional data. For each European region, Table 1 gives the local currency per U.S. dollar for 1988, third quarter 1989, and fourth quarter 1989 together with the final estimate for the whole of 1989. Also shown, for reference purposes, are the same figures for the Japanese yen. As can be seen from this table, the Semiconductor Industry Weighted Average (SIWA) for all the European currencies for 1989 has decreased 7.0 percent with respect to the U.S. dollar, compared with 1988. This represents an increase of 3.8 percent in the exchange rates from third quarter 1989 to fourth quarter 1989. Table 2 shows the 1989 quarterly values for the same regions.

Table 3 illustrates how to interpret the effect of the currency shifts on the Dataquest forecast numbers. For example, the table shows that the constant dollar forecast of $10,208 million for the 1989 total European semiconductor market becomes $9,537 million when adjusted for changes in European currencies.

Table 4 shows the 1989 monthly values of local currency per U.S. dollar for each European region and Japan.

Included in the tables is the European Currency Unit (ECU). This unit, established in March 1979, is a weighted average of the currencies of all member countries of the European Community (EC). It is calculated by the IMF from each country's gross national product (GNP) and foreign trade.

Also included is the aforementioned SIWA. This unit is based on the semiconductor consumption of each European country featured here (EC and non-EC members) and uses the base year 1980 equal to 100 as a reference point. The SIWA is useful for interpreting the effect of European currency fluctuations with respect to the U.S. dollar, specifically for the European semiconductor industry.

James Heal

TABLE 1
European Currencies—1988 to 1989
(Local Currency per U.S. Dollar)

Region	1988	Q3 1989	Percent Change 3Q89-4Q89	Q4 1989	1989	Percent Change 1988-89
Austria	12.35	13.54	5.7	12.77	13.23	(7.1)
Belgium	36.77	40.27	5.5	38.06	39.40	(7.2)
Denmark	6.73	7.48	5.7	7.05	7.31	(8.6)
Finland	4.18	4.34	2.9	4.21	4.29	(2.7)
France	5.96	6.50	5.2	6.17	6.38	(7.0)
Ireland	0.66	0.72	5.1	0.68	0.71	(6.5)
Italy	1,301.60	1,386.60	3.7	1,335.43	1,372.09	(5.4)
Luxembourg	36.77	40.27	5.5	38.06	39.40	(7.2)
Netherlands	1.98	2.17	5.7	2.05	2.12	(7.1)
Norway	6.52	7.04	2.7	6.85	6.90	(5.9)
Portugal	143.96	161.27	3.0	156.38	157.46	(9.4)
Spain	116.49	120.60	4.0	115.76	118.38	(1.6)
Sweden	6.13	6.54	2.3	6.39	6.45	(5.2)
Switzerland	1.46	1.66	3.2	1.61	1.63	(12.0)
United Kingdom	0.56	0.63	(0.7)	0.63	0.61	(10.1)
West Germany	1.76	1.92	5.7	1.81	1.88	(6.8)
ECU	0.85	0.93	4.3	0.89	0.91	(7.1)
SIWA (Base 1980 = 100)	121.46	132.73	3.8	127.65	130.01	(7.0)
Japan	128.11	142.42	(0.5)	143.18	138.02	(7.7)

Source: IMF
Dataquest
March 1990

TABLE 2
European Currencies—1989 by Quarter
(Local Currency per U.S. Dollar)

Region	Q1	Q2	Q3	Q4	Total Year 1989
Austria	13.01	13.61	13.54	12.77	13.23
Belgium	38.75	40.53	40.27	38.06	39.40
Denmark	7.18	7.53	7.48	7.05	7.31
Finland	4.29	4.32	4.34	4.21	4.29
France	6.29	6.56	6.50	6.17	6.38
Ireland	0.69	0.72	0.72	0.68	0.71
Italy	1,357.30	1,409.03	1,386.60	1,335.43	1,372.09
Luxembourg	38.75	40.53	40.27	38.06	39.40
Netherlands	2.09	2.18	2.17	2.05	2.12
Norway	6.72	7.01	7.04	6.85	6.90
Portugal	152.01	160.18	161.27	156.38	157.46
Spain	115.52	121.63	120.60	115.76	118.38
Sweden	6.31	6.55	6.54	6.39	6.45
Switzerland	1.58	1.70	1.66	1.61	1.63
United Kingdom	0.57	0.62	0.63	0.63	0.61
West Germany	1.85	1.93	1.92	1.81	1.88
ECU	0.89	0.93	0.93	0.89	0.91
SIWA (Base 1980 = 100)	126.64	133.04	132.73	127.65	130.01
Japan	128.53	137.95	142.42	143.18	138.02

Source: IMF
Dataquest
March 1990

TABLE 3
Effect of Changes in European Currencies per U.S. Dollar on Dataquest Forecasts—1988 versus 1989
(Millions of U.S. Dollars)

	1988	1989	Percent Change 1988-1989
European Semiconductor Consumption (At Constant 1988 Exchange Rates)	$8,491	$10,208	20.2
Weighted European Currency (Assumed) (Base 1980 = 100)	121.46	121.46	N/M
Weighted European Currency (Latest Estimates)	121.46	130.01	(7.0)
Effective Consumption (At August YTD Exchange Rates)	$8,491	$9,537	12.3

N/M = Not Meaningful

Source: IMF
Dataquest
March 1990

TABLE 4
European Currencies—1989 by Month
(Local Currency per U.S. Dollar)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	1989	1988	Percent Change 1988-89
Austria	12.87	13.03	13.12	13.16	13.72	13.94	13.33	13.55	13.75	13.15	12.88	12.27	13.23	12.35	(7.1)
Belgium	38.35	38.83	39.08	39.17	40.94	41.47	39.65	40.29	40.88	39.21	38.35	36.63	39.40	36.77	(7.2)
Denmark	7.08	7.20	7.27	7.28	7.59	7.72	7.36	7.49	7.59	7.28	7.11	6.77	7.31	6.73	(8.6)
Finland	4.24	4.34	4.30	4.19	4.34	4.43	4.27	4.34	4.41	4.27	4.25	4.12	4.29	4.18	(2.7)
France	6.25	6.31	6.32	6.33	6.62	6.72	6.42	6.50	6.59	6.33	6.22	5.95	6.38	5.96	(7.0)
Ireland	0.68	0.69	0.70	0.70	0.73	0.74	0.71	0.72	0.73	0.70	0.69	0.66	0.71	0.66	(6.5)
Italy	1,344.20	1,356.70	1,371.00	1,372.40	1,418.30	1,436.40	1,371.00	1,383.50	1,405.30	1,369.20	1,343.50	1,293.60	1,372.09	1,301.60	(5.4)
Luxembourg	38.35	38.83	39.08	39.17	40.94	41.47	39.65	40.29	40.88	39.21	38.35	36.63	39.40	36.77	(7.2)
Netherlands	2.07	2.09	2.10	2.11	2.20	2.23	2.14	2.17	2.20	2.11	2.06	1.97	2.12	1.98	(7.1)
Norway	6.66	6.72	6.79	6.79	7.05	7.19	6.95	7.04	7.12	6.94	6.90	6.70	6.90	6.52	(5.9)
Portugal	150.28	151.96	153.79	154.65	160.92	164.98	158.91	161.22	163.67	159.16	157.53	152.44	157.46	143.96	(9.4)
Spain	114.69	115.66	116.20	116.19	121.94	126.76	119.04	120.53	122.24	118.61	116.49	112.18	118.38	116.49	(1.6)
Sweden	6.26	6.31	6.37	6.36	6.59	6.69	6.47	6.54	6.60	6.45	6.42	6.29	6.45	6.13	(5.2)
Switzerland	1.56	1.57	1.60	1.65	1.73	1.71	1.63	1.66	1.69	1.63	1.62	1.57	1.63	1.46	(12.0)
United Kingdom	0.56	0.57	0.58	0.59	0.61	0.65	0.62	0.63	0.64	0.63	0.64	0.63	0.61	0.56	(10.1)
West Germany	1.83	1.85	1.86	1.87	1.95	1.98	1.89	1.93	1.95	1.87	1.83	1.74	1.88	1.76	(6.8)
ECU	0.88	0.88	0.89	0.90	0.93	0.95	0.91	0.93	0.94	0.91	0.89	0.86	0.91	0.85	(7.1)
SIWA (Base 1980 = 100)	125.34	126.68	127.89	128.42	133.86	136.83	130.77	132.72	134.69	130.28	128.73	123.96	130.01	121.46	(7.0)
Japan	127.96	127.60	130.02	131.97	138.01	143.86	141.11	141.11	145.05	141.93	143.52	144.10	138.02	128.11	(7.7)

Source: IMF
Dataquest
March 1990

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Research *Newsletter*

AUTOMOTIVE ELECTRONICS IN EUROPE—THE REAL ISSUE IS COST

SUMMARY

Western Europe is the largest automotive producer in the world, accounting for 30 percent of world production.

Competition among manufacturers is fierce. There is a continuing battle to incorporate more and more electronic features for safety, performance and convenience. As a result, sophisticated electronic systems are spreading from luxury cars into high-volume midrange models, putting pressure on semiconductor manufacturers to quickly enhance their technology while at the same time increasing reliability and reducing cost.

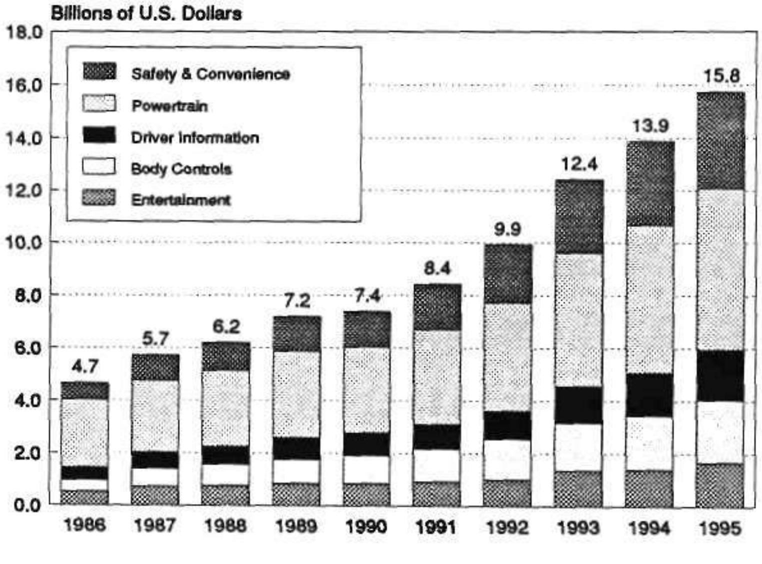
This newsletter gives an overview of the European transportation semiconductor markets, based on an analysis of transportation semiconductor vendors in Europe. The results of our study show that there are few technological barriers at the moment. The key issue remains reliability and cost.

OVERVIEW

Developments in ASICs, mixed analog and digital design, reliability and packaging have contributed to a steep rise in semiconductor content as a proportion of total vehicle value. The same developments are also responsible for driving down the cost of existing electronic systems.

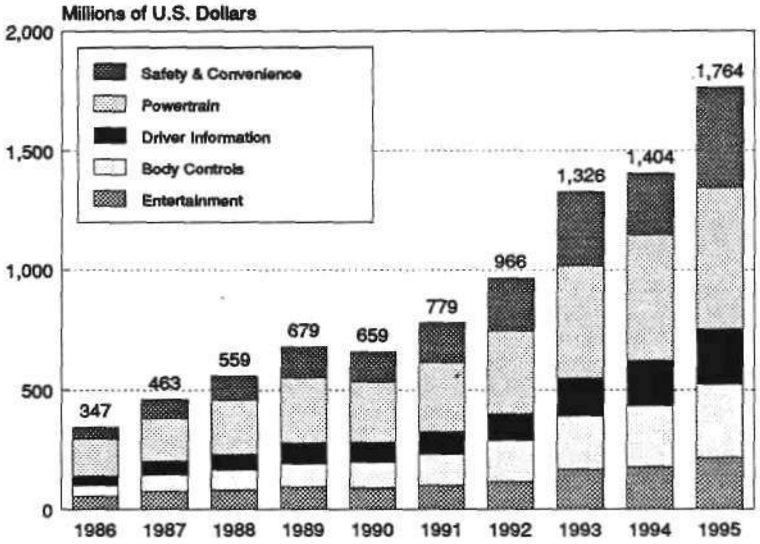
Dataquest estimates that the transportation semiconductor total available market (TAM) in

FIGURE 1
Estimated European Transportation Electronic Equipment Forecast



Source: Dataquest
April 1990

Figure 2
Estimated European Transportation Semiconductor Consumption Forecast



Source: Dataquest
April 1990

Europe grew by 21.5 percent in U.S. dollars in 1989, compared to 1988. In 1989 the transportation electronic equipment market grew by 16.0 percent. This clearly indicates that currently, semiconductor consumption in transportation equipment is increasing.

We see the trend continuing over the next five years. Over the period 1991 to 1995, we forecast the transportation semiconductor TAM will grow at a compound annual growth rate (CAGR) of 22.7 percent, compared to a CAGR of 16.9 percent for the transportation electronic equipment market.

Figure 1 shows the total transportation database analysis of electronic equipment production in Europe, and Figure 2 illustrates estimated semiconductor consumption for transportation applications by equipment type.

Historically, safety and convenience, driver information, and body controls have grown above the average transportation electronic equipment CAGR of 17.5 percent (1986 to 1990). This trend is also reflected in the semiconductor TAM for the same segments, which indicates the increased volume of semiconductor usage in these three segments.

We estimate, in our forecast, strong growths for safety and convenience, and driver information applications. Body control applications will show growth above the average transportation semiconductor CAGR over the period 1991 to 1995.

These anticipated growths are due to the following factors:

- Developing technologies: antilock braking systems (ABS), power steering, multiplexing, radio data systems (RDS), in-car navigation, traffic control.
- European Commission (EC) research and development initiatives under Eureka and ESPRIT scheduled to mature in the mid-1990s:
  - Eurotrac: Pollution reduction systems
  - Europolis: Control systems to aid urban and interurban traffic, and metropolitan traffic information control and monitoring
  - Carmat 2000: New fabrication techniques for car body production
  - ERTIS: Transborder road information systems
  - Prometheus: Road traffic control and monitoring to minimize congestions
  - Cell Bus: Electric vehicle propulsion systems
  - Carminat: Driver information display systems
- Progressive tightening of European emission control legislation—full adoption of the "Luxembourg Agreement" (Ref: EC Directives 83/351, or the similar UN/ECE Regulation 15.04;

88/76; 88/436; 88/77; 89/458) to enforce strict rules about vehicle fuel emission levels across Europe by 1993.

- Further growth will come from the large-scale appearance of Japanese car manufacturing activity in Europe, possibly bringing with them their own semiconductor suppliers.

Entertainment

European semiconductor consumption for in-car entertainment systems, mainly car radios, is estimated to have grown at a 12.6 percent CAGR between 1986 and 1990. The emergence of RDS and its acceptance by the major broadcasters in Europe is already stimulating growth in this segment. RDS is becoming standard in an increasing number of radios supplied by Ford, Philips, Bosch (Blaupunkt) and General Motors (GM). France, West Germany and the United Kingdom are expected to give national support to this program.

Over the next five years, car entertainment applications will expand to include compact disc (CD) players and noise reduction systems such as the Lotus-developed "Adaptive Noise Control System," licensed to Blaupunkt. We forecast an increased growth for this segment of 21.2 percent CAGR for the period 1991 to 1995.

Body Controls

Multiplexing will connect all electrical vehicle subsystems such as lights, instrumentation, engine controls and ABS onto one common bus, and represents a radical development for the 1990s. Multiplexing will commence very shortly in Europe, with Mercedes and BMW expected to pioneer it later this year. Initially, it will appear in high-end cars because the cost per unit of introducing this new technology is still high. Successfully to change up to multiplexing, car manufacturers will need to cooperate closely with their suppliers. Many other manufacturers such as Austin Rover, Ford, GM, Honda, Nissan, Toyota and Volkswagen–Audi are known to be well advanced with their multiplexing plans.

We estimate a 25.0 percent CAGR in body control semiconductor consumption between 1986 and 1990, with a 23.5 percent CAGR forecast for 1991 to 1995.

Driver Information

Semiconductor consumption in the driver information systems segment includes dashboard, diagnostics, navigational computers and audio annunciation systems. Overall, these are estimated to have grown by 20.7 percent CAGR between 1986 and 1990. We expect the German, French, Italian and U.K. governments to progress furthest in this direction through their interests in the Prometheus project.

GEC-MEDL has just completed installation of "Autoguide" traffic sensor networks on major motorways in the United Kingdom, with a parallel program (ARIAM) in West Germany using Bosch-ANT systems. Similar developments are underway in France. With the infrastructure moving into place, the next phase will be for cars in these countries to be fitted with driver information units.

Dataquest forecasts a semiconductor consumption CAGR of 25.2 percent between 1991 and 1995 for this segment.

Powertrain

Powertrain is a more mature market for semiconductors. It covers electronic ignition, emission systems, fuel control, turbo/engine control, transmission control, and diagnostics or on-board computer systems. Many of these are today found in most midrange cars, but there is still room for further penetration.

We have seen a CAGR of 12.6 percent between 1986 and 1990, in terms of semiconductor consumption in powertrain. EC regulations will further tighten emission controls and pave the way for electronic engine control units made by Motorola, ITT, Bosch, Siemens and Marelli-Autronica. These units control fuel flow and ensure the most efficient injection of fuel. We forecast a 19.6 percent CAGR for semiconductor consumption in this area between 1991 and 1995.

A new electronic engine management unit, Modular Engine Management System (MEMS), has been introduced into Rover's latest 214Si saloon car. Based on an Intel 8096 microprocessor, the system has an 8-kilobyte memory and allows full diagnostics using Rover's own smart card based ROSCO (Rover Service Communications Protocol). Similar applications have also been developed by Ford, GM, Hyundai and Mazda.

Safety and Convenience

Car safety and convenience systems, mainly ABS and antiskid/antislip systems, are expected to create further semiconductor demand. On the safety front, other developments include the latest version of Bosch's ABS-2E system, which due to its lower cost can now be fitted into compact cars. The electronic controller is substantially reduced in size and attached directly to the hydraulic modulator for the first time. Consequently, it can be installed more easily and at lower cost.

Dataquest estimates a 26.6 percent CAGR for semiconductors in these areas, between 1991 and 1995, compared to a 25.7 percent CAGR in the last four years, 1986 to 1990.

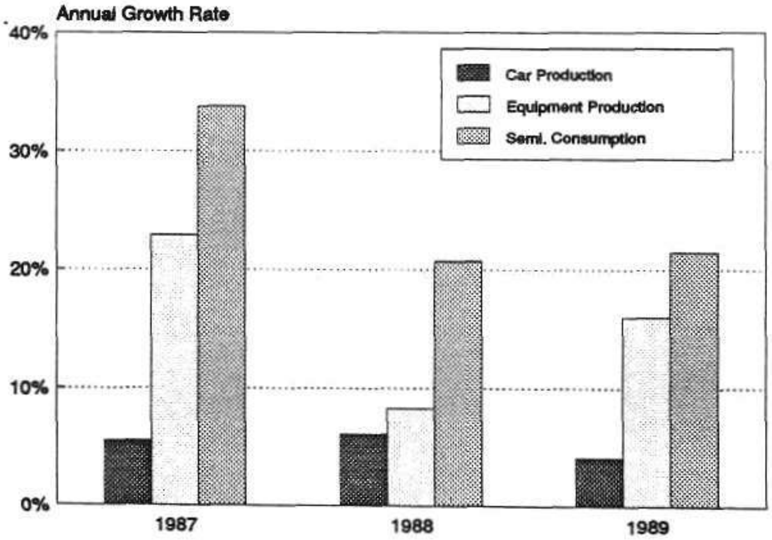
CONCLUSIONS

The transportation industry experienced rapid growth in the late 1980s and is set for continued growth this decade. Recent announcements by Fiat, Ford, GM, Mercedes-Benz, and Volkswagen to site production in Eastern Europe indicate that volume production of automobiles will continue to grow in Europe. Consequently growth in the automotive electronic equipment market is as favorable as ever. Figure 3 summarizes how transportation semiconductor consumption growth rates have consistently outperformed both car production revenue, and revenue for the electronic systems in cars.

Looking to the future, we predict technological developments in the semiconductor industry will form a basis for practical solutions for the car manufacturer. We anticipate the development of the "smart car" through closer technological and cooperative relationships between semiconductor manufacturers, system designers and automotive manufacturers. The outlook is good, particularly in Europe which has the largest volume of both production and sales worldwide.

Mike Williams

FIGURE 3
Comparison of Annual Growth Rates



Source: Dataquest
April 1990

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Research *Newsletter*

1990 FORECAST BY APPLICATION—THE KEY TRENDS

SUMMARY

Dataquest's survey of European semiconductor consumption in 1989 gives a total revenue of $9,537 million, a 12.3 percent growth over 1988. In terms of growth by application, data processing ($3,080 million) and transportation ($677 million) come top of the league with 21.3 and 21.1 percent growth rates respectively, followed some distance behind by industrial ($1,792 million) with 10.3 percent, communications ($1,880 million) with 8.3 percent, military ($533 million) with 5.5 percent and, lastly, consumer ($1,575 million) with 3.2 percent.

Over the period 1990 to 1995, we forecast the compound annual growth rate (CAGR) for total semiconductor consumption in Europe to be 17.4 percent, higher than that of both Japan (16.6 percent) and North America (17.1 percent). In terms of growth by application in Europe, we forecast the dominance of data processing and transportation applications to continue with 21.0 and 20.3 percent CAGRs respectively. These are followed by communications with 17.0 percent, consumer with 14.9 percent, industrial with 13.3 percent, and military with 7.7 percent.

This newsletter gives an overview of the major long-range consumption trends by application in Europe, presenting our five-year semiconductor forecast and an historical analysis for the previous five years.

THE GROWTH-SHARE CHARTS EXPLAINED

The figures in this newsletter present Dataquest's estimates and forecasts for the long-range trends in European semiconductor consumption by application for the period 1986 to 1995. For each application, we show relative market size along the horizontal axis and annual growth along the vertical axis. To aid readability, only relative market sizes and compound annual growths for the extreme years, 1986 and 1995, are shown.

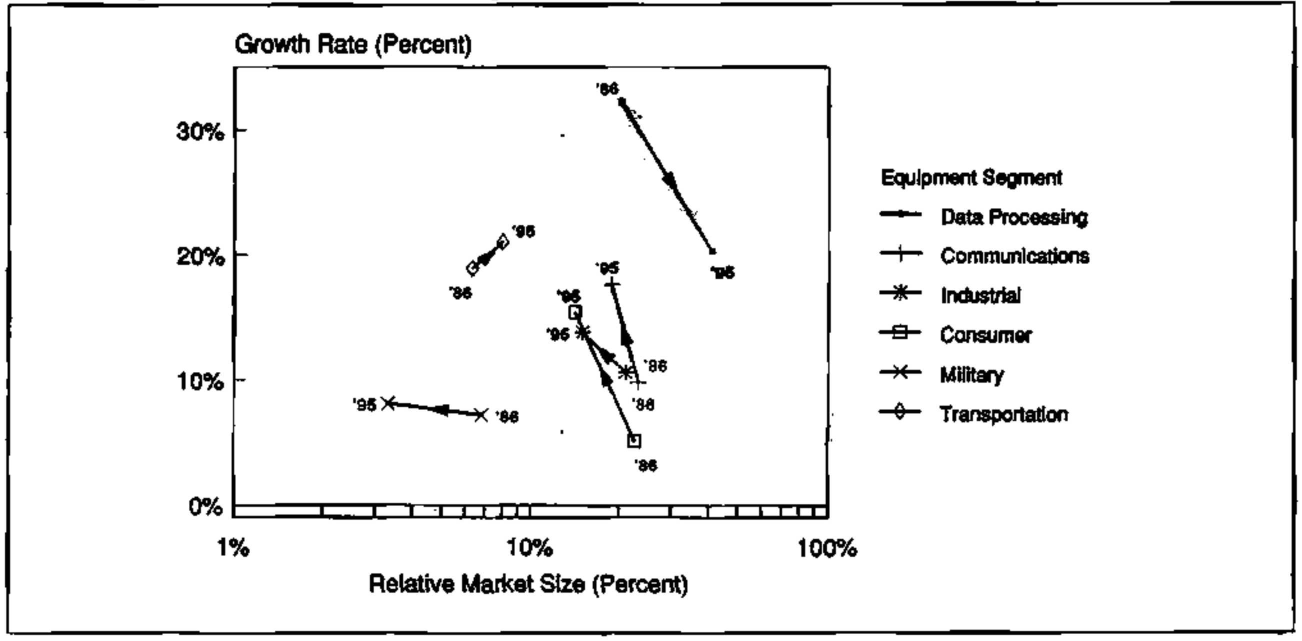
These data are consolidated from analyses of more than 90 application segments in Europe, and incorporate the preliminary results of Dataquest's survey of semiconductor consumption in Europe by application for 1989. For further details, clients of Dataquest's European Semiconductor Application Market service should refer to the recently published "European Semiconductor Application Markets (ESAM) Reference Tables 1990."

Figure 1 gives an overview of the broad trends by the six application categories:

- Data Processing
- Communications
- Industrial
- Consumer
- Military
- Transport

Figures 2 to 7 describe the trends within each of the above segments.

Figure 1
Total European Semiconductor Consumption



Source: Dataquest
April 1990

OVERVIEW

Semiconductor consumption in the data processing sector (see Figure 1) will continue to lead the market. However, we expect the high 32.3 percent CAGR for the 1986 to 1990 period to decline to 20.3 percent over 1991 to 1995, due mainly to two factors:

- Recent rises in MOS memory and microcomponent prices have contributed to abnormally high historic revenue growth.
- Hardening of governmental and European Community attitude towards local content over recent years. The effects have been particularly strong in dot matrix and laser printers, workstations and personal computers, with the result that companies like Amstrad, Apple, Canon, IBM, NEC and Tandon have invested strongly in local production. The consequent growth in semiconductor consumption has boosted the data processing consumption above that of the underlying end-user market.

The same local content issues that have raised data processing equipment production in Europe will next take effect in the consumer market. The low margins in consumer equipment production will induce many Far Eastern-owned factories to seek alternatives to importing PCBs and paying 4.9 percent duty. Instead, we expect them to purchase and mount locally, leading to a strengthening of local consumer semiconductor consumption. We forecast a 14.9 percent CAGR for the 1991 to 1995 period—compared with a poor 3.2 percent CAGR estimated for the 1986 to 1990 period.

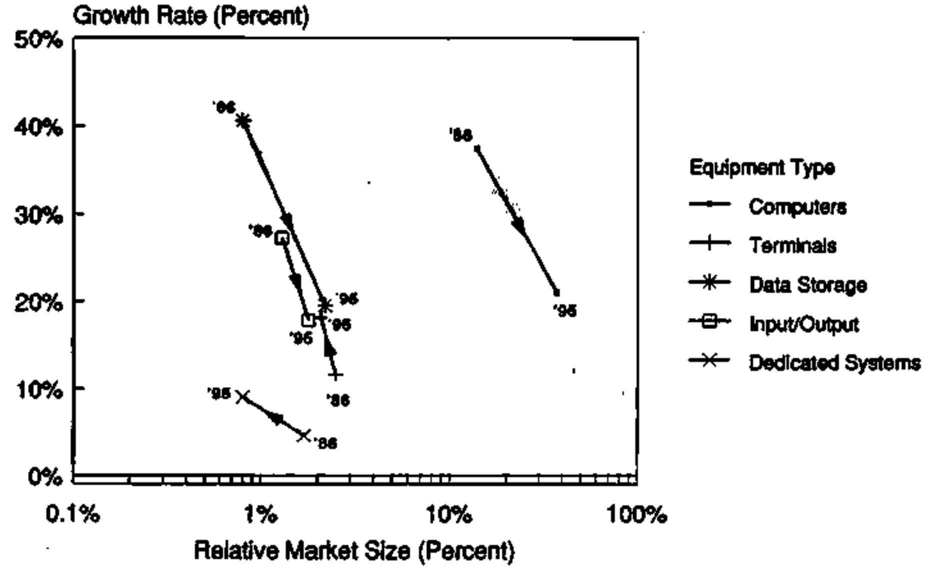
Aside from data processing we forecast that only transportation, pushed by a combination of growing semiconductor content in cars and tightening environmental legislation in Europe, will increase its share of total semiconductor consumption. We forecast a rise from 6.3 percent of total semiconductor consumption in 1986, to 8.0 percent by 1995.

The continuing pattern of declining military spend in Western Europe has led to an outlook of continued, but weak, growth in absolute military semiconductor consumption. We estimate that this failure to show growths comparable with the other major applications segments will force a dramatic decline in share, from 6.8 percent of total European consumption in 1986 to an estimated 3.3 percent by 1995.

DATA PROCESSING—STILL OUT IN FRONT

As mentioned, we forecast reduced semiconductor growths in each of the major data processing sectors (see Figure 2). However, we expect terminals and dedicated systems to buck the overall trend. New developments in terminal design and data communications standards are leading to greatly improved functionality. In particular, recent X.Terminal offerings from NCD and NCR appear set to challenge the trend of the last half-decade from centralized mainframe to distributed workstation based computing. Other terminal and dedicated systems applications will enjoy similar high growths: point-of-sale terminals, smart card automatic teller machines (ATMs) and readers, and bar code readers.

Figure 2
Electronic Data Processing Semiconductor Consumption in Europe



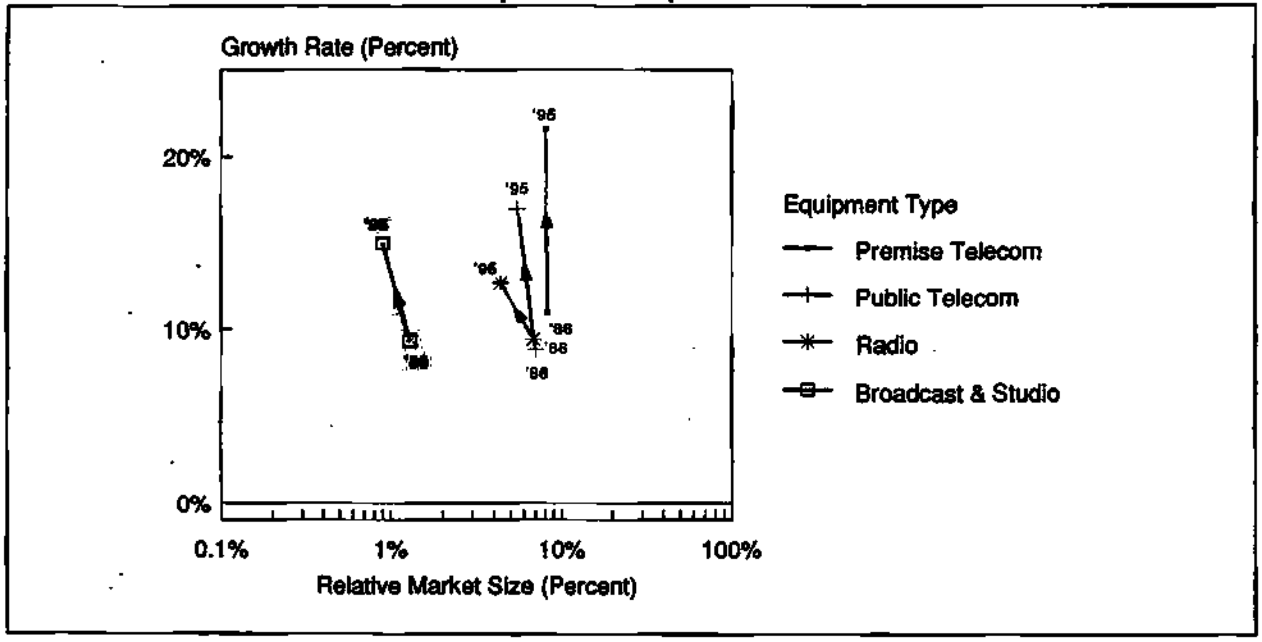
Source: Dataquest
April 1990

COMMUNICATIONS—CUSTOMER PREMISE TO DRIVE DEMAND

Spurred on by the European Commission's Green Paper on telecommunications, liberalization of hardware supply and equipment services will accelerate competition among suppliers to both the public and private networks in Europe. Despite this, we believe the pattern of almost 100 percent supply of the European public network by local production will continue, with suppliers like Alcatel, Ericsson and Siemens maintaining their strong positions against non-European manufacturers.

The strongest applications drivers will increasingly come from telecom premise applications (Figure 3)—particularly from digital cordless (CT2 and DECT), optical local area networks (FDDI), digital cellular (GSM) and facsimile over the coming three to four years. Beyond this period, we foresee that personal communications networks (PCNs) and ISDN (particularly PC cards and videophones) will emerge to drive the market as volume applications.

Figure 3
Communications Semiconductor Consumption in Europe



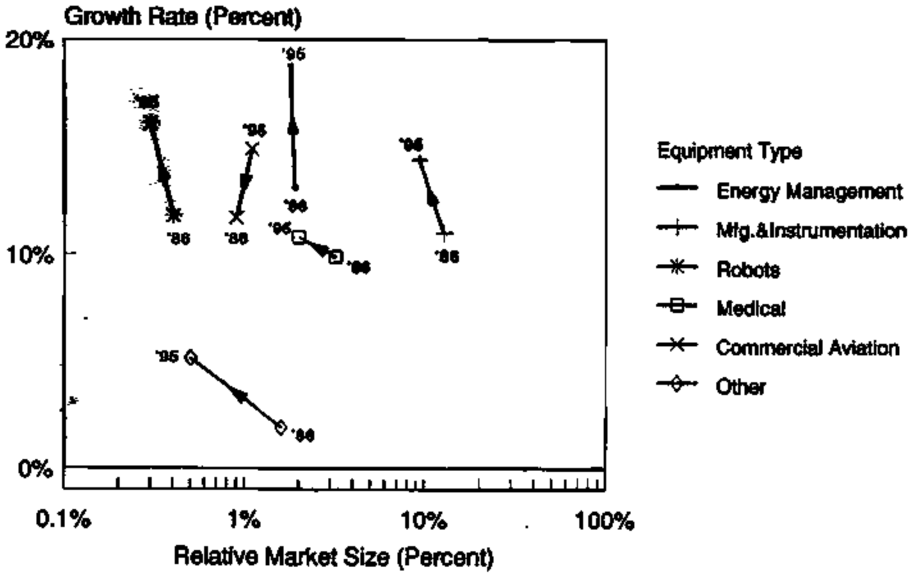
Source: Dataquest
April 1990

INDUSTRIAL

The industrial markets (Figure 4) consist of a large number of small-volume applications, usually served indirectly through semiconductor distributors. European players traditionally perform well in these markets, with companies like ABB, Landis & Gyr, Schlumberger and Siemens on a continued ascendency as powerful global players in key markets such as transportation, power generation, instrumentation, control and medical systems.

Of particular note is energy managment, where many applications (utilities metering, lighting and heating control) are already beginning to benefit from a sense of urgency on environmental issues such as global warming, resource conservation and pollution.

Figure 4
Industrial Semiconductor Consumption in Europe



Source: Dataquest
April 1990

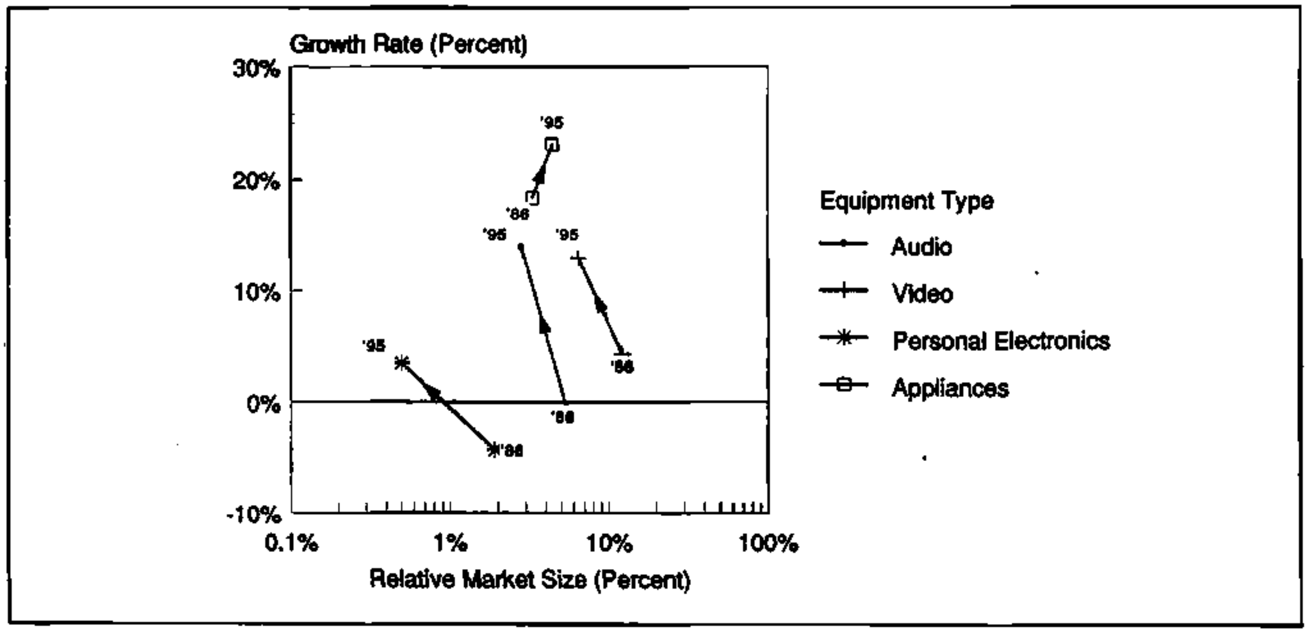
CONSUMER

The consumer electronics market in Europe has been flat for some years, and is forecast to enjoy only moderate 2 to 5 percent growth over the coming years. With the exception of camcorders, almost predominantly manufactured in Japan, only a few innovations appear set to revolutionize home electronics.

In 1989, we estimate that only 40, 48 and 50 percent of European consumption of compact discs (CDs), video recorders (VCRs) and microwave ovens respectively came from European production. Local content rules, antidumping measures and import duties will continue to force a shift towards local production and procurement.

Rising semiconductor content in many consumer applications is another growth contributor, and is especially true for appliances which have not had any semiconductor content previously. Manufacturers increasingly regard adding electronic functions to these applications as opportunities to add functionality and differentiate their products from those of their competitors. This is particularly the case for refrigerators (digital temperature indicators, multiple compartments), microwave ovens (food weighing, cook sensing, programmed cycles), and washing machines and dishwashers (special wash cycles, load weighing).

Figure 5
Consumer Semiconductor Consumption in Europe



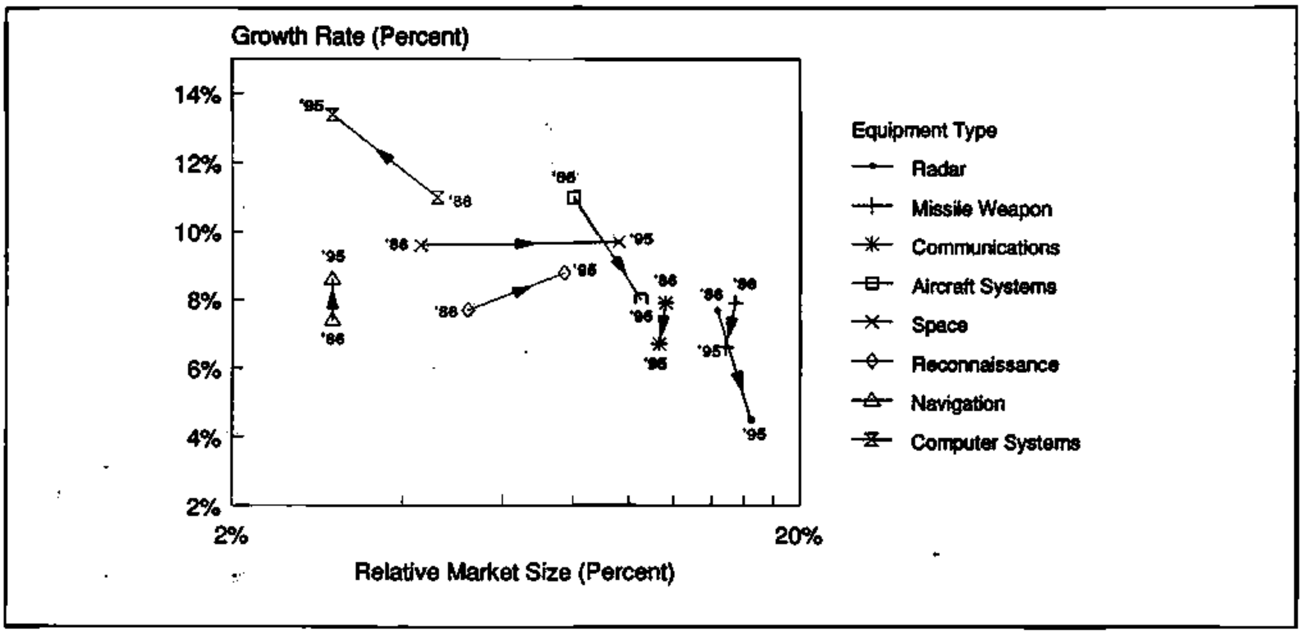
Source: Dataquest
April 1990

MILITARY

Semiconductor consumption for military applications in Europe is inextricably linked to the defense budgets of the United Kingdom, West Germany and France. In recent years these budgets have just kept pace with inflation. Events in Eastern Europe will almost certainly result in a freezing of defense expenditure. Recent plans from the British government, the largest spender on defense in Europe, indicate an increase of only 0.5 percent for equipment procurement for the 1990 to 1991 period. In real terms, this is equivalent to a 7 percent cut. Similar reductions will very probably occur in both France and West Germany.

Traditionally, a strong component of European defense electronics has also come from exports to the Middle East. However, demand from this area has slowed considerably with the decline in spend of these mainly oil-based countries and the cessation of the Iran–Iraq conflict.

Figure 6
Military Semiconductor Consumption in Europe



Source: Dataquest
April 1990

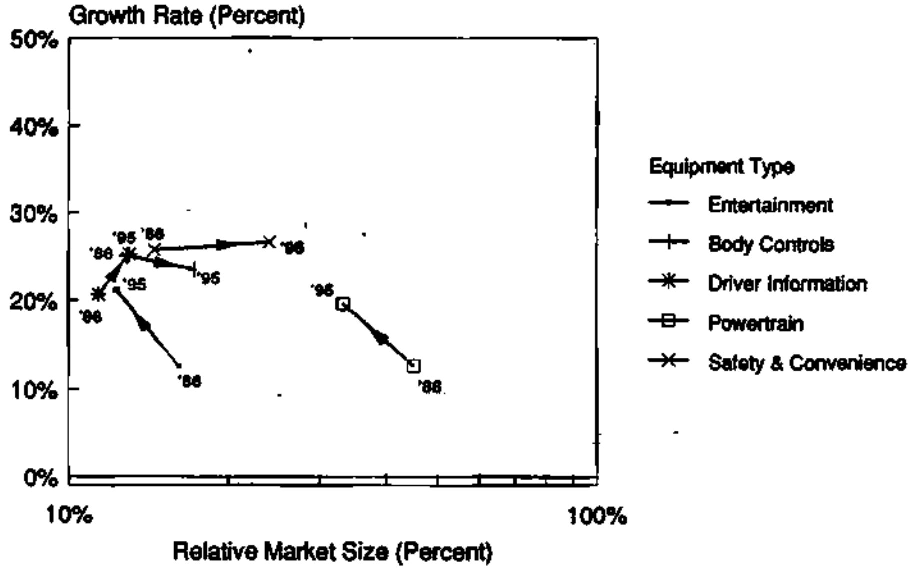
TRANSPORTATION

Fuel economy, safety issues and tightening emission regulations will have a growing influence on transportation applications in future. These factors will have greatest impact on fuel-injection and engine control units. To comply with the Commission's emissions regulations, we expect to see both systems offered as standard on both luxury and standard cars of all sizes from 1993.

In addition, we foresee strong emerging demand for body control systems (multiplexers and subsystem communications) in Europe. These will appear first in European top-range cars (Mercedes and BMW). However, many of these features exist already in a number of Japanese models (Toyota, Honda and Mazda) sold in North America. It is likely that these Japanese manufacturers—which all have substantial European manufacturing facilities—will introduce similar features in Europe, with a consequent demand for local components.

Jonathan Drazin
Mike Williams

Figure 7
Transportion Semiconductor Consumption in Europe



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PRINTER SEMICONDUCTOR CONTENT TRENDS

SUMMARY

The emerging printer controller market promises rich and growing opportunities for manufacturers of memory devices and application-specific microprocessors. ASIC manufacturers, on the other hand, face a less certain market, with opportunities tempered by the threat of controller board consolidation. Dataquest recommends that suppliers of logic and microprocessor products develop performance-enhancing, application-specific products for this market.

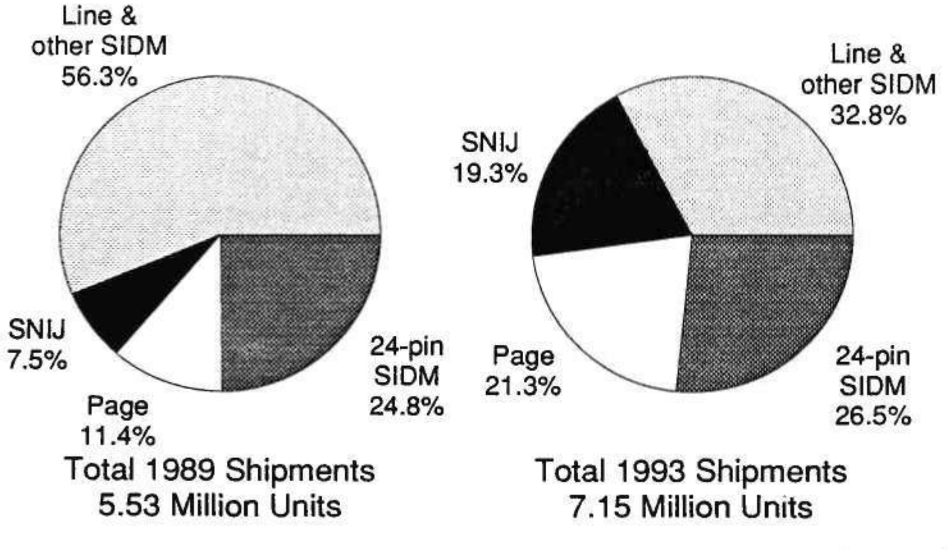
This newsletter will provide a quantitative analysis of this market at the component level and will examine the critical price and performance issues facing semiconductor suppliers seeking to meet the needs of this dynamic market.

OVERVIEW

The printer industry is undergoing a quiet revolution, and laser printers are leading the way. A new class of printer, the intelligent printer, is rapidly displacing the simple, traditional dot matrix as the business printer of choice.

For the purpose of this analysis, an intelligent printer is defined as any printer that interprets a high-level page description language (PDL). At present, these are the page (commonly referred to as laser) and the ink jet class printers. Intelligent printers are experiencing explosive growth, and we believe that they will eventually dominate the market. Figure 1 shows Dataquest's estimate of the European printer market for 1988 and our forecast for 1993.

FIGURE 1
European Market Unit Shipments by Printer Type



Source: Dataquest
March 1990

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MARKET ISSUES AND OPPORTUNITIES

In order to fully appreciate future demands on printer controller designs, it is necessary to examine the competitive issues and technical challenges facing the page printer industry today. The two most critical issues are simply the usual high-technology clichés: price and performance.

Although market acceptance has been enthusiastic, growth would be faster still if page printers were more affordable. In fact, it can be argued that the high price of today's page printers has forced many customers to use them as a shared resource (e.g., as a departmental printer), thereby shrinking the market.

Performance is also a problem. Although users like the quality and features of the page printer, they tend to be dissatisfied with the speed of this device. Higher-performance page printers are likely to enjoy a substantial competitive edge over today's slower models. The challenge that faces semiconductor suppliers is to help page printer manufacturers increase performance *while* bringing printer costs down.

We believe that these challenges translate directly into market opportunities for semiconductor manufacturers. Products that reduce total system costs and/or boost system performance will not only be well received by the industry, but could actually accelerate market expansion. Table 1 summarizes Dataquest's view of the European page printer semiconductor market; Table 2 lists the manufacturing locations of page printers in Europe.

Table 2
Page Printer Manufacturing Locations in Europe

Manufacturer	Location	Country
Agfa-Gevaert	Mortsel	Belgium
Bull	Belfort	France
Canon	Brittany	France
Dataproducts	Dublin	Eire
IBM	Stockholm	Sweden
Mercante	Copenhagen	Denmark
Olivetti	Aglie	Italy
Philips	Siegen	West Germany
Rank Xerox	Madrid	Spain
	Gloucester	United Kingdom
Siemens	Munich	West Germany
Technitron	Slough	United Kingdom

Source: Dataquest
March 1990

THE TREND TOWARD INTELLIGENT PRINTERS

Traditional printers have been primarily mechanical devices that apply ink to paper as specified by the host computer. Page printers, on the other hand, are nonimpact devices with sophisticated controllers. The host computer issues output information in the form of a PDL, such as Adobe's PostScript or Hewlett-Packard's recently released PCL 5. The controller (usually located within the printer itself) then interprets this high-

Table 1
European Page Printer Market Forecasts

	1989	1993	CAGR 1989-1993
Market Shipments (K)	652	1,519	23.6%
Market Revenue ($M)	$2,686	$5,195	17.9%
Average Selling Price ($)	$4,120	$3,420	(4.5%)
Semiconductor Content per Unit ($)	$407.2	$489.0	4.7%
Semiconductor I/O Ratio	9.9%	14.3%	
Percent Local Semiconductor Consumption	15%	24%	
European Semiconductor Consumption ($M)	$39.1	$182	46.9%

Source: Dataquest
March 1990

level output description and generates detailed instructions for the print engine. Although they lack the sophistication and power of the page printer, most new ink jet printers qualify as smart in that they usually have a microprocessor-based controller that interprets a PDL.

IMPLEMENTATION

In order to interpret PDL commands and drive the print engine, the controller must implement the basic functions of system interface, raster image generation, and print-engine control. The controller also requires its own subsystem clock as well as page and software storage. Figure 2 shows a typical printer controller block diagram.

System Interface—Versatility Is Key

The system interface block implements the functions of interface protocol and handshaking along with the buffering of input data and instructions. Because there are several different connector standards, the controller must be capable of receiving data via a variety of serial and parallel connectors. In addition, data may also be transmitted via a system bus such as AppleTalk or SCSI.

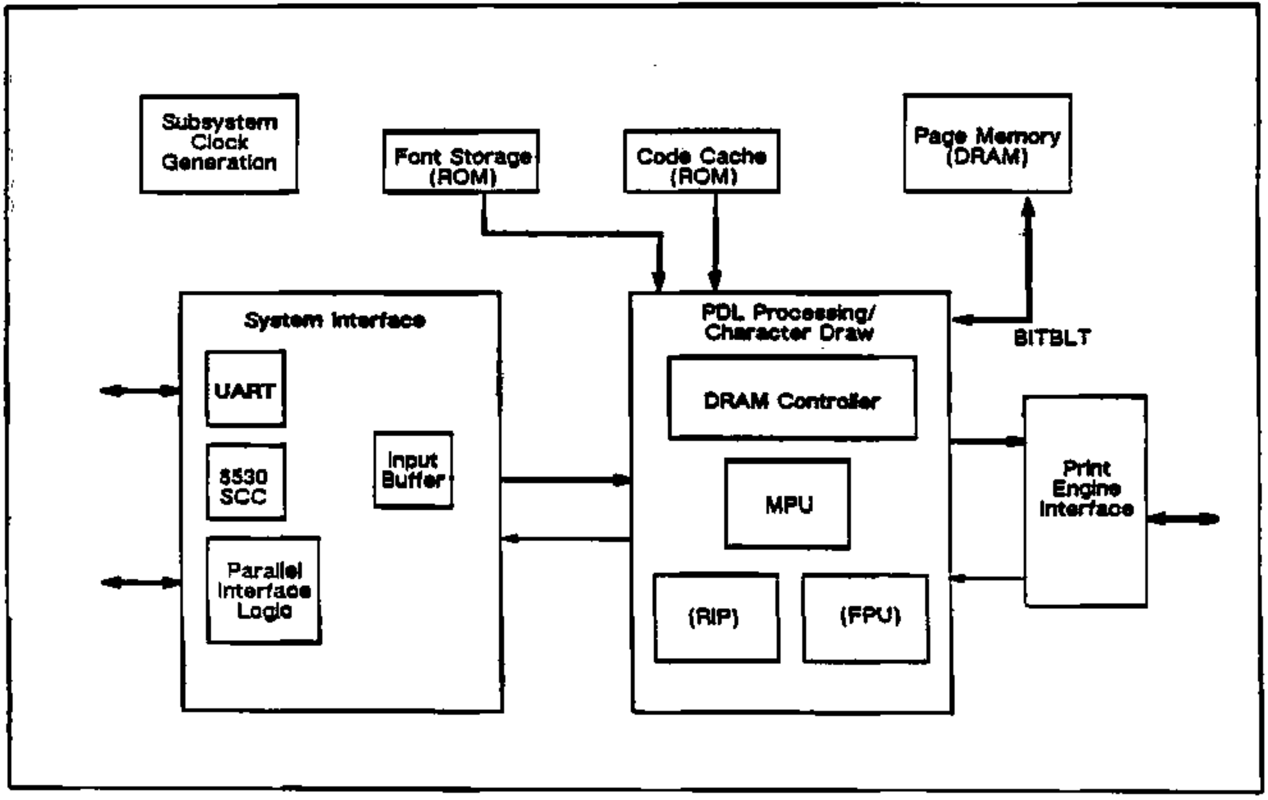
Systems interface circuitry usually consists of transceiver chips coupled to off-the-shelf peripheral communications devices for the serial interface and an interface logic section for the parallel and/or bus interface. The growing acceptance of intelligent subsystems buses, such as SCSI and AppleTalk, is likely to call for an ASIC or application-specific standard product (ASSP) solution, which would provide designers with a universal systems interface building block.

The typical input buffer is currently implemented in a simple FIFO configuration (usually two 512 × 9 FIFOs).

Processor Core—Toward a Specialized Compute Engine

Once the PDL data and commands are cued into the input buffer, the microprocessor (MPU)

FIGURE 2
Laser Printer Controller Block Diagram



Source: Dataquest
March 1990

must execute the commands in order to generate output images. Although this could be done by the MPU alone, character generation and graphics tasks sometimes are off-loaded to a raster image processor (RIP) and/or a floating-point unit (FPU). In addition, the bit-block transfer (BITBLT) function can be assigned to a dedicated "traffic cop" in order to streamline operations.

Current implementations tend to use a standard general-purpose microprocessor. This results in severe performance bottlenecks due to the processor-intensive nature of the BITBLT and character drawing and manipulation operations.

In Dataquest's opinion, this is a temporary solution that will soon give way to chip set implementation in which the various drawing, manipulation, and image-transfer functions are executed by separate dedicated blocks of customized logic.

We believe that this will be the next logical step, as it allows for the optimization of each logic block to a particular function (character drawing and BITBLT, for example, make very different demands on the CPU) and then allows them to run concurrently. A chip set approach enables system designers to mix and match, making the price/performance trade-offs necessary to position the printer for a particular end-user segment (such as single-user or departmental print server).

Because high-performance applications will continue to place speed ahead of system cost, high-end controllers should feature multiple device implementations for the foreseeable future. We expect to see the current implementation, using programmable logic devices (PLDs) and other fast logic to augment a standard processor, giving way to high-performance chip sets.

Low-end laser and ink jet printers are another matter, however. In order for single-user printers to achieve maximum market penetration, total system cost must decline substantially. This cost pressure argues for the eventual use of a low-cost, single-chip, application-specific processor. Interim solutions should feature low-cost standard microprocessors that are augmented by simple ASICs.

Storage—Color, High-Resolution Demand More Bits

Memory requirements fall into two categories: nonvolatile memories (typically ROM), which are used for code and font storage, and page memory (typically DRAM), which is used to store the bit-mapped images of the page to be printed.

Nonvolatile applications routinely require 1MB or 1.5MB of memory, depending on the number of fonts supported. A typical high-performance page printer can contain as much as 4MB to 6MB of ROM. This figure will depend on the variety of fonts required and on the amount of memory required to support each font (which, in turn, varies according to the sophistication of the PDL). Dataquest anticipates that future systems will store many more fonts in memory ranging from DRAM to various types of disk drives.

Page memory applications can require anywhere from 512KB to 8MB of DRAM, but the majority currently use 1MB to 1.5MB. Most printers with less than 1MB use a technique known as band buffering, in which only a fraction of a page is stored at a given time. Banding can greatly reduce memory costs; however, the substantial speed trade-off imposed by banding argues against widespread use of this technique in the future.

Performance enhancements and the addition of color output capabilities are likely to increase memory requirements substantially over the next five years. By 1993, we expect that the average system may utilize 8MB of DRAM.

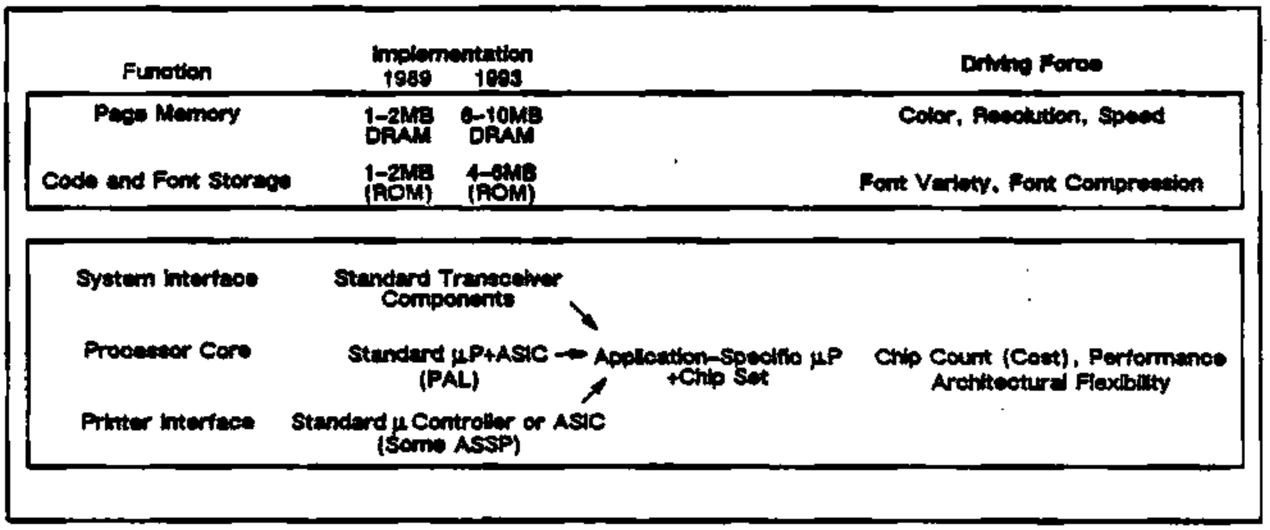
Print Engine Interface—Standardization, Consolidation to Come

Although much of the interface functionality could eventually be integrated into the processor core, current design constraints should ensure that the print engine interface remains an independent functional block for the foreseeable future. The print sequencer, status monitoring, and control functions can be implemented in an ASIC or through the use of either a standard microcontroller (such as the 68008) or a dedicated interface chip (such as the WD65C10). Because they represent support logic rather than core logic, these functions are likely candidates for consolidation into future generations of chip sets or ASSPs. Figure 3 summarizes the anticipated evolution of the various functional blocks.

SEMICONDUCTOR CONTENT/ CONSUMPTION FORECAST

The previous discussion deals with the entire class of intelligent printers. The quantative portion of this analysis, however, addresses only the page printer portion of the intelligent market. The other

FIGURE 3
Typical Semiconductor Implementation



Function	Implementation 1989	Implementation 1993	Driving Force
Page Memory	1-2MB DRAM	6-10MB DRAM	Color, Resolution, Speed
Code and Font Storage	1-2MB (ROM)	4-6MB (ROM)	Font Variety, Font Compression
System Interface	Standard Transceiver Components		
Processor Core	Standard µP+ASIC (PAL)	Application-Specific µP +Chip Set	Chip Count (Cost), Performance Architectural Flexibility
Printer Interface	Standard µ Controller or ASIC (Some ASSP)		

Source: Dataquest
March 1990

Table 3
European Page Printer Semiconductor Consumption (Millions of Dollars)

	1989	1993	CAGR 1989-1993
Total Semiconductor	$39.1	$181.8	46.9%
IC	$39.1	$181.8	46.9%
Bipolar Digital	$1.2	$0.9	(5.7%)
Memory	$0.0	$0.0	-
Logic	$1.2	$0.9	(6.7%)
MOS Digital	$37.6	$180.0	47.9%
Memory	$31.6	$153.9	48.5%
Microcomponents	$3.3	$24.3	64.2%
Logic	$2.6	$1.8	(8.8%)
Analog	$0.3	$0.9	33.5%
Discrete	$0.0	$0.0	-

Source: Dataquest
March 1990

significant segment, ink jet printers, is not expected to surpass page printers in either dollar or unit terms by 1993. With lower average selling prices (ASPs) putting strong pressure on component costs, the total available semiconductor market for ink jet printers is expected to remain substantially smaller than that of the page printer through 1993.

Table 3 gives Dataquest's estimated European semiconductor market for page printer controllers. We expect total semiconductor demand for these controllers to increase from $39.1 million in 1989 to more than $180 million in 1993.

The high overall compound annual growth rate (CAGR) of 46.9 percent will be driven by continued strong growth (17.9 percent CAGR) of the laser printer market in Europe. This will be further bolstered by additional manufacturers to those shown in Table 2 deciding to locate production facilities in Europe. We estimate that, at present, European production supplies less than 20 percent of the European market.

During this period, CAGRs are forecast to range from a negative 6.7 percent for bipolar logic to a positive 64.2 percent for MOS microcomponents. Although this is not the highest growth area in percentage terms, MOS memories will realize the greatest growth in absolute terms.

Table 4 summarizes Dataquest's estimated semiconductor content trends for the page printer market. Three factors drive the shifts in semiconductor content. First, the sliding price of page printers exaggerates the increase in semiconductor content percentages. Second, recent high memory costs have encouraged printer manufacturers to minimize their memory content—the falling cost per bit of most memory products along with the increasing requirements discussed earlier should combine to push the memory content percentage up sharply. Finally, the rapid increase in microcomponent content is a direct result of that category's cannibalization of the other logic categories.

DATAQUEST CONCLUSIONS

Laser printer controllers appear to be the next emerging embedded control market. Unlike most past nonreprogrammable applications, it appears that the processing requirements of intelligent printer control cannot be fully satisfied using standard microcomponents alone. This calls for the emergence of high-performance, application-specific standard products to serve this market.

The growing popularity of intelligent printers, along with current performance shortfalls, virtually ensures enthusiastic market reception for high-performance application-specific standard products that reduce total system cost.

DATAQUEST RECOMMENDATIONS

Memory Suppliers

Because memory costs represent a large portion of total controller cost, system designers are likely to continue using standard, lower-cost memories wherever possible. Competition for memory suppliers should turn on the issues of price and availability. However, because this market is a rapidly changing one, in terms of both market growth and system architectures, we recommend that memory suppliers keep close ties with systems designers in order to accommodate any changes in future systems requirements.

Microprocessor Suppliers

Today's compute engines have provided only marginal system performance, partly as a result of the specialized requirements associated with PDL implementation. We therefore recommend that MPU manufacturers develop compute engines that are specifically optimized for this application. Certain companies are already modifying existing designs for this purpose while others are creating completely new processors. In addition, system designers are likely to have strong preferences

Table 4
Page Printer Semiconductor Content Forecast (Dollars)

	1989	1993	CAGR 1989-1993
Total Semiconductor	$407.2	$489.0	4.7%
IC	$407.2	$489.0	4.7%
Bipolar Digital	$12.4	$2.4	(33.5%)
Memory	$0.0	$0.0	-
Logic	$12.4	$2.4	(33.5%)
MOS Digital	$391.9	$484.2	5.4%
Memory	$27.1	$4.8	(35.0%)
Microcomponents	$3.0	$2.4	(4.8%)
Logic	$0.0	$0.0	-
Analog	$27.1	$4.8	(35.0%)
Discrete	$0.0	$0.0	-

Source: Dataquest
March 1990

toward designing around a single compute engine for their entire product lines. We therefore recommend that MPU suppliers offer a complete product line with a full price/performance range of its own.

ASIC Suppliers

Opportunities in the ASIC arena are likely to be transitional. As systems designs mature, processor-supporting ASICs should give way to ASSPs. In order to survive this transition, we recommend that ASIC manufacturers translate these designs into their own ASSPs. In diversifying into ASSPs, ASIC manufacturers will have to adjust their sales and marketing approach for these products. This adjustment usually involves establishing a standard products division.

Chip Set Suppliers

Chip set suppliers have done well in the PC arena by capitalizing on their systems-level expertise to consolidate a standard architecture. Although the time is not yet right for such a consolidation on the printer controller board, soon it will be. Chip set companies would do well to follow this market closely, looking for general acceptance of application-specific processors and then consolidating the support logic that surrounds them.

Table 5 summarizes Dataquest's recommendations for the various semiconductor supplier groups.

FINAL PREDICTION

Once this market matures and controller architecture becomes more stable, price pressure will force further consolidation. Dataquest believes that the chip count on the logic portion of the controller board will continue to decline. This will pit ASIC, chip set, and processor suppliers against one another as the controller approaches a one-chip implementation. Winners in this battle will possess strength not only in microprocessor design but also in system design and low-cost manufacturing.

Jonathan Drazin
Sarah Weeks
Kevin Landis

TABLE 5
Recommendations

Supplier Group	Key Issues	Recommendations
Memory Suppliers	Price, availability	Emphasize good communications; JIT delivery
Microprocessor	System performance, chip count	Develop application-specific compute engine; offer broad price/performance range
ASIC	Increasing integration, consolidation	Develop application-specific cores; evolve into standard chip set products
Chip Set	System expertise, stability of architecture	Follow market closely; enter when architecture stabilizes

Source: Dataquest
March 1990

APPENDIX—GLOSSARY OF TERMS

Semiconductor Industry Abbreviations

ASIC	application-specific integrated circuit
ASSP	application-specific standard product
BITBLT	bit-block transfer
DRAM	dynamic RAM
FIFO	first in first out
FPU	floating-point unit RAM
JIT	just-in-time
MPU	microprocessor unit
RAM	random access memory
RIP	raster image processor
ROM	read-only memory
SCSI	small computer systems interface
UART	universal asynchronous receiver transmitter

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Research Newsletter

GSM IN EUROPE—CELLULAR TURNS DIGITAL

SUMMARY

The Groupe Speciale Mobile (GSM) pan-European digital cellular network is to be launched across Europe from July 1991. This newsletter examines how the market for GSM digital cellular telephones will develop in Europe over the next few years. In particular, we will look at the constituent parts of a GSM telephone, discuss what impact they will have on its selling price, and forecast the market for semiconductors that will result.

The semiconductor cost per first-generation GSM handset will exceed three times that used in current analog cellular handsets. Despite the increase, we argue that the average selling price of GSM handsets will not be sufficiently higher than for analog cellular so as to prejudice its market acceptance. Of this content, 60 percent will consist of CMOS logic, 30 percent of high-frequency bipolar/CMOS/BiCMOS linear technologies and 10 percent of mixed analog-digital BiCMOS/CMOS technologies.

We forecast an aggressive rollout for GSM, with 276,000 units forecast to be shipped in 1991, rising almost linearly to nearly 2.5 million units by 1994. This will drive a semiconductor market worth $60 million in the first year, climbing to $421 million by 1994.

INTRODUCTION

GSM is to be adopted by 17 European countries from July 1991. The first services are likely to commence in West Germany, the United Kingdom and Scandinavia. GSM initially focused on the radio transmission methods, or "air interface," used to communicate between mobiles and base stations. The GSM air interface is time-division multiple access (TDMA), made up of 123 channels of 200-kHz bandwidth, each with 8 speech slots per channel in two bands:

- 890- to 915-MHz (mobile receive)
- 935- to 960-MHz (mobile transmit)

Speech is compressed and encoded at 13 kbit/s, less than one-quarter of the 64-kbit/s rate commonly used for digital voice transmission.

Today, GSM defines all the major interfaces between the building blocks in the network, shown in Figure 1. Mobile stations (MS) communicate with a local base station system (BSS). Each BSS consists of a controller (BSC) and a number of transceiver stations (BTS). Connection between the base stations and the public-switched telephone network (PSTN) is made via mobile switching centers (MSC). Other blocks, not shown in Figure 1, are defined to provide for management and maintenance of the network.

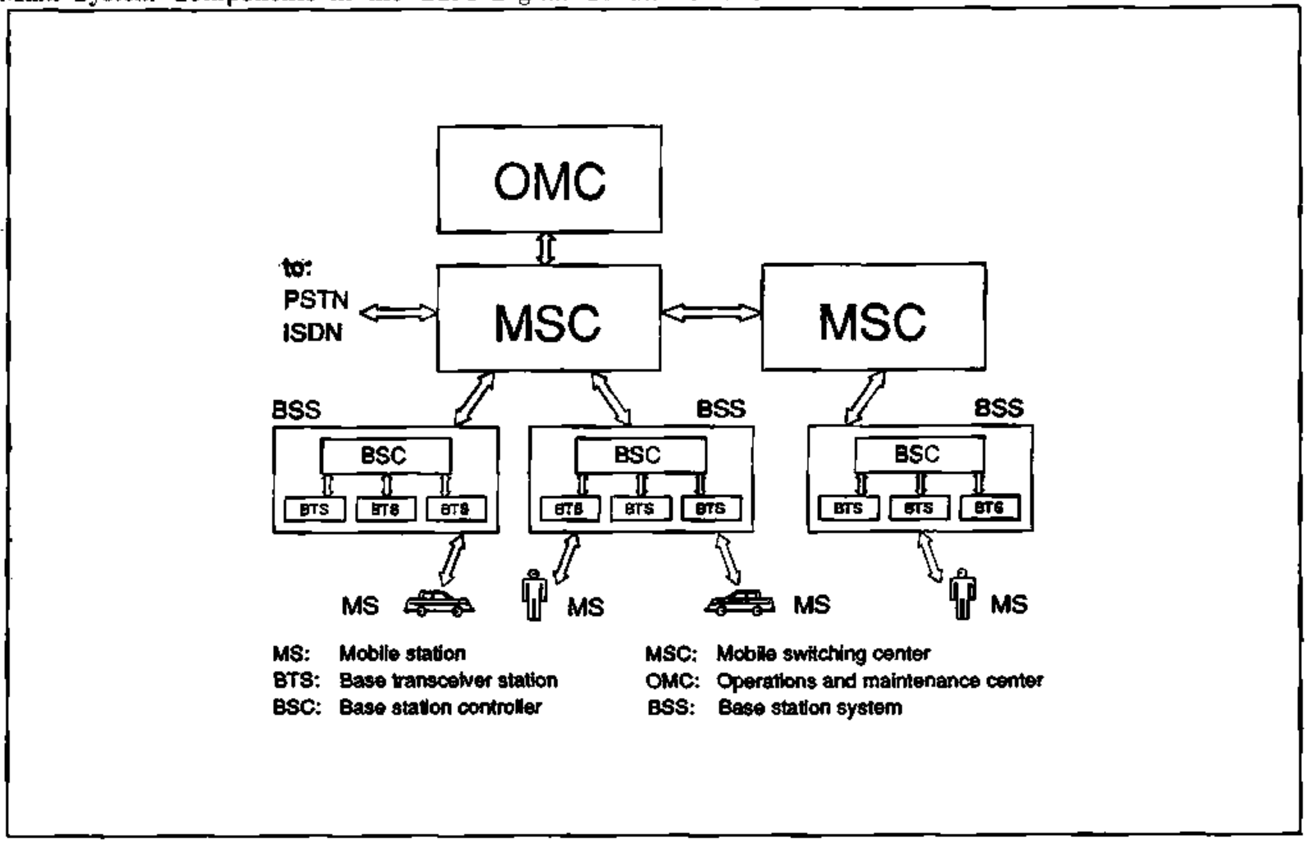
GSM—ITS ADVANTAGES OVER ANALOG

GSM will offer significant improvements over existing analog cellular networks. The main benefits are as follows:

- Pan-European coverage will permit roaming across 17 countries and allow GSM to address *one* large potential market of 320 million people in Europe, far greater than those of either the United States or Japan.
- Greater spectrum efficiency compared to analog cellular, thereby reducing congestion in major cities. This will also result in improved *economic* efficiency compared to the analog cellular networks, with fewer base transceiver stations needed to support GSM subscribers.

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

FIGURE 1
Main System Components in the GSM Digital Cellular Network



Source: Dataquest
March 1990

- GSM's digital air interface and digital infrastructure will bring greater service quality and greater functionality compared to analog cellular. Many of the annoying quirks associated with analog cellular telephony (poor speech quality, lack of security, low call reliability, and call fading) will be substantially eliminated.
- Communication within the GSM network will be based largely on CCITT Integrated Services Digital Network (ISDN) standards to minimize the degree of additional development required. This will allow for easy connection to the many public and private ISDNs that are expected to emerge throughout Europe and worldwide over the next few years.

In addition to compatibility with ISDN, GSM's main interfaces will be public domain and conform to layers 1–3 of the Open Systems Interconnection (OSI) model. OSI compatibility will allow GSM to carry complementary services to telephony, such as voice mail, facsimile, paging, messaging and data communication.

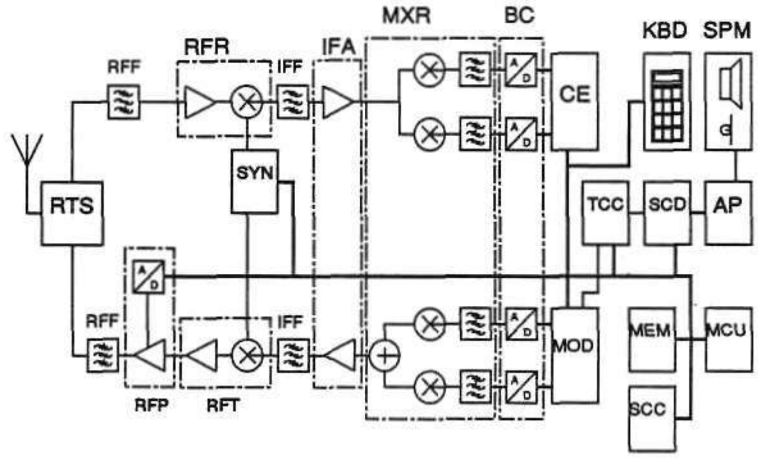
INSIDE THE GSM TELEPHONE

Demand for compact, hand-portable units is currently the strongest growth area in the analog cellular market. This represents a major challenge to designers of digital handsets, since these must be comparable in size and weight with analog handsets in order to be acceptable. In turn, this places tight criteria on the components employed for GSM, since they must both minimize power consumption to reduce battery size and occupy as few parts as possible.

Figure 2 is a block diagram for a GSM mobile telephone based on a single IF stage with quadrature processing at baseband. This is loosely based on developments being made by some manufacturers. Besides an 8-bit microprocessor, an LCD/keyboard, a smart card controller and some memory, there will be few standard parts employed in the first generation of handsets.

At the front end, the design objective of integrating both receive and transmit paths onto one piece of silicon is unlikely to be achieved for some years. The limitations are not complexity or

FIGURE 2
The GSM Digital Cellular Telephone



RTS:	Receive/transmit switch	CE:	Channel equaliser
RFR:	Receive amplifier/mixer	MOD:	GMSK modulator
RFT:	Transmit amplifier mixer	TCC:	TDMA channel coder/decoder
RFP:	Transmit power amplifier	SCD:	Speech coder/decoder
RFF:	RF bandpass filters	AP:	Audio processor
SYN:	Frequency synthesizer	KBD:	Keyboard / LCD controller
IFF:	IF bandpass filters	SPM:	Speaker / microphone
IFA:	IF amplifiers	MCU:	16-bit microcontroller
MXR:	IF and IQ mixers / low pass filters	SCC:	Smart card controller
BC:	Baseband D/A and A/D converters	MEM:	Non-volatile memory (EEPROM)

Source: Dataquest
March 1990

yield but, instead, the problems associated with power dissipation and interference between mixer stages. We expect two to three chip hybrids to be the most common solution initially. Packaging and screening will represent a major cost, making the RF front end an increasingly significant cost as greater levels of CMOS integration erode the back-end logic costs. Ultimately, the design approach will shift in favor of direct conversion from RF to baseband, removing the IF stages entirely and eliminating most of the bulky external filters currently employed.

The greatest complexities in design are represented by the channel equalizer, TDMA channel and speech decoder ICs. The equalizer—occupying more than 50,000 gates of semi-random logic on high-performance CMOS ASIC—synchronizes frame transmission with the base station and eliminates unwanted signals reflected from hills and buildings. The TDMA channel IC interleaves and recovers voice and control data across multiple frames to minimize bit errors caused by sporadic interference—similar to the method employed to read compact disks.

The need to maximize cell capacity requires use of efficient voice compression algorithms for GSM. The technique chosen is the Codebook Excited Linear Predictive (CELP) method originally developed by AT&T. CELP will initially use a bit rate of 13 kbit/s per voice channel. However, there is provision to provide for a 6.5-kbit/s option in the near future, with the effect of doubling the cell capacity from approximately 200 callers per cell, for 13-kbit/s codecs, to 400 callers per cell for 6.5-kbit/s.

The drive to reduce power consumption and battery weight will result in the use of techniques similar to those being applied to conserve power in the PC laptop market, namely dropping clock frequencies in dormant ICs and reducing the power rail on CMOS logic ICs from 6V to 3V. Innovations are also expected in battery technology following recent announcements of rechargeable titanium-nickel and lithium ion cells with two to four times the capacity of present cells.

TABLE 1
Estimated Component Content for a First-Generation GSM Class IV (2W) Handset

Function	Technology	Cost
Receive/transmit switch	SAW duplexer	$25.00
Transmit power amplifier	Bipolar/MOSFET discrete	$5.00
Transmit amplifier/mixer	Bipolar ASIC	$7.00
Frequency synthesizer	Bipolar ASIC	$15.00
Bandpass filters	SAW filters	$14.00
IF amplifier/mixer	Bipolar/BiCMOS	$8.00
Baseband converters	BiCMOS ASIC	$14.00
Channel equalizer	CMOS ASIC	$18.00
Modulator	CMOS ASIC	$14.00
Speech coder/decoder	CMOS ASIC	$18.00
Channel coder/decoder	CMOS ASIC	$14.00
Audio processor	CMOS/BiCMOS ASIC	$4.00
8-bit microcontroller	Standard CMOS IC	$8.00
LCD/keyboard controller	Standard CMOS IC	$4.50
Smart card controller	Standard CMOS IC	$6.00
Memory (256K)	Flash EPROM	$13.00
LCD display		$3.00
Total Semiconductor Content		$151.50
Total Non-Semiconductor Content		$39.00
Total Component Content		$190.50
Average Selling Price		$2,149.00
Semiconductor I/O Ratio		7.0%

Source: Dataquest
March 1990

WHAT PRICE GSM INITIALLY?

Table 1 costs the components shown in Figure 2 for a first-generation GSM Class IV (2W) hand portable. At the GSM launch in mid-1991, we forecast the total component value will be $190.50, of which 80 percent ($151.50) is semiconductor. By 1994, we expect the total component value to have declined to $151.50 with the greatest savings made by integration of the CMOS back-end logic.

Component contents will be similar in the higher transmit power Class I to III versions, with the exception of the RF power amplifier stage where more costly power discretes must be employed. Where compactness is not an issue, such as in fixed in-car mobiles, cheaper but bulkier ceramic filters are likely to be used in preference to surface acoustic wave (SAW) filters.

In terms of semiconductor consumption per unit, the GSM digital telephone is a big departure from the $50 content in analog telephones today. An obvious concern is what effect this triple increase in content will have on the selling price of GSM handsets? Will GSM be so unattractively priced compared to analog cellular that its uptake becomes adversely affected?

Despite the greater manufacturing costs, we predict that the GSM telephone will be priced only marginally (25 to 30 percent) higher than analog cellular handsets. For the following reasons, we expect the benefits of GSM perceived by subscribers, airtime resellers and network providers alike to more than offset this additional price:

- The other major manufacturing cost factors in a GSM handset will not rise pro rata with the triple increase in semiconductor content. The casing, cabling, antenna, battery, display and keyboard technology in first-generation GSM handsets will be substantially the same as for today's analog units.
- Competition for manufacture and supply of GSM telephones will be far greater than for analog cellular, resulting in lower ex-factory markups and distribution margins. The GSM telephone will be a pan-European product where, in many cases, subscribers will have the option not only to use the telephone anywhere in Europe but also to *purchase* it anywhere in Europe.
- GSM offers a higher marginal return on new network investment compared to analog because, per base station, it can accommodate a greater number of subscribers. Operators who discount handset prices to entice new subscribers onto their networks (such as Cellnet and Vodaphone in the United Kingdom) are likely to take this into account by discounting GSM handsets to a greater degree than for analog.
- It is clearly European Commission policy to liberalize the purchase and supply of telecommunications equipment within the Community. The open market of the United Kingdom has recently been joined by liberalization of mobile equipment in France, Spain and West Germany, with Italy expected to follow shortly. Similar moves have occurred in the Scandinavian countries.

There is already evidence that the launch of GSM will coincide with a general liberalization of cellular airtime resale across Europe. As this market restructuring occurs, the $2,000 to $3,000 prices paid for handsets today in regions like France, Scandinavia and West Germany will reduce towards the U.K. prices of $300 to $1,500.

In West Germany—the greatest potential market for GSM telephones—the government is investigating ways to modify the Deutsche Bundespost Telekom's (DBT) cellular service to allow it to compete fully with the new Mannesman consortium. It proposes to achieve this by introducing to DBT a new tier of resellers and dealers. There is a similar trend elsewhere in Europe with, in most cases, governments setting up two rival networks, one public and one private.

In the United Kingdom we expect Cellnet and Vodaphone, wary of the imminent threat from the four new licensed PCN operators, to invest heavily in GSM and move towards decreased cell sizes in urban areas, where PCN will be most active (see below).

THE MARKET FOR THE SEMICONDUCTORS

Based upon our earlier assumptions, Figure 3 presents our forecasts for total semiconductor consumption by GSM handsets in Europe alongside our forecast for the total shipments of GSM handset units that this will drive.

We expect rollout of GSM to be aggressive with, assuming no major technical delays in service launch, 280,000 handsets shipped in the first year (1991). In 1994, we expect shipments of GSM handsets to have reached 2.4 million units, outnumbering shipments of analog units by five to one in the same year.

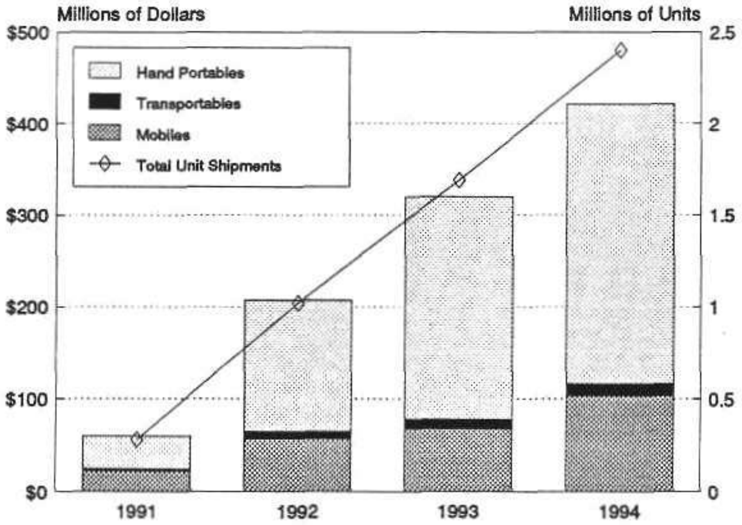
We forecast total semiconductor sales for GSM handsets in 1991 to be $60 million, rising sharply to $207 million by 1992, through to $421 million by 1994, representing a 190 percent CAGR over the 1991 to 1994 period. Of this revenue, we estimate that approximately 60 percent will consist of CMOS logic, 30 percent of high-frequency bipolar/CMOS/BiCMOS linear technologies and 10 percent of mixed analog-digital BiCMOS/CMOS technologies.

GSM—FUTURE GENERATIONS

Within the next five years, we expect GSM's open system compatibility to clearly differentiate it from analog cellular, in terms of both the features in the handset and the improved services that the operators will provide:

- Fast call setup times
- High-quality speech with DSP enhancement
- High-speed modem connection
- Integral pager/messaging
- Facsimile connection
- Call redirect
- Voice mail
- Caller blocking and identification

FIGURE 3
Forecast GSM Handset Shipments and Semiconductor Consumption by Handset Type



Source: Dataquest
March 1990

An important phase in GSM's evolution will start in the United Kingdom with the launch in 1993 of personal communications networks (PCNs). Other countries, such as France, West Germany and the United States, also view PCN as a way to take GSM one stage further: turning wireless telephony into a true mass market. PCN will be based upon "pico-cells" of much smaller sizes compared to those to be used for GSM. The PCN solution for Europe will almost certainly be based on GSM standards to permit maximum sharing of electronic components between the two systems.

DATAQUEST CONCLUSIONS

No semiconductor vendor can afford to ignore the opportunities presented by the digital telephone market. GSM is just one of a rapidly developing set of other digital standards in Europe: CT2, DECT and PCN. Each translates into handsets suitable for specific types of end user but, while the standards differ, they share common needs for common ICs, particularly in the analog front end, the bandpass filters and the microcontrollers.

Vendors with GSM design experience stand to benefit by applying their expertise to related standards in other markets. Similar moves to digital cellular telephony are being made in the United States, where the US Digital standard has recently been adopted by the American National Standards Institute (ANSI). US Digital will allow network operators to replace analog transceivers with digital ones, without the need to overhaul their existing network.

Our forecasts indicate that, with the development of GSM into a mass-consumer standard such as PCN, semiconductor demand from this application will begin to rival that from personal computers in size towards the end of the 1990s—with the added twist that many personal computers could themselves contain cordless modems based on GSM. However, over the next two to three years, vendors must strive to supply GSM telephone manufacturers with solutions that permit their GSM units to offer the same price/performance benefits as analog ones.

Jonathan Drazin

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Research *Newsletter*

SIEMENS ACQUIRES NIXDORF'S COMPUTER ACTIVITIES

Siemens AG officially announced on January 10, 1990, that it has decided to acquire Nixdorf Computer AG and intends to merge the computer activities of the two companies into a new company that will be called Siemens-Nixdorf Informationssysteme AG. Pending government approval, Siemens initially will acquire 51 percent of Nixdorf Computer's voting shares, which is equal to roughly one-quarter of its overall market capital. The new entity, which will be a subsidiary of Siemens AG, will have the equivalent of DM 12 billion in annual sales (combined worldwide sales of Siemens and Nixdorf are about DM 68 billion). This is roughly twice Nixdorf's worldwide sales of DM 5.6 billion. The West German Cartel Office will review the planned merger, and a final decision is expected within four months.

OVERVIEW: A PC PERSPECTIVE

Although neither company is in the "top 10" list of PC manufacturers Europe-wide, both are very well known in their local market, especially within the business sector. Unlike other recent mergers, there are not so many geographical synergies between the two companies. Instead, there is a potential for strengthening their local position (possibly becoming number two in the West German business market) and preparing for whatever opportunities Eastern Germany, Eastern Europe, and the USSR have to offer.

The probabilities for making the merger work are good because both companies share a number of similarities that will help them understand each other. In addition to the obvious fact that both companies are German, they both came into PCs from the mini/mainframe world with third-party-sourced products. Realizing the strategic importance of PCs, they moved toward designing and in-house manufacturing of their own products. Both also began with a direct sales force selling primarily into their own existing client base but then became active in developing dealer channel strategies and targeting the open market. In addition, they share a common focus on the upper end of the business market and have no interest in the home sector or in mass merchandising.

Siemens is generally recognized as one of the strongest vendors of high-end PCs in the West German business market, with a wide range of laptop, desktop, and industrial models. The company's shipment figures for West Germany rose from 21,500 PCs in 1987 (4.9 percent of the business market) to an estimated 50,000 in 1989 (5.6 percent of the business market). Practically all of Siemens' PCs are now manufactured by the company in its Augsburg, West Germany, production facility.

Nixdorf's PC activities began several years ago, but volumes have remained low and the company, although it had the potential, never succeeded in establishing itself as a leading vendor on the West German PC market. This was probably due to an overconcentration on its midrange systems. Then in 1988 and 1989, the company began expanding its product line, broadening its range of target customers, and shifting from third-party sourcing to in-house manufacturing. Although Nixdorf has manufacturing capabilities in Paderborn, West Germany, a significant proportion of PC production has been done in the company's Singapore-based plants.

DATAQUEST ANALYSIS

The takeover will provide greater critical mass across the range of computing platforms and provide access to a larger combined set of major accounts. The new company will benefit not only from Siemens' financial strengths but also from its

TABLE 1
West Germany Business Market Shipments (Units)

	1987	1988	1989 (est.)
Siemens	21,500	34,450	50,000
Nixdorf	13,200	24,650	39,500
S-N I AG	34,700	59,100	89,500
Total Business Market	439,759	684,741	895,135
Siemens-Nixdorf Percent of Business Market	7.9%	8.6%	10.0%

Source: Dataquest Europe S.A.
February 1990

components know-how in microprocessors and memory devices.

From a PC point of view, this will not result in a significant increase in geographic coverage, nor will it create a top contender in Europe's PC market. However, the merging of resources does create in West Germany an entity that will be able to command 10 percent of the PC business market (see Table 1) and possibly become the future number two player.

Given the current developments in East Germany and Eastern Europe, as well as Siemens' recent business prospects with the USSR, Siemens-Nixdorf Informationssysteme AG is well positioned to monitor and take advantage of whatever opportunities develop in the East. From a PC perspective, there may be a better return on investment from strengthening its position in West Germany and preparing itself for potential Eastern European markets than from trying to force itself into and develop market share in the rest of Western Europe.

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Jennifer Berg
Kees Dobbelaar

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Research Newsletter

SIEMENS AG INTENDS TO ACQUIRE "MAJORITY" OF NIXDORF COMPUTER AG

Nixdorf Computer AG and Siemens AG officially announced on Wednesday, January 10, that Siemens intends to acquire 51 percent of Nixdorf's capital, pending the West German Cartel Office's approval. (The Cartel Office's final decision is expected within four months.) The financial value of the transaction has not been disclosed. Common shares were acquired from the Nixdorf family, which previously controlled all the voting shares. Nixdorf said that nonvoting preferred shares listed in German exchanges will not be affected by the merger.

The new company, a majority-owned subsidiary of Siemens called Siemens-Nixdorf Information Systems AG, would combine the Siemens data and information systems activities with those of Nixdorf. Annual sales of the company would be DM 12.0 billion (US$7.15 billion), which contrasts with Nixdorf's current worldwide sales of DM 5.6 billion (US$3.34 billion).

Nixdorf stated that "given the relatively few overlapping lines of business, a merger opens up good business opportunities and favorable synergistic aspects."

DATAQUEST ANALYSIS

The move clearly places into context the difficulties faced by Nixdorf. Despite repeated claims from Paderborn, West Germany, where Nixdorf is located, that the company intended to remain independent, Nixdorf has had to accept the inevitable in the face of very poor results anticipated for 1989.

From Siemens' point of view, the merged company would have greater critical mass in the computer and midrange markets and would have access to both Siemens' and Nixdorf's large accounts. In addition, the components division of Siemens most likely would have a guaranteed customer for memory and microprocessor devices. This will be important in 1990 and beyond, as the semiconductor industry looks set for a recession.

Traditionally, Siemens and Nixdorf have not addressed identical market segments. In the cases where there have been overlaps, they usually have involved complementary product lines. The new company will benefit from strength in the mainframe business (number two in Europe, with a 15 percent market share from the BS 2000 Siemens range) and the midrange where it would have a combined share of 10 percent of the work group, small department, and large department computer categories. Its share of the PC business remains low. Although Dataquest anticipates that the new company will not aim to be a leader in the mass market for PCs, the provision of PCs as part of its distributed product offering within a client-server environment will be a key challenge for the company in the 1990s.

The new company clearly will benefit from the huge financial resources of Siemens and will gain access to technology in the high-end computer market, as well as in the areas of telecommunications and semiconductors.

In addition, the new company will find a degree of synergy in its geographic coverage. Nixdorf has considerable strength in Spain, for example, although both companies are relatively weak in Northern Europe. However, the merger may not be sufficient to gain international positions outside its traditional markets. In particular, the new company would still be virtually absent from the United States.

WILL THE OPERATION BE A SUCCESS?

It is, of course, far too early to be categorical about this question. Indeed, several formalities still remain to be undertaken before the company can be formed. It does appear, however, that a large amount of synergy could be gained from the acquisition.

On a worldwide scale, the company would be positioned firmly within the top 10 manufacturers in the world and would be vying with Bull and Olivetti to be the top Europe-based supplier.

To reiterate, the company would face the following two key challenges in the 1990s:

- The lack of U.S. market share
- The development and implementation of a unified strategy incorporating mainframes, UNIX minicomputers, and PCs

On a final note, although the new entity will be a clear second in Germany behind IBM, its share in the very volatile computer market should not justify a negative decision from the Cartel Office.

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Philippe DeMarcillac

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Research *Newsletter*

VISUAL EVOLUTION AT ELECTRONICS SHOW

SUMMARY

The 1989 Electronics Show, sponsored by the Electronic Industries Association of Japan (EIAJ), was held in Osaka in October and reflected the current interest in the consumer electronics market. Participants included 466 companies and organizations from 19 countries. The five-day show attracted approximately 255,000 visitors, with a notable increase in attendees from the Newly Industrialized Economies (NIEs).

NEW VISUAL PRODUCTS

Many companies exhibited new products related to high-grade visual equipment, including large-screen TV, projection displays, and extended-definition television (EDTV). The advanced S-VHS VCRs, which are rapidly becoming popular, were demonstrated through the use of videocassettes and received a great deal of attention from the attending public. Table 1 indicates the Japanese companies that presented new or existing consumer products at the show.

Extended-Definition TV

Of the state-of-the-art consumer electronic products that were displayed, EDTV attracted the most attention. EDTV broadcasting service started on August 24, 1989, in Japan. The new Japanese EDTV system enables existing TV systems to receive ghost-free broadcasts. The EDTV manufacturers actively promoted their products at the Osaka

TABLE 1
Japanese Participants in Visual Equipment Markets

Company	Color TV	Liquid Crystal TV	Satellite Broadcast Receiver	Portable VTR	Camcorder	Digital Audio Tape Recorder	TV Phone
Casio		*		*		*	
Citizen		*					
Fujitsu	*		*	*	*	*	
Hitachi	*	*	*	*	*	*	*
JVC	*	*	*	*	*	*	
Matsushita	*	*	*	*	*	*	*
Mitsubishi	*		*	*	*	*	*
NEC	*	*	*	*	*	*	*
Pioneer	*		*			*	
Sanyo	*	*	*	*	*	*	*
Sony	*	*	*	*	*	*	*
Toshiba	*	*	*		*	*	*

Source: Dataquest
January 1990

show, because it was the first large-scale exhibition held since the new broadcasting service began. Table 2 summarizes the major features of the EDTV sets displayed by major suppliers.

DATAQUEST CONCLUSIONS

In the Japanese color television market, there is an increasing demand for television sets with high-quality pictures and larger screens. These preferences reflect the Japanese consumers' regard for high-grade durable goods. With the rapid shift of purchasing trends from "anything available" to "something of value," it is natural to see a strong demand for color TV sets with higher qualities. This aim for the best available product is also observed in other consumer electronic equipment.

With this favorable environment, TV manufacturers expect the EDTV broadcasting service to stimulate the current sluggish demand for TV sets. However, prices for the EDTV sets are more than ¥100,000 higher than prices of ordinary sets; we believe that a price reduction is needed before EDTV gains wide consumer acceptance.

The Broadcasting Technology Association (BTA) has begun development of second-generation EDTV, which is expected to be available in the next six to seven years. The second-generation products are expected to have higher-quality pictures and screens with 9:16 aspect ratios—the same as the high-definition TV currently under development.

In order to move EDTV into a major market, we expect television manufacturers to step up promotional measures, including advertising, software improvements, and price reductions.

Jonathan Drazin
Hideaki Nemoto

TABLE 2
EDTV Comparison

Company	Size (Inches)	Product Code	Price (Yen)	Vertical Resolution	Horizontal Resolution	Connector for Ghost Free	Merits/Technology
Fujitsu	29	BS-29D35	410,000	450	—	X	Broadcasting satellite, built-in type
	32	BS-32D35	480,000	450	—	X	Broadcasting satellite, built-in type
	32	32V-D35	430,000	450	—	X	Audio-visual surrounding type
Hitachi	33	C33-ED1	408,000	450	—	X	High-capacity digital circuits Lower price
Matsushita	29	TH-29XD1	360,000	450	600	—	Three-dimension filter
	67	VIP70	4,500,000	450	650	—	Electronic conference use
NEC	29	C-29ED1	368,000	450	560	X	
	29	C-29ED2	398,000	450	750	X	Ghost-free tuner (GCT-1000/ ¥250,000) Scan converter (NSC-2100/ ¥480,000)
Sanyo	32	C-32ED1	460,000	450	—	X	Field memories and line memories
Sharp	33	33C-ED1	465,000	450	—	X	—
Sony	29	KV-29ED1	369,000	450	—	—	—
	45	KX-45ED1	2,430,000	450	—	—	OEM production (monitor type)
	45	KX-45ED1T	2,520,000	450	—	—	OEM production (tuner built-in type)
Toshiba	34	34ED1A(N)	468,000	450	—	X	Ghost-free TV tuner (TT-GC9/ ¥109,000)

Source: Dataquest
January 1990

Newsletters 1989

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Research Newsletter

EUROPEAN DEFENSE ELECTRONICS: 1992 AND BEYOND

SUMMARY

Given the general relaxation of military tensions, progress in arms talks, and tightening fiscal constraints, Western European governments are focusing defense resources increasingly on quantitatively smaller but qualitatively more capable forces. This trend emphasizes procurement of electronics and, therefore, semiconductors for new weapon systems, modernization and upgrading of existing systems, and the development of force multipliers such as improved command, control, communications, and intelligence (C3I) systems.

THE MARKET

The determination of the members of the European Community (EC) to integrate Western European markets in 1992 may pose a significant new challenge to non-European defense electronics companies that are seeking contracts abroad. European officials deny any protectionist intent, yet there is considerable concern that outside businesses may be subject to protectionist barriers in various forms—for example, import quotas or local content requirements. Although defense items ostensibly are to be excluded from EC regulations, members have pushed for tariffs on dual-use technologies because of their civilian applications. Because the majority of U.S. defense exports to EC nations are system components, such tariffs could have significant impact on the trade relationship.

The year 1992 will be less a market watershed than a continuation of an ongoing process of integration in Europe. Taking a cue from the success of other pan-European ventures such as Ariane-Space and Airbus industries, the Independent European Program Group (IEPG) has sought to develop a European-wide defense procurement system. European avionics and electronics industries are currently undergoing major restructuring that will probably result in more concentrated groupings in areas such as flight controls, optical systems, and sensors. The GEC/Siemens takeover of Plessey is the most recent example of this concentration. The real effect of the 1992 phenomenon will be the more effective competition from rationalized European industries made possible by integrated economies.

One continuing area of dispute for U.S. and European companies is technology security. European and U.S. government views on the export of high-technology items always have differed, with the United States favoring tighter restraints and political controls over transfers. U.S. restrictions on technology transfers to third-world countries will continue to dampen American exports. Moreover, the relationship between the regulations of the 17-member Coordinating Committee on Multilateral Export Controls (COCOM) regarding restricted technologies and trade relationships involving EC members that are not part of COCOM is not clear.

MARKET OUTLOOK

The outlook for defense spending in the major European countries is not much different than that in the United States. Fiscal and political pressures in every nation are leading to real declines in defense expenditure or, at best, level budgets in real terms. Popular support for defense spending is eroding rapidly in many European states; the erosion is being fed by continuing improvements in East/West relations, increasing environmental concerns, and tighter budgetary constraints overall. Rapid progress in the Vienna talks on conventional forces in Europe could produce an arms-control agreement by the middle of the next decade that will require NATO governments to reduce their ground and air forces by up to 20 percent in some weapons categories.

These factors threaten the initiation of new development programs as well as the continuation of several high-profile procurement programs that already are under way. As a result, many European governments are looking for means to upgrade existing systems with new electronics rather than procure new weapons. Belgium's decision in May 1989 to reduce defense spending is a case in point, as it dashed previous hopes for Belgian purchases of the European Fighter Aircraft (EFA), the French Rafale, or the Agile Falcon F-16 planned to be developed by the United States and certain European countries.

Traditionally, a strong component of European-produced defense electronics has been exports to the Middle East; however, demand for systems has slowed substantially as the war between Iran and Iraq has subsided and oil-based economies struggle with continuing lower prices of that commodity.

Figures 1 and 2 present Dataquest's forecast of military electronics production and derived semiconductor consumption. We expect electronic equipment production to grow 3.3 percent in 1990 and accompanying semiconductor consumption to grow 5.6 percent.

MAJOR PROGRAMS

Figure 3 presents the estimated total development and production spending and the accompanying electronics content of some of the important, electronics-intensive, Western European defense programs.

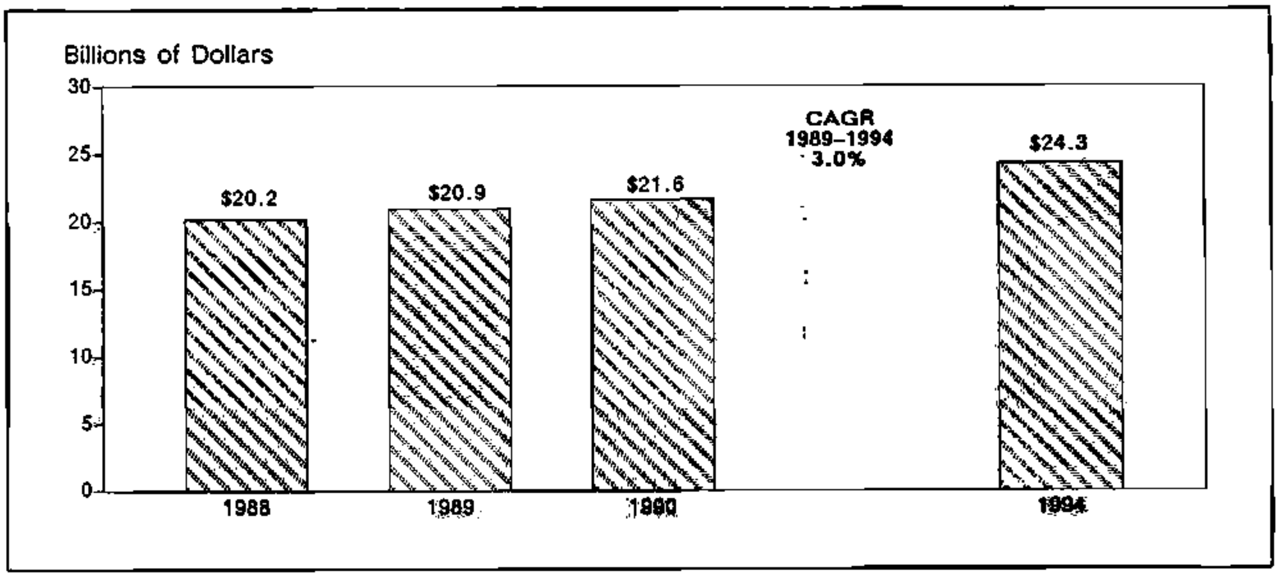
Rafale Aircraft

France dropped out of the EFA program in 1986 to pursue its own new fighter aircraft, the Rafale. Among other things, the Rafale will be armed with an antiradar missile and laser-guided missiles, as well as the MICA and Magic 2 air-to-air missiles. The Rafale also will incorporate terrain-avoidance capability with track-while-scan radar and simultaneous ground attack/air defense scan modes.

A joint company, Avion de Combat European (ACE) International, has been established by the four primary Rafale contractors—Dassault-Breguet (60 percent), SNECMA (20 percent), Thomson-CSF (10 percent), and Electronique Serge Dassault (ESD) (10 percent). Dassault-Breguet will build the airframe, and SNECMA will manufacture the M88 engine for the Rafale. The first prototype is expected to fly in 1991, and full-scale production is scheduled for 1994.

The radar will be based on Thomson's RBG (formerly RDX) multimode phased array radar. Thomson-CSF, with 66 percent of the work, will concentrate on the antenna and air-to-air operating modes; ESD will be responsible for ECCM and air-to-ground operating modes. The $318 million

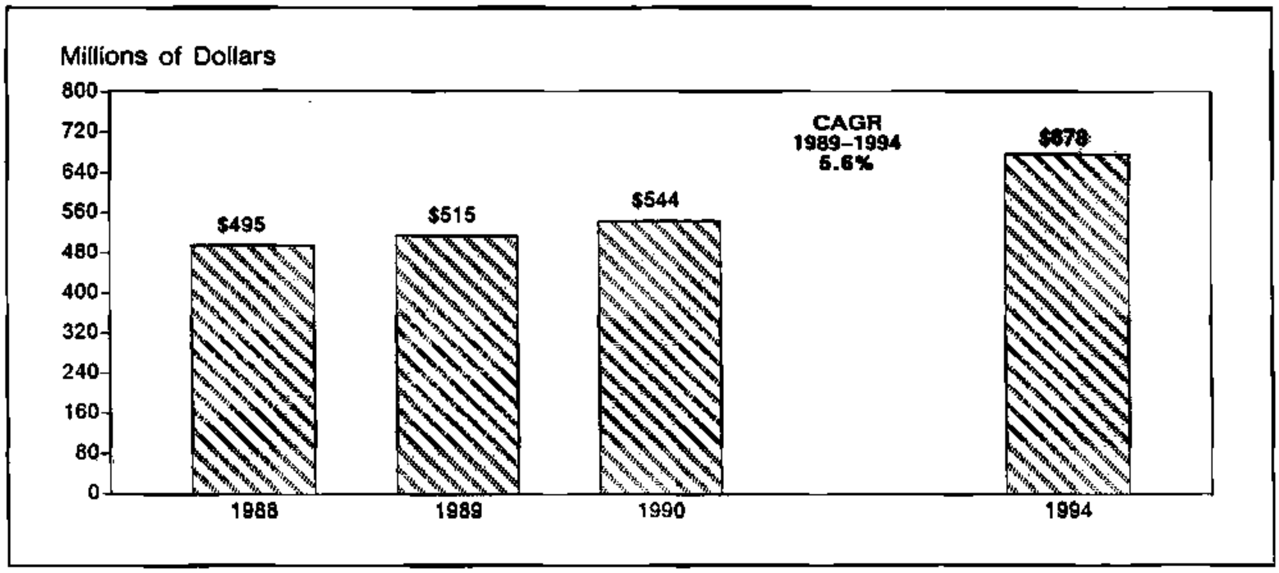
FIGURE 1
European Military Electronic Equipment Production



0005616-1

Source: Dataquest
November 1989

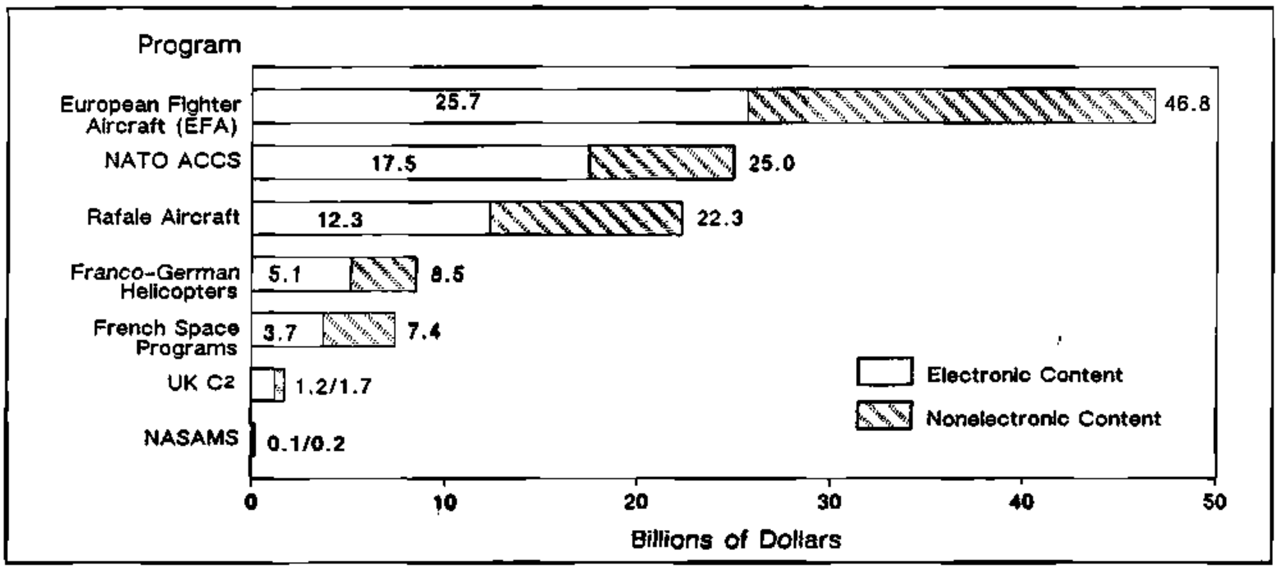
FIGURE 2
European Military Semiconductor Consumption



0005616-2

Source: Dataquest
November 1989

FIGURE 3
Important European Military Program Spending



0005616-3

Source: Defense Forecasts
Dataquest
November 1989

radar contract, which eventually could total approximately $1.6 billion, was awarded to Thomson and ESD in April 1989.

Space Programs

France has an active space program and will be expanding its military satellite program. In December 1988, Minister of Defense Jean-Pierre Chevenement revealed a 15-year military space program that would increase funding as well as European cooperative efforts. The plan calls for spending approximately $7.4 billion to add a radar-based reconnaissance satellite, a ground-based space surveillance system, and an electronic intelligence satellite to existing programs.

France is expected to contribute approximately $1.1 billion between 1987 and 1991 to two satellite programs developed jointly with Italy and Spain. The programs are the Helios military observation satellite and the Syracuse Communications Systems satellite. Another major program is the Telecom (I, II, and III) satellite.

Command and Control Systems

The Improved U.K. Air Defense Ground Environment C2 System (IUKADGE/ICCS) program is approximately five years behind schedule and $200 million over budget. Designed to link air- and ground-based radars and command centers for air defense of the United Kingdom, the largest obstacle for the IUKADGE has been software. Contractors have been using a mix of COBOL, FORTRAN, and RTL 2 programming languages. The total program cost is estimated to be approximately $1.7 billion; the prime contractor is UKADGE Systems Ltd., a consortium comprised of Hughes Aircraft, Marconi, and Plessey. More than 80 percent of the IUKADGE program is funded by NATO.

Norwegian Advanced Surface-to-Air Missile System (NASAMS)

The NASAMS will adapt the Hughes AIM-20 AMRAAM for surface-to-air use as part of the Norwegian southern air defense system upgrade. Beginning in 1991 or 1992, Norway hopes to replace Nike missile batteries with two full batteries of NASAMS. The six-year program will include a total of 18 launchers with 118 AMRAAM missiles; the three-phase contract is valued at $215 million.

The NASAMS fire unit will consist of a Hughes TPQ-36A 3-D low-altitude surveillance radar, a fire distribution center manufactured by Norsh Forrsvarsteknologi A/S (NFT) of Norway and three missile launcher subunits each with six missiles; a battery will consist of three fire units.

HKV, a joint venture of Hughes Aircraft and NFT, was awarded $13 million in early 1989 for a Phase I demonstration and evaluation of this surface-to-air application of the AMRAAM.

JOINT EUROPEAN PROGRAMS

European Fighter Aircraft (EFA)

The EFA is being developed jointly by the United Kingdom, West Germany, Italy, and Spain. A multirole fighter, the EFA will feature, among other things, fly-by-wire controls, stealth characteristics, composite materials, look-down-shoot-down radar, terrain-following capability, and multiple target acquisition systems.

Development work on the aircraft has been divided among the four members of the Eurofighter consortium, according to the proportion of planes each country plans to buy: British Aerospace, 33 percent; Messerschmitt-Boelkow-Blohm (MBB) of West Germany, 33 percent; Aeritalia of Italy 21 percent; and CASA of Spain, 13 percent. A four-country agreement was signed in May 1988 that authorized full-scale development of the EFA, with contracts signed in early 1989 for close to $8 billion. Production is scheduled to begin in 1995, with initial deployment in 1996, but this schedule is not likely to be met. The program calls for 765 aircraft to be produced through 2005, although more may be added later to accommodate foreign sales. Development costs for the EFA are estimated at $10.8 billion, with procurement costing another $36.0 billion.

Electronics manufacturers will be the main beneficiaries of the EFA program, as avionics systems are expected to account for at least one-half, and perhaps as much as 65 percent, of the total cost. Although most electronic subsystems still are in early conceptual stages, a four-country consortium has been formed to bid on design and production of the EFA's digital fly-by-wire flight control system: Aeritalia, Bodenseewerk Geratetechnik (West Germany), GEC Avionics (United Kingdom), and Inisel (Spain). A group led by FIAR of Italy also was formed to develop the infrared search and track system for the EFA. Other members of the group include Eltro of West Germany and Thorn-EMI of the United Kingdom.

Of the EFA's components, its multimode pulse-Doppler radar system requires the longest lead time in development and paces the development of other items. Two multinational industry teams—one led by Ferranti Defense Systems (United Kingdom) and the other by AEG (West Germany) and Marconi Defense Systems (United Kingdom), are bidding fiercely for the contract. Ferranti's proposal, the ECR-90, is based on radars developed for Sweden's JAS-39 Gripen program and in service with the United Kingdom's Royal Navy Harriers. The ECR-90 will use a high-power signal processor that incorporates Ericsson's 32-bit D80A chip. AEG's proposal, the MSD 2000, is based on Hughes' APG-65 radar.

The radar selection already is one year overdue and, accordingly, the delivery of the first 12 flyable preproduction radar units has slipped to November 1991. The entire radar program is expected to be worth approximately $1.8 billion. Work on radar development and production eventually will be divided among the four EFA participating countries using the same ratio as for the overall program.

PAH-2/HAC-3GT/HAP Franco-German Helicopter

France and West Germany are working together to develop and produce a new combat helicopter that will be fielded in the late 1990s. The constant dollar cost of the program is projected at $8.5 billion. Two versions of the helicopter are to be produced: one for antitank missions and one for escort and fire support.

Of the real procurement costs, $1.3 billion is earmarked for mission equipment packages, including navigation aids, observation equipment, weapon sights, fire control gear, and a mast-mounted avionics package. The main contractor for the mission equipment packages will be SOFRADIR, a French concern owned jointly by Thomson-CSF, SAT, and CEA Industries. French and West German subcontractors will be involved. In January 1989, three teams made bids for the avionics and mission management contracts, which are valued at more than $100 million: ESD and Litef of West Germany; Societe Francaise d'Instruments de Mesure (SFIM) and Bodenseewerk Geratetechnik; and a team made up of Crouzet (France), SFENA (France), Teldix (Bosch) (West Germany), and MBB's Dynamics Division (West Germany).

France and West Germany also will jointly develop infrared charge-coupled device (IRCCD) technology for the helicopter's optronic systems. The main contractor for the helicopter program as a whole is Eurocopter, a consortium of Aerospatiale (France) and MBB.

NATO Air Command and Control System (ACCS)

When deployed in the year 2000 (at the earliest), Dataquest believes that ACCS will integrate, process, and relay NATO air-defense tracking and targeting information, providing an automated command and control system to support all European air operations. We also expect data to be gathered into mobile, ground-based automated data processing systems and then channeled into a Combined Air Operations Center for dissemination. The ACCS consists of eight elements: AFATDS, ASAS, FAADC2I, CSSCS, MCS, MSE, and SINCGARS. ACCS funding should double from $4 billion in fiscal 1988 to $8 billion by fiscal 1992. ACCS will replace the existing NATO Air Defense Ground Environment system. Work is expected to begin in 1991 and last 18 years. France has indicated that it may participate.

DATAQUEST CONCLUSIONS AND RECOMMENDATIONS

Because of slowing growth of local defense spending and export markets, Western European defense electronics production growth is expected to remain in the 3 percent range. However, a selected set of modernization and upgrade opportunities remain for electronic OEMs and their semiconductor suppliers.

In the spirit of 1992, defense program spending and risk are being shared increasingly among countries. Additionally, Dataquest believes that the consolidation of defense electronics OEMs is not over. The implication for semiconductor suppliers is that extensive local presence will be needed in multiple countries for each program in order to obtain and retain design wins. As OEMs continue consolidating, they will begin enjoying the benefits of economy of scale, including more purchasing leverage.

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Greg Sheppard
Barry Blechman

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Research *Newsletter*

EUROPEAN SEMICONDUCTOR PROCUREMENT SURVEY

SUMMARY

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

THE MARKET SEGMENTS

Data Processing Segment

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

TABLE 1
European Procurement Survey Key Results

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

Source: Dataquest
October 1989

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

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

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

Communications Segment

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

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

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

Transportation Segment

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

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

Industrial Segment

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

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

Military Segment

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

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

Consumer Segment

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

DATAQUEST CONCLUSIONS

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

Bipin Parmar

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Research *Newsletter*

ESTIMATED 1988 EUROPEAN SEMICONDUCTOR MARKET SHARE RANKINGS BY APPLICATION SEGMENT

SUMMARY

This newsletter presents the results of Dataquest's survey of semiconductor vendor market share by application segment in Europe and total European semiconductor market share rankings for 1988 (see Tables 1 and 2). The data processing segment remained the largest segment, with 29.9 percent of the total market. From the European-company perspective, it was also the weakest: collectively, European vendors occupied only 20.0 percent of the data processing segment (see Table 3) compared with 46.1 percent for North American companies and 28.9 percent for Japanese companies.

For the most part, Philips and SGS-Thomson ranked first and second, respectively, in Europe. With the exception of data processing, their total market shares were reflected by identical positions in the communications, industrial, and consumer segments (see Tables 4, 5, and 6). Overall, indigenous European vendors performed best in the consumer segment, where vertically integrated vendors (i.e., Philips, Siemens, and Telefunken) often could exploit their presence in related equipment markets. North American companies fared best in the military and data processing segments, reflecting the pattern of their own home markets. Japanese and Rest of World (ROW) companies performed strongly in data processing, largely because of the supremacy of companies such as Hitachi, NEC, Samsung, and Toshiba in the world MOS memory markets.

SURVEY RESULTS

Data processing was the largest segment, representing 29.9 percent of the total market in Europe. North American companies continued to dominate with a collective 46.1 percent, compared with 28.9 percent for Japanese companies and 20.0 percent for European companies. Furthermore, this is the only segment where ROW companies—principally Samsung of South Korea, with a 4.4 percent share—made a strong impact. The top three vendors—Toshiba, Texas Instruments, and Intel—each held almost identical market shares and, combined, took a 32.4 percent share of this segment. The strongest European player was Siemens, which was ranked fifth. Of the top ten vendors, two were European, four were North American, three were Japanese, and one was South Korean.

The communications segment represented 20.4 percent of the total market. European and North American companies existed on an almost equal basis with a collective 40.3 and 45.4 percent, respectively. Philips' lead was unchallenged, with three companies—SGS-Thomson, Motorola, and Texas Instruments—competing closely for second, third, and fourth place, respectively. Of the top ten vendors, four were European, five were North American, and one was Japanese.

TABLE 1

Estimated 1988 European Semiconductor Market by Application Segment (Millions of U.S. Dollars)

Segment	Revenue	Percent of Total
Data Processing	$2,540	29.9%
Communications	1,736	20.4
Industrial	1,625	19.1
Consumer	1,526	18.0
Military	505	6.0
Transportation	559	6.6
Total	$8,491	100.0%

Source: Dataquest
October 1989

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Table 2
Estimated 1988 Total European Semiconductor Market Share Rankings (Millions of U.S. Dollars)

1988 Rank	Ranked Companies	1988 Revenue	1988 Cumulative Summary	1988 Market Share Percent	1988 Cumulative Summary Percent
1	Philips	$1,018	$1,018	12.0%	12.0%
2	SGS-Thomson	$ 652	$1,670	7.7%	19.7%
3	Texas Instruments	$ 647	$2,317	7.6%	27.3%
4	Motorola	$ 616	$2,933	7.3%	34.5%
5	Siemens	$ 569	$3,502	6.7%	41.2%
6	Intel	$ 485	$3,987	5.7%	47.0%
7	Toshiba	$ 390	$4,377	4.6%	51.5%
8	NEC	$ 387	$4,764	4.6%	56.1%
9	National Semiconductor	$ 386	$5,150	4.5%	60.7%
10	AMD	$ 277	$5,427	3.3%	63.9%
Total—European Companies		$3,196	-	37.6%	-
Total—North American Companies		3,664	-	43.2	-
Total—Japanese Companies		1,466	-	17.3	-
Total—ROW Companies		165	-	1.9	-
Total—All Companies		$8,491	-	100.0%	-

Source: Dataquest
October 1989

Table 3
Estimated 1988 European Data Processing Market Share Rankings (Millions of U.S. Dollars)

1988 Rank	Ranked Companies	1988 Revenue	1988 Cumulative Summary	1988 Market Share Percent	1988 Cumulative Summary Percent
1	Toshiba	$ 278	$ 278	10.9%	10.9%
2	Texas Instruments	$ 275	$ 553	10.8%	21.8%
3	Intel	$ 270	$ 823	10.6%	32.4%
4	NEC	$ 175	$ 998	6.9%	39.3%
5	Siemens	$ 172	$1,170	6.8%	46.1%
6	Motorola	$ 163	$1,333	6.4%	52.5%
7	National Semiconductor	$ 148	$1,481	5.8%	58.3%
8	Philips	$ 122	$1,603	4.8%	63.1%
9	Hitachi	$ 116	$1,719	4.6%	67.7%
10	Samsung	$ 112	$1,831	4.4%	72.1%
Total—European Companies		$ 507	-	20.0%	-
Total—North American Companies		1,172	-	46.1	-
Total—Japanese Companies		733	-	28.9	-
Total—ROW Companies		128	-	5.0	-
Total—All Companies		$2,540	-	100.0%	-

Source: Dataquest
October 1989

TABLE 4
Estimated 1988 European Communications Market Share Rankings By Application Segment (Millions of U.S. Dollars)

1988 Rank	Ranked Companies	1988 Revenue	1988 Cumulative Summary	1988 Market Share Percent	1988 Cumulative Summary Percent
1	Philips	$ 195	$ 195	11.2%	11.2%
2	SGS-Thomson	$ 158	$ 353	9.1%	20.3%
3	Motorola	$ 154	$ 507	8.9%	29.2%
4	Texas Instruments	$ 144	$ 651	8.3%	37.5%
5	Intel	$ 99	$ 750	5.7%	43.2%
6	Siemens	$ 97	$ 847	5.6%	48.8%
7	AMD	$ 77	$ 924	4.4%	53.2%
8	National Semiconductor	$ 72	$ 996	4.1%	57.4%
9	Toshiba	$ 71	$1,067	4.1%	61.5%
10	Plessey	$ 68	$1,135	3.9%	65.4%
Total—European Companies		$ 700	-	40.3%	-
Total—North American Companies		788	-	45.4	-
Total—Japanese Companies		230	-	13.2	-
Total—ROW Companies		18	-	1.0	-
Total—All Companies		$1,736	-	100.0%	-

Note: Columns may not add to totals shown because of rounding.

Source: Dataquest
October 1989

TABLE 5
Estimated 1988 European Industrial Market Share Rankings (Millions of U.S. Dollars)

1988 Rank	Ranked Companies	1988 Revenue	1988 Cumulative Summary	1988 Market Share Percent	1988 Cumulative Summary Percent
1	Philips	$ 182	$ 182	11.2%	11.2%
2	SGS-Thomson	$ 149	$ 331	9.2%	20.4%
3	Texas Instruments	$ 122	$ 453	7.5%	27.9%
4	Motorola	$ 110	$ 563	6.8%	34.6%
5	Siemens	$ 106	$ 669	6.5%	41.2%
6	ASEA Brown Boveri	$ 88	$ 757	5.4%	46.6%
7	Intel	$ 72	$ 829	4.4%	51.0%
8	National Semiconductor	$ 70	$ 899	4.3%	55.3%
9	Harris	$ 65	$ 964	4.0%	59.3%
10	Hitachi	$ 62	$1,026	3.8%	63.1%
Total—European Companies		$ 677	-	41.7%	-
Total—North American Companies		739	-	45.5	-
Total—Japanese Companies		208	-	12.8	-
Total—ROW Companies		1	-	0.1	-
Total—All Companies		$1,625	-	100.0%	-

Note: Columns may not add to totals shown because of rounding.

Source: Dataquest
October 1989

TABLE 6
Estimated 1988 European Consumer Market Share Rankings (Millions of U.S. Dollars)

1988 Rank	Ranked Companies	1988 Revenue	1988 Cumulative Summary	1988 Market Share Percent	1988 Cumulative Summary Percent
1	Philips	$ 437	$ 437	28.6%	28.6%
2	SGS-Thomson	$ 137	$ 574	9.0%	37.6%
3	Siemens	$ 118	$ 692	7.7%	45.3%
4	ITT	$ 108	$ 800	7.1%	52.4%
5	Telefunken	$ 86	$ 886	5.6%	58.1%
6	Motorola	$ 49	$ 935	3.2%	61.3%
7	Texas Instruments	$ 41	$ 976	2.7%	64.0%
8	National Semiconductor	$ 35	$1,011	2.3%	66.3%
9	NEC	$ 27	$1,038	1.8%	68.0%
10	Plessey	$ 23	$1,061	1.5%	69.5%
Total—European Companies		$ 871	-	57.1%	-
Total—North American Companies		441	-	28.9	-
Total—Japanese Companies		196	-	12.8	-
Total—ROW Companies		18	-	1.2	-
Total—All Companies		$1,526	-	100.0%	-

Source: Dataquest
October 1989

The industrial segment represented 19.1 percent of the total market. European and North American companies again coexisted almost equally in this segment with 41.7 and 45.5 percent, respectively. Top-ranked Philips was followed by SGS-Thomson and Texas Instruments. Of the top ten vendors, four were European, five were North American, and one was Japanese.

The consumer segment made up 18.0 percent of the total market. European companies dominated with a collective 57.1 percent share of this segment, compared with 28.9 percent for North American companies and 12.8 percent for Japanese companies. Philips clearly took first place with a sizable 28.6 percent of this segment. This share was more than three times that of its closest competitor, SGS-Thomson, in second place with 9.0 percent. Of the top ten vendors, five were European, four were North American, and one was Japanese. Except for the North American company ITT (the operations of which are largely European) in fourth place, European vendors occupied each of the top five positions.

The military segment accounted for 6.0 percent of the total market (see Table 7). North American companies led with a 56.6 percent share, compared with 40.6 percent for European companies and only 2.8 percent for Japanese companies. Motorola ranked first, followed by SGS-Thomson; Philips and Plessey shared third place. Of the top ten vendors, five were European and five were North American.

The transportation segment represented 6.6 percent of the total market (see Table 8). European and North American companies held approximately equal shares, with 42.2 and 42.6 percent, respectively, followed by Japanese companies with 15.2 percent. Motorola easily occupied first place with 14.8 percent of the market, with close competition among NEC, SGS-Thomson, and Siemens for the next three positions. Of the top ten vendors, four were European, five were North American, and one was Japanese.

Jonathan Drazin
Byron Harding

TABLE 7
Estimated 1988 European Military Market Share Rankings (Millions of U.S. Dollars)

1988 Rank	Ranked Companies	1988 Revenue	1988 Cumulative Summary	1988 Market Share Percent	1988 Cumulative Summary Percent
1	Motorola	$ 57	$ 57	11.3%	11.3%
2	SGS-Thomson	$ 48	$105	9.5%	20.8%
3	Philips	$ 45	$150	8.9%	29.7%
3	Plessey	$ 45	$195	8.9%	38.6%
4	National Semiconductor	$ 40	$235	7.9%	46.5%
4	Texas Instruments	$ 40	$275	7.9%	54.5%
5	AMD	$ 32	$307	6.3%	60.8%
5	Analog	$ 32	$339	6.3%	67.1%
6	Matra Harris	$ 19	$358	3.8%	70.9%
7	MEDL	$ 16	$374	3.2%	74.1%
Total—European Companies		$205	-	40.65%	-
Total—North American Companies		286	-	56.6	-
Total—Japanese Companies		14	-	2.8	-
Total—ROW Companies		0	-	0	-
Total—All Companies		$505	-	100.0%	-

Source: Dataquest
October 1989

TABLE 8
Estimated 1988 European Transportation Market Share Rankings (Millions of U.S. Dollars)

1988 Rank	Ranked Companies	1988 Revenue	1988 Cumulative Summary	1988 Market Share Percent	1988 Cumulative Summary Percent
1	Motorola	$ 83	$ 83	14.8%	14.8%
2	NEC	$ 64	$147	11.4%	26.3%
2	SGS-Thomson	$ 64	$211	11.4%	37.7%
3	Siemens	$ 60	$271	10.7%	48.5%
4	ITT	$ 47	$318	8.4%	56.9%
5	Philips	$ 37	$355	6.6%	63.5%
6	Telefunken	$ 25	$380	4.5%	68.0%
6	Texas Instruments	$ 25	$405	4.5%	72.5%
7	National Semiconductor	$ 21	$426	3.8%	76.2%
8	Harris	$ 18	$444	3.2%	79.4%
Total—European Companies		$236	-	42.2%	-
Total—North American Companies		238	-	42.6	-
Total—Japanese Companies		85	-	15.2	-
Total—ROW Companies		0	-	0	-
Total—All Companies		$599	-	100.0%	-

Source: Dataquest
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PRINTER MANUFACTURING SCENE TRANSFORMED IN EUROPE

SUMMARY

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

RECENT PRINTER INDUSTRY HISTORY

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

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

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

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

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

DATAQUEST SURVEY OF JAPANESE PRINTER MANUFACTURERS

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

Table 1

Factors in Choosing Locations

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

Source: Dataquest
October 1989

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

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

Major Printer Components

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

Table 2

Major Semiconductor Printer Components

Serial Dot Matrix Printer

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

Estimated total semiconductor value = $18.10

(Continued)

Table 2 (Continued)

Major Semiconductor Printer Components

Ink Jet Printer

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

Estimated total semiconductor value = $58.10

Page Printer (Laser Printer)

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

Estimated total semiconductor value = $214.10

Source: Dataquest
October 1989

OPPORTUNITIES FOR EUROPE-BASED SEMICONDUCTOR VENDORS

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

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

The Printer Market's Potential Impact on the Semiconductor Market

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

- Serial printers
- Line printers
- Page printers

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

Serial Printers

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

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

Line Printers

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

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

Page Printers

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

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

Printer Production in Europe

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

Table 3

Western European Printer Manufacturing Sites

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

(Continued)

Table 3 (Continued)

Western European Printer Manufacturing Sites

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

*Production plans announced, but not yet finalized

Source: Dataquest
October 1989

DATAQUEST CONCLUSIONS

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

Bipin Parmar

APPENDIX

PRINTER INDUSTRY DEFINITIONS

The following categories comprise all electronic printers:

- Serial printers
- Line printers
- Page printers

Serial Printers

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

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

Line Printers

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

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

Page Printers

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

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

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Research Newsletter

DOMESTIC METERING: THE MARKET IN EUROPE

SUMMARY

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

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

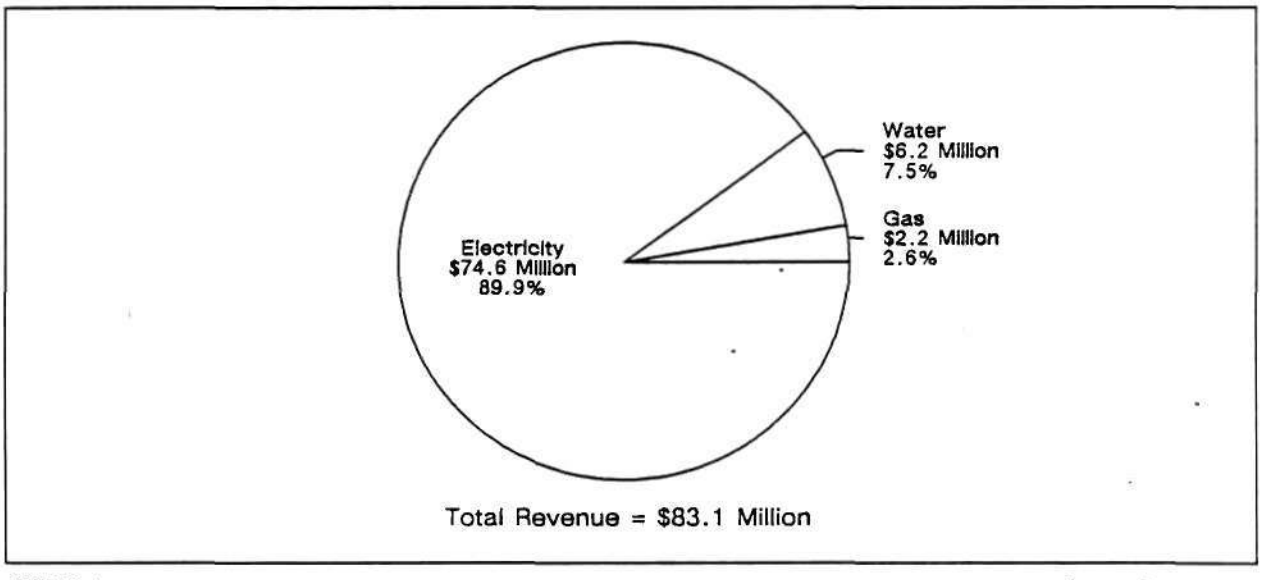
ELECTRONIC METERS BRING NEW FEATURES

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

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

FIGURE 1

European Semiconductor Revenue Forecast by Domestic Metering Application (1994)



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Source: Dataquest
October 1989

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

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

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

Source: Dataquest
October 1989

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

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

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

ELECTRICITY—COGS AND DISKS RULE ... FOR NOW

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

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

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

Semiconductor Content

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

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

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

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

TABLE 2
Estimated Semiconductor Content for an Electronic Meter and Teleswitch

Electronic Meter (With LCD Display)

Function	Technology	Cost
8-Bit Microcontroller with LCD Controller	Standard CMOS	$ 4.00
1-Kbit EEPROM	Standard NMOS	0.65
Analog Power Multiplier and Frequency Conversion	Linear CMOS ASIC	3.50
Discretes	Bipolar	0.80
Total Semiconductor Content		$ 8.95
Average Selling Price		$42.00
I/0 Ratio		21.3%

Tariff Teleswitch*

Function	Technology	Cost
8-Bit Microcontroller	Standard CMOS	$ 4.00
RF Front-End/Preamplifier	Analog ASIC bipolar	3.00
Receiver/Filter/Decoder	Analog/digital ASIC CMOS	5.50
Discretes (Relay Drivers & LED)	Mixed	0.90
Total Semiconductor Content		$13.40
Average Selling Price		$60.00
I/0 Ratio		22.3%

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

Source: Dataquest
October 1989

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

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

Market Analysis

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

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

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

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

TABLE 3
Key Electronic Electricity Meter Suppliers

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

Source: Dataquest
October 1989

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

MIXED PROSPECTS FOR WATER METERS

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

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

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

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

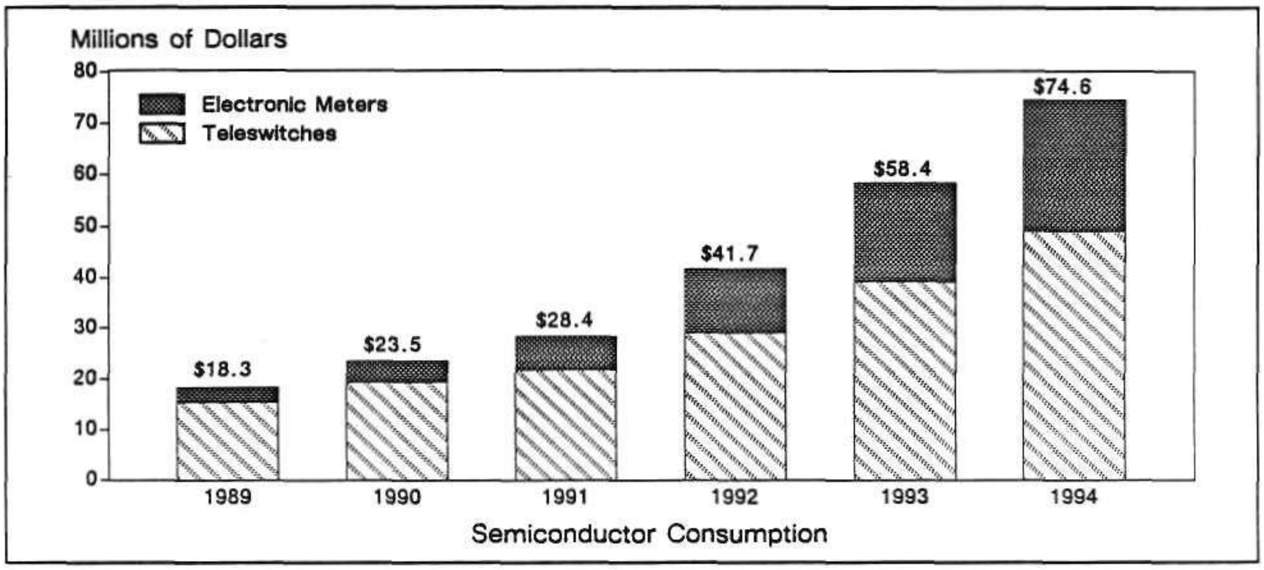
ELECTRIFIED GAS?

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

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

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

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



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Source: Dataquest
October 1989

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

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

DATAQUEST CONCLUSIONS

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

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

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

Jonathan Drazin

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Research *Newsletter*

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THE EUROPEAN PC HOME MARKET: AN UNKNOWN POTENTIAL

SUMMARY

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

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

CHARACTERISTICS OF THE HOME MARKET

Price-Driven with Special Requirements

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

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

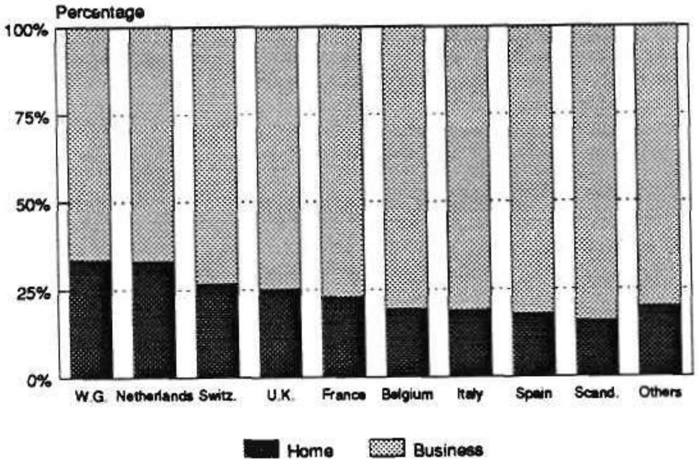
Increasingly Sophisticated Applications

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

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

Figure 1

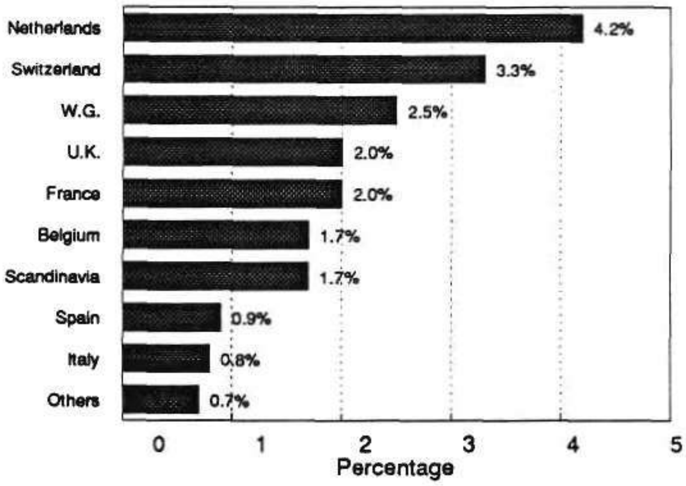
European 1988 PC Market
Estimated Breakdown by Market Sector



Source: Dataquest
September 1989

Figure 2

European 1988 PC Market
Estimated Penetration of Households by Country



Source: Dataquest
September 1989

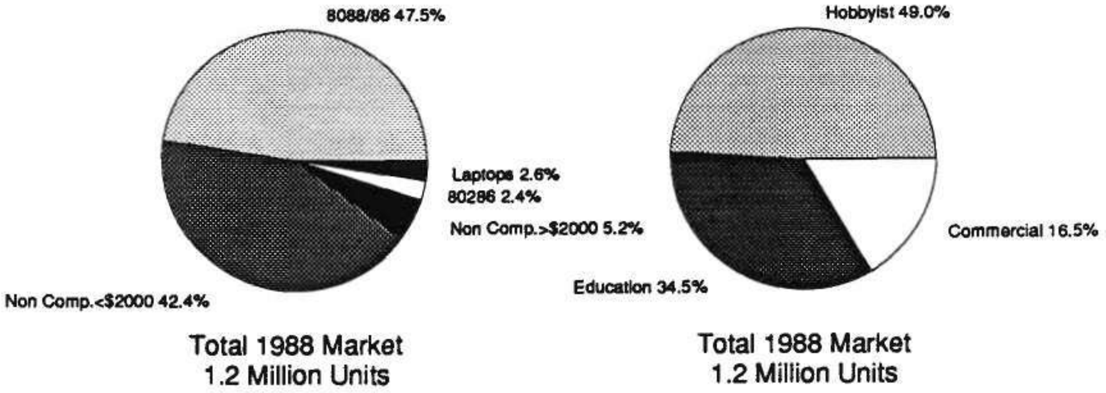
In the past, using computers to work at home was limited to executives and the professions, but more and more employees are now taking work home, and a small but growing number of employees actually work at home. Links between the office and the "home office" are thus likely to become much more widespread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

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

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

Figure 3

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



Source: Dataquest
September 1989

Which Computer?

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

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

Expensive Entry Tickets in Promotion and Distribution

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

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

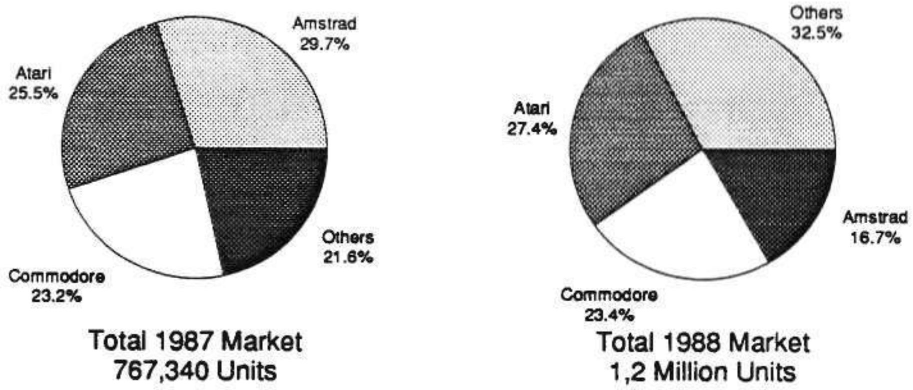
El Corte Inglés in Spain; Vroom & Dreesmann in the Netherlands; Bilka in Denmark; and Kaufhof in West Germany.

Specialist Vendors Dominate the Market

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

Figure 4

European PC Home Market
1987 and 1988 Shipments by Vendor



Source: Dataquest
September 1989

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

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

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

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

DATAQUEST ANALYSIS

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

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

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Research *Newsletter*

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PART III
DIGITAL CELLULAR RADIO—THE MARKET FORCES

INTRODUCTION

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

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

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

BACKGROUND

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

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

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

Current Networks

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

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

IMPLEMENTATION OF DIGITAL NETWORKS

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

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

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

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

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

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

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

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

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

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

DATAQUEST CONCLUSIONS

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

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Research *Newsletter*

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PART II
CELLULAR RADIO IN EUROPE—GROWING INTO THE FUTURE

INTRODUCTION

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

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

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

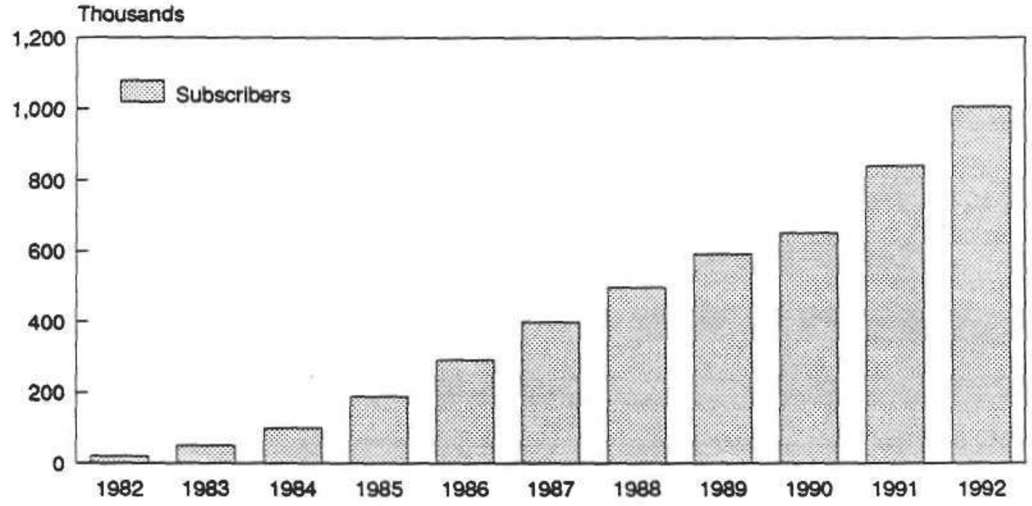
BACKGROUND

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

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

Figure 1

Scandinavian Cellular Market 1982–1992



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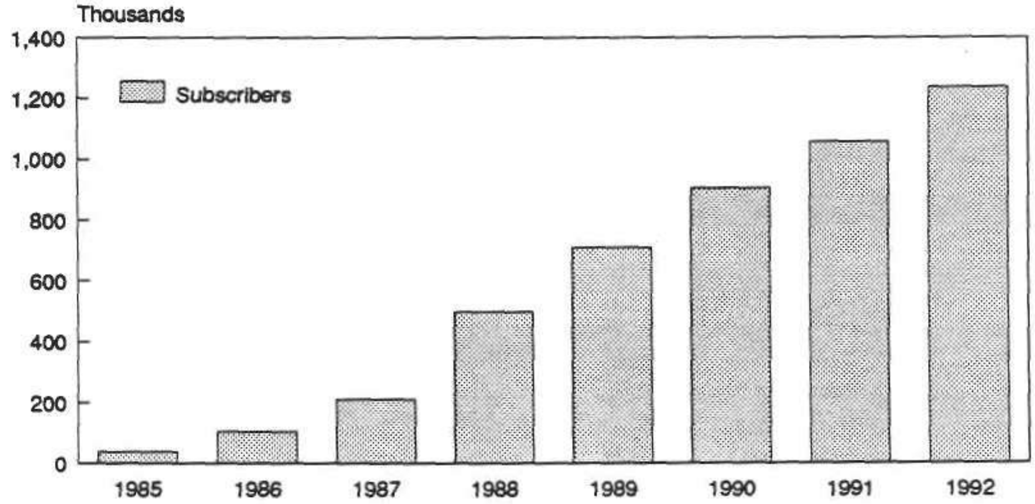
Source: Dataquest
July 1989

Figure 2

United Kingdom Cellular Market 1985–1992



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Source: Dataquest
July 1989

Table 1

Systems in Operations Across Europe

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

Source: Dataquest
July 1989

Market Structure

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

COMPETITIVE ENVIRONMENT IN THE UNITED KINGDOM

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

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

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

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

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

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

The Market in Mainland Europe

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

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

THE FUTURE

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

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

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

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

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

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

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

DATAQUEST ANALYSIS

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

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

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

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

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Jim Eastlake
Ted Richardson

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Research *Newsletter*

ESAM Code: Volume II Newsletters
1989-15
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PART I
CELLULAR RADIO—ITS HISTORY AND PRINCIPLES

INTRODUCTION

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

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

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

PRINCIPLES OF CELLULAR RADIO

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

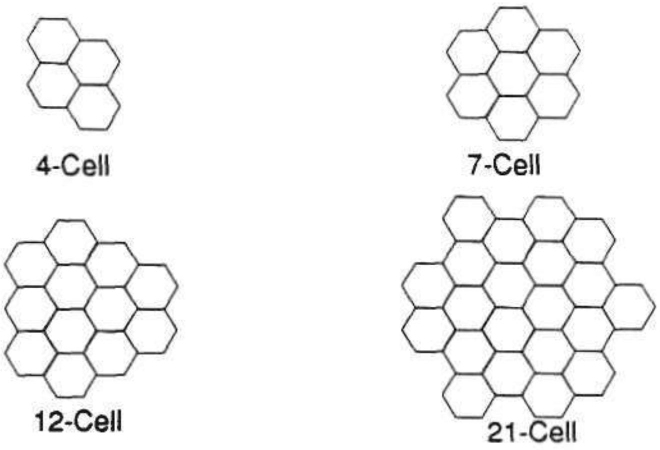
Cell Structure

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

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

Figure 1

Cell–Repeat Patterns



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Source: Dataquest
July 1989

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

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

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

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

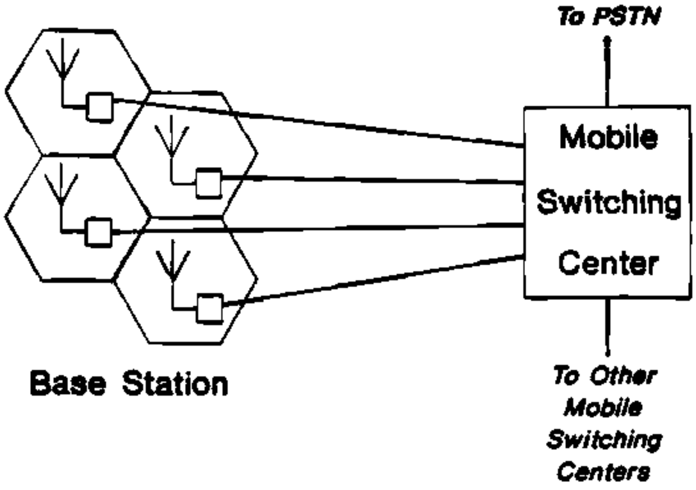
System Structure

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

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

Figure 2

Cellular Radio Network



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Source: Dataquest July 1989

Registration

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

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

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

In-Call Hand-Off

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

ADJACENT AND CO-CHANNEL INTERFERENCE

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

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

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

CONCLUSIONS

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

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

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

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Ted Richardson

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

SUMMARY

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

Many key issues were discussed, including the following:

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

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

SPEAKER HIGHLIGHTS

The following extracts are highlights from the conference presentations.

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

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

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

However, five factors could affect that prediction as follows:

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

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

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

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

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

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

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

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

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

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

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

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

"Positioning Internationally"
Robert Freischlag, President
Fujitsu Mikroelektronik

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Byron Harding

NEW DIRECTORY OF DATAQUEST PUBLICATIONS

A new directory describing 30 Dataquest Research Publications is now available from Dataquest's Direct Marketing Group. The directory includes information on the following:

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

OVERVIEW

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

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

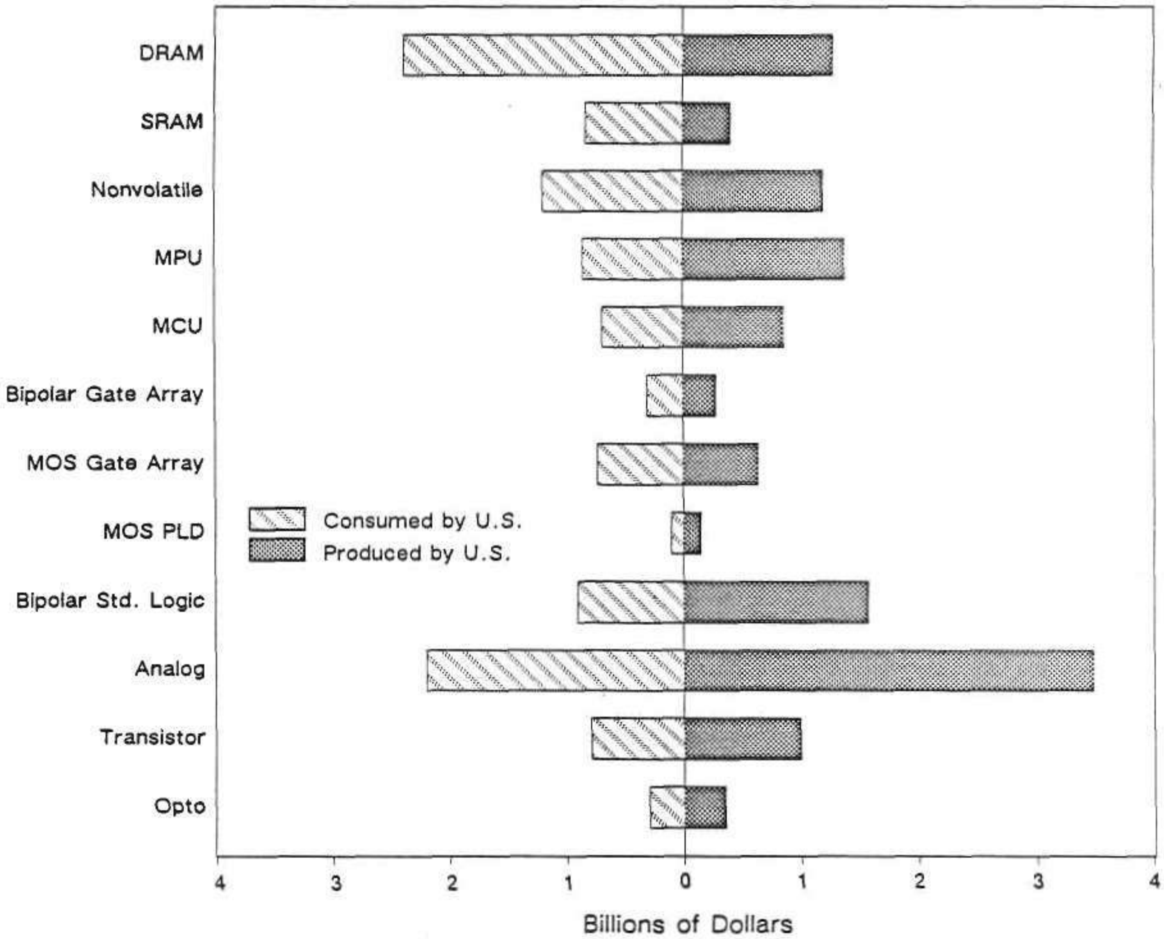
PROFILES BY REGION

U.S. Companies

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

Figure 1

Semiconductor Consumption/Production Profile
United States

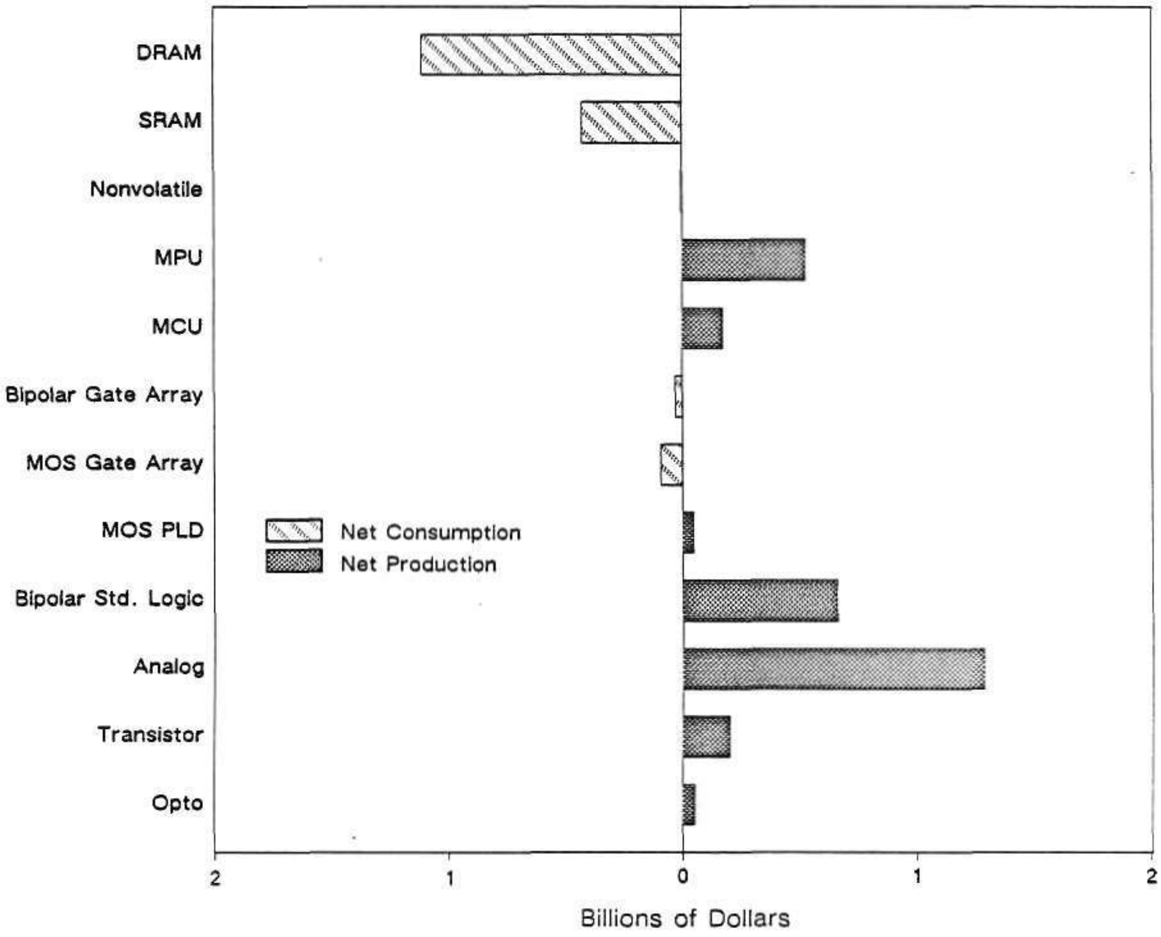


0004342-1

Source: Dataquest
July 1989

Figure 2

Difference between Semiconductor Consumption and Production United States



0004342-2

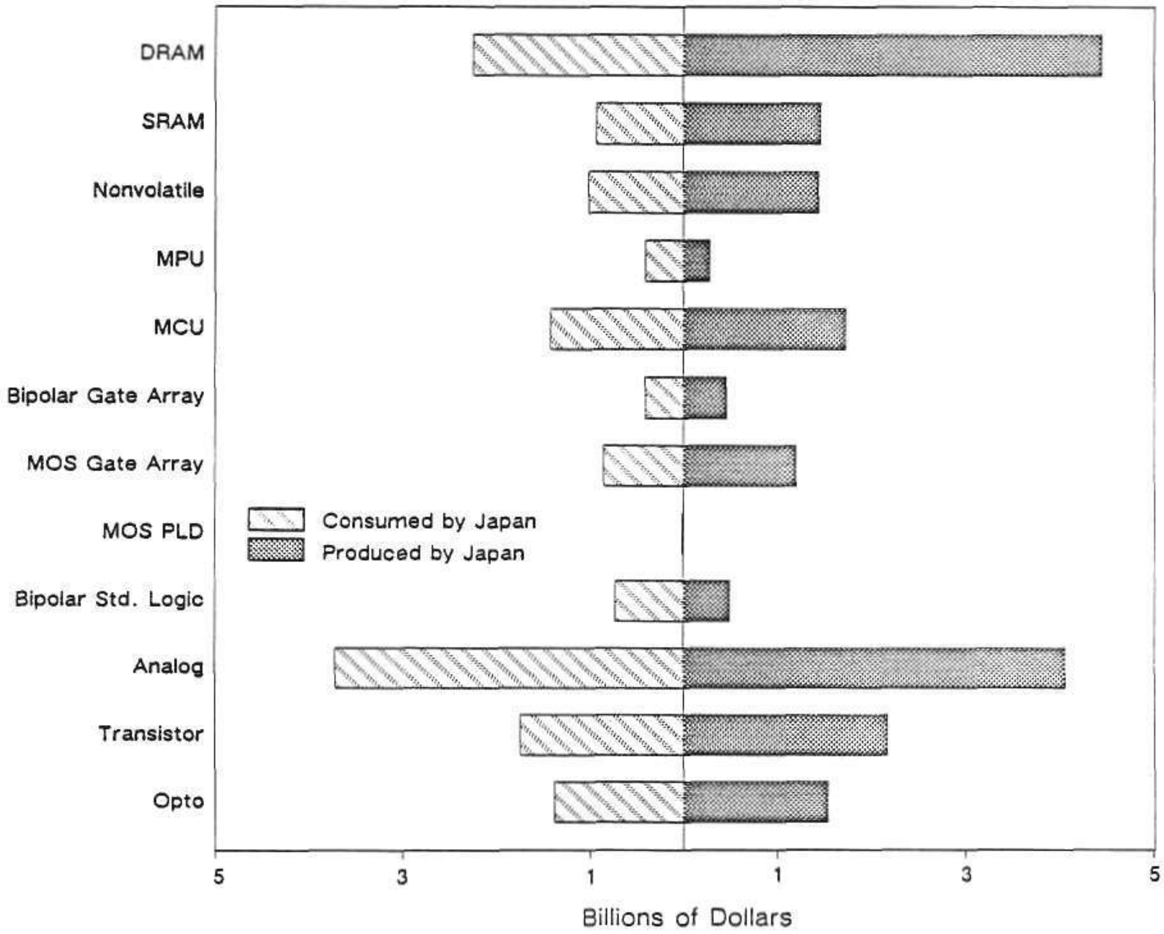
Source: Dataquest
July 1989

Japanese Companies

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

Figure 3

Semiconductor Consumption/Production Profile
Japan

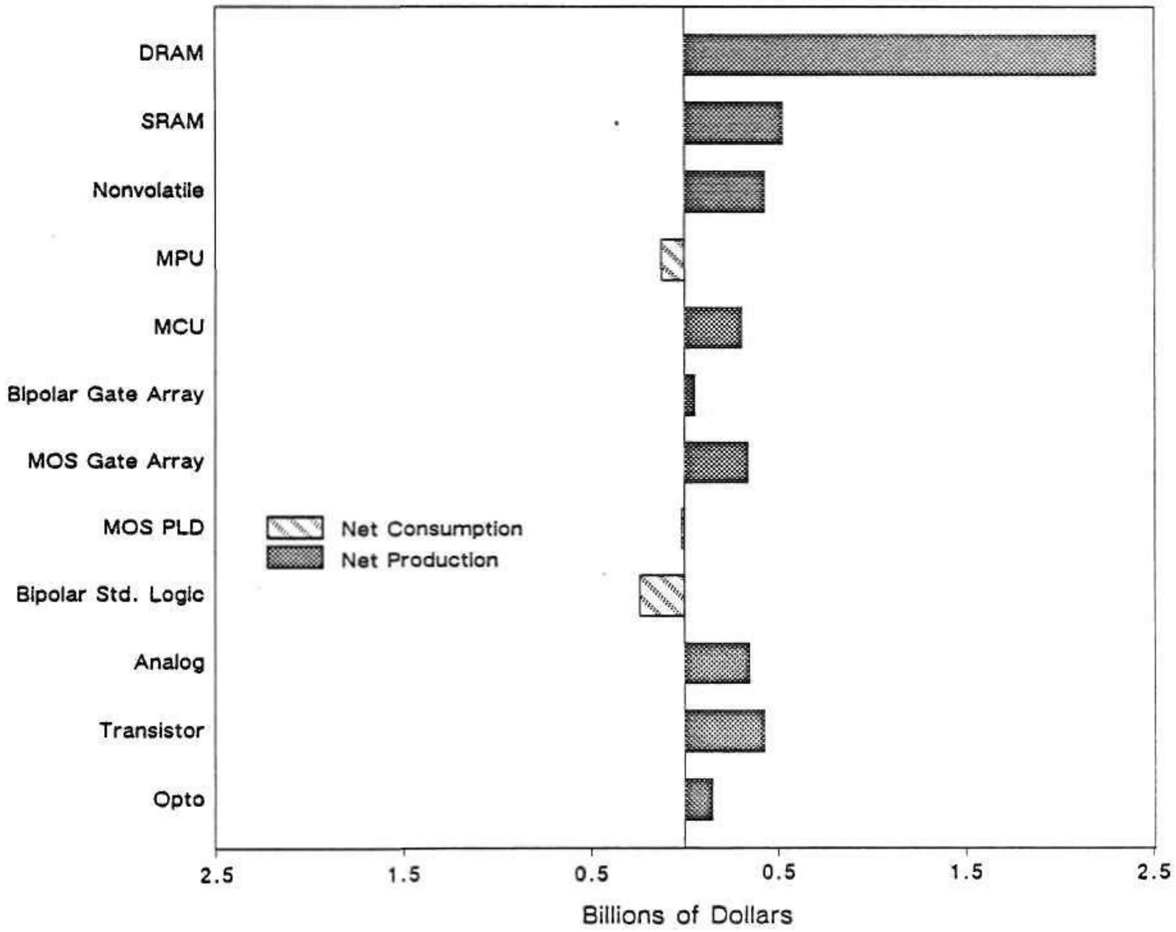


0004342-3

Source: Dataquest
July 1989

Figure 4

Difference between Semiconductor Consumption and Production
Japan



0004342-4

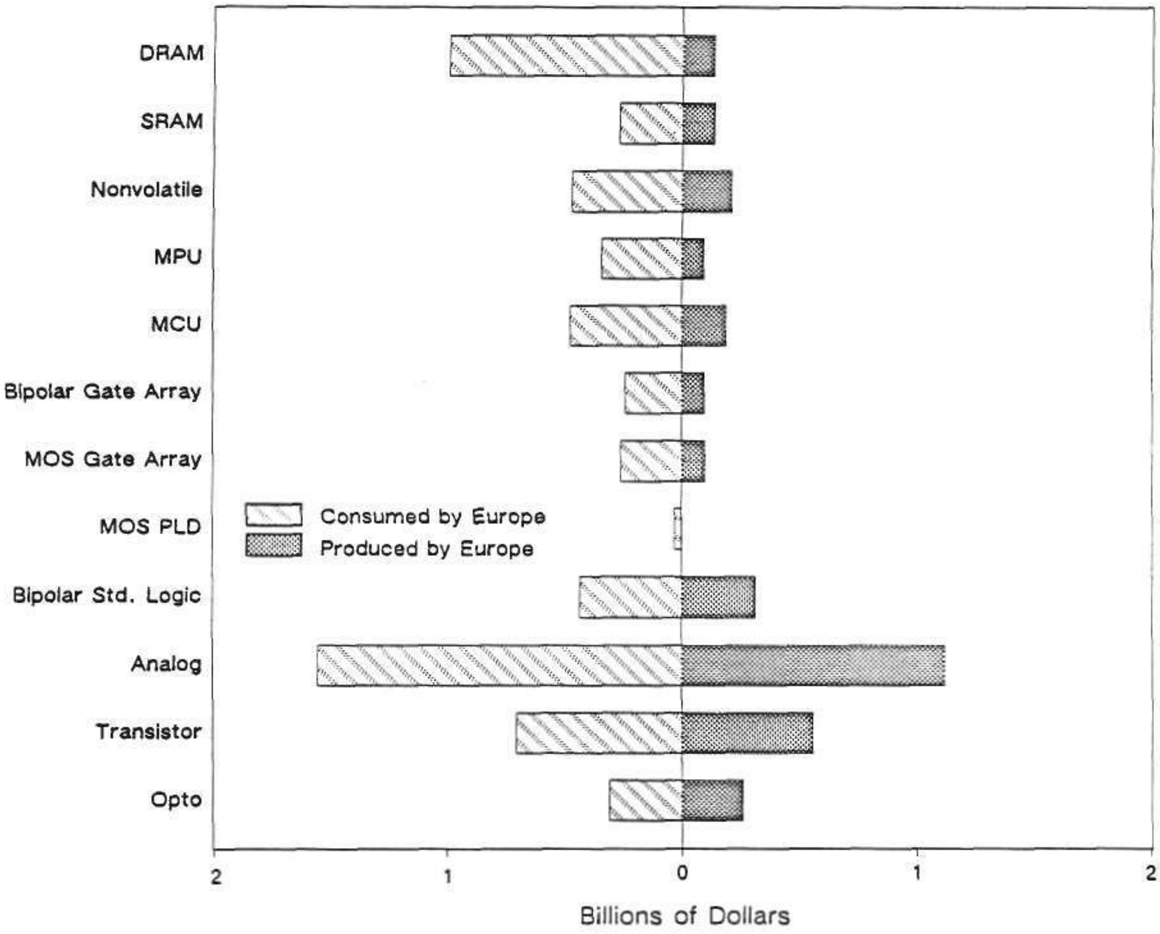
Source: Dataquest
July 1989

European Companies

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

Figure 5

Semiconductor Consumption/Production Profile
Europe



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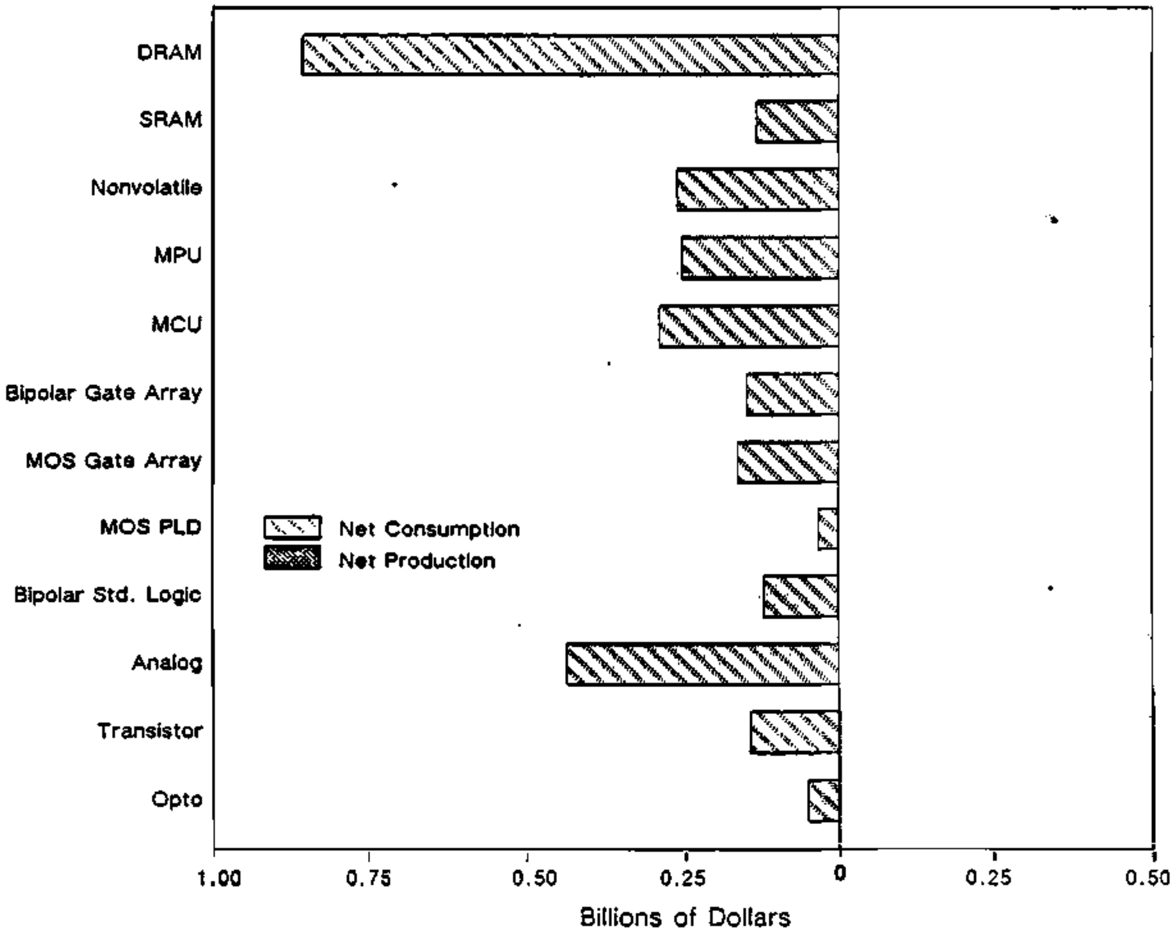
Source: Dataquest
July 1989

Figure 6

Difference between Semiconductor Consumption and Production Europe



0004342-6

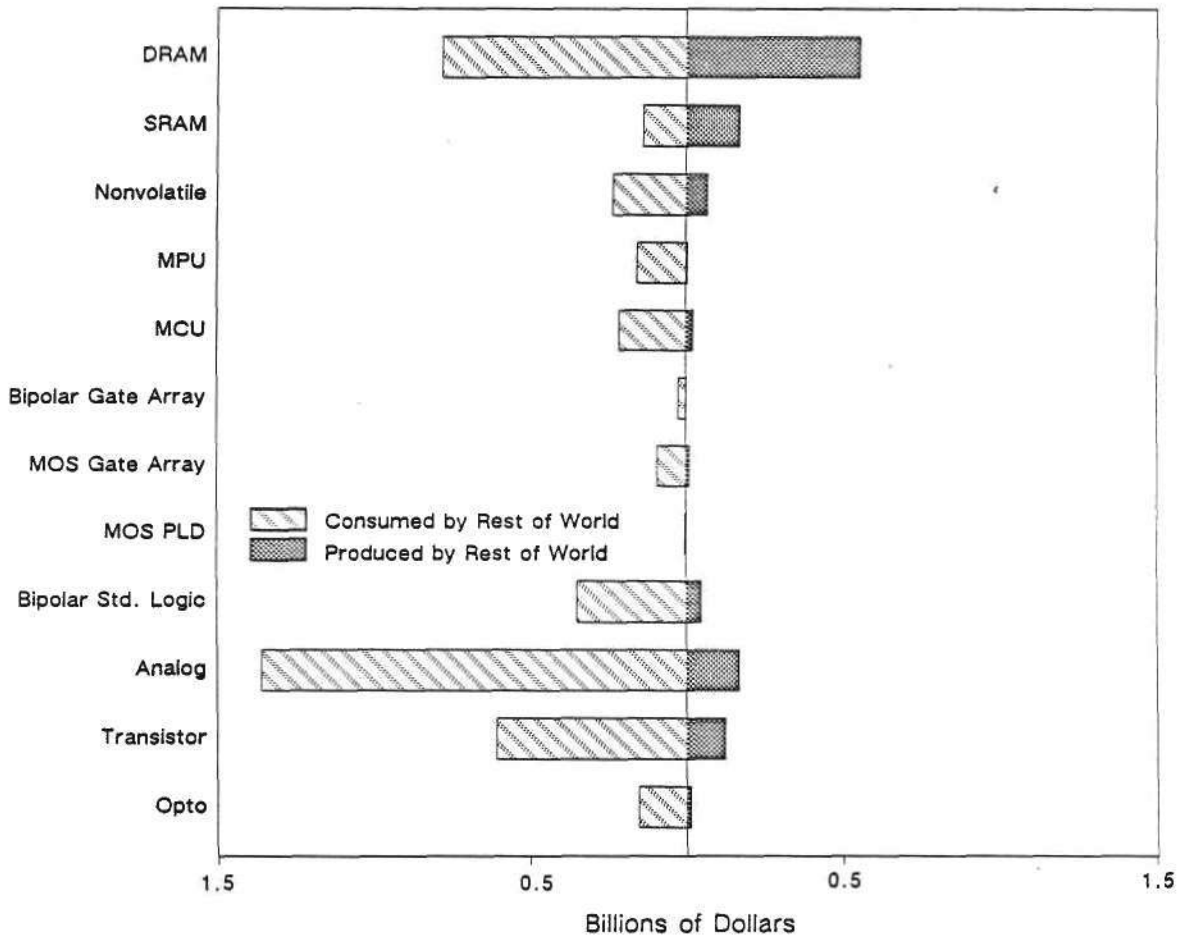
Source: Dataquest
July 1989

Asia/Pacific and ROW Companies

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

Figure 7

Semiconductor Consumption/Production Profile
Rest of World

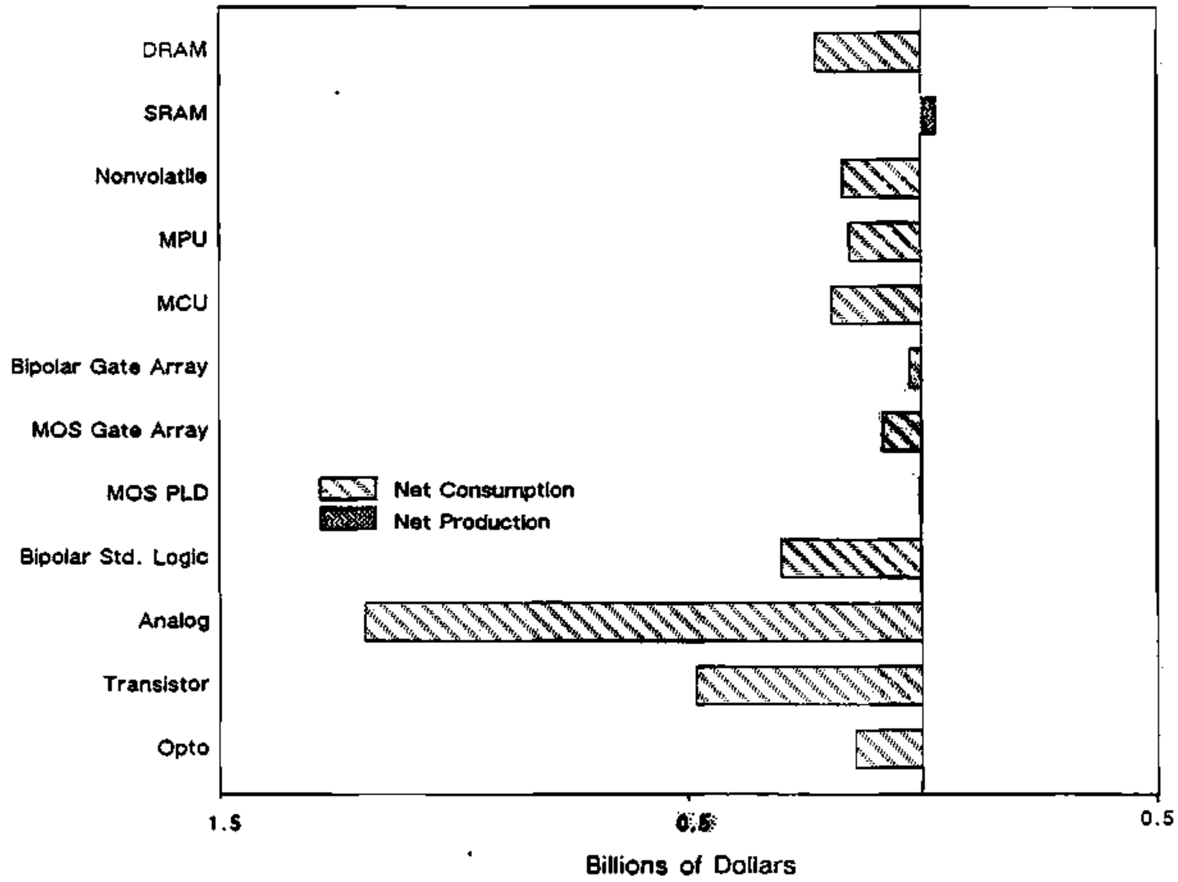


0004342-7

Source: Dataquest
July 1989

Figure 8

Difference between Semiconductor Consumption and Production
Rest of World



0004342-8

Source: Dataquest
July 1989

DATAQUEST ANALYSIS

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

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

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

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

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

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

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

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Byron Harding
David Angel

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Research Newsletter

ESAM Code: Volume II, Newsletters
1989-12
0004018

THE PC CHIP SET MARKET: WADE IN CAREFULLY—THE POOL IS FULL!

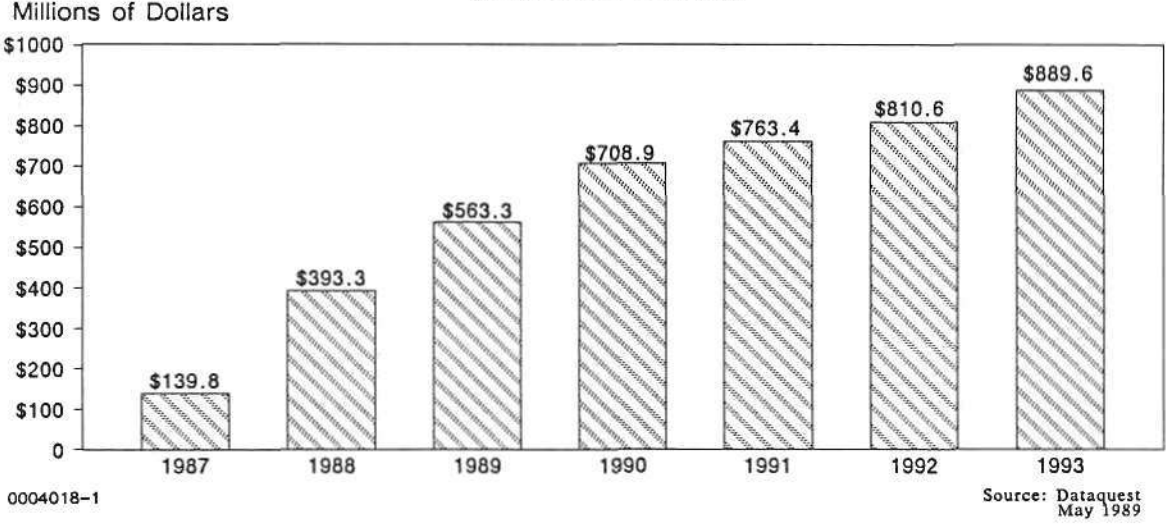
INTRODUCTION

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

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

Figure 1

Worldwide PC Chip Set Market Forecast
(Millions of Dollars)



0004018-1

Source: Dataquest
May 1989

HIGH GROWTH RATE ATTRACTS MANY NEW ENTRANTS

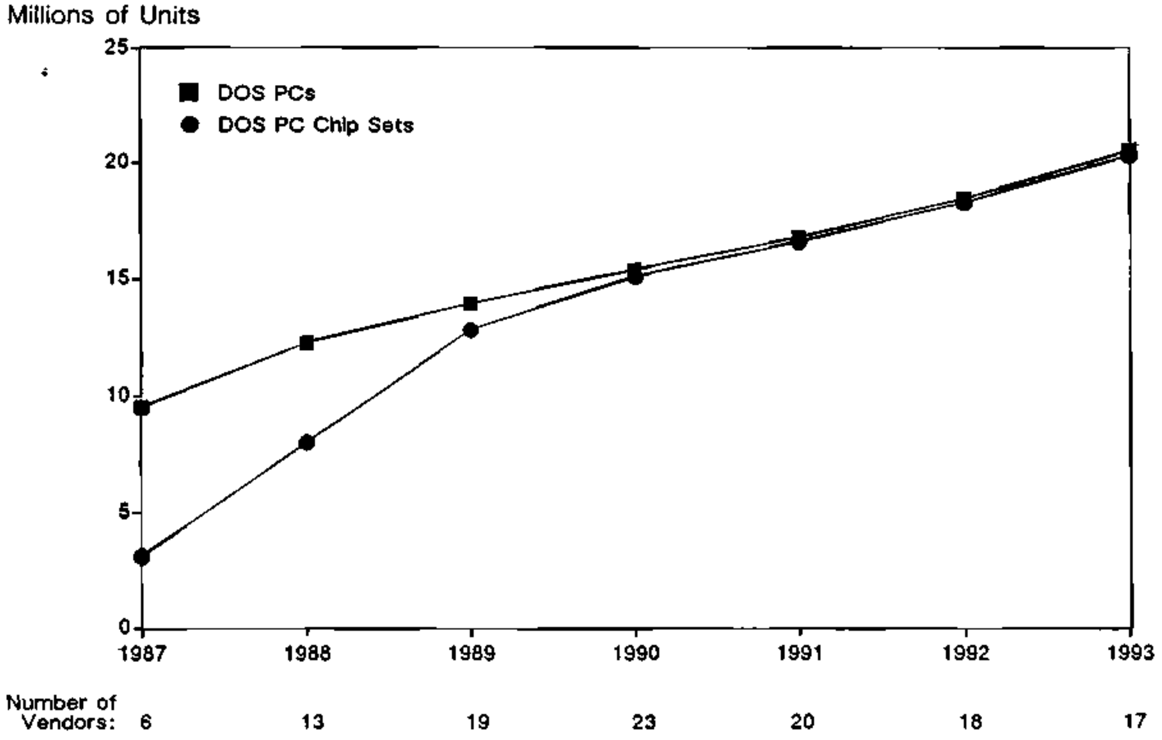
Dataquest estimates the compound annual growth rate (CAGR) for chip set unit shipments from 1987 to 1993 to be about 38 percent, an attractive rate of growth to investors, which should entice them to seek ways to participate in this industry. However, because of the nature of the relationship between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

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

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

Figure 2

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



0004018-2

Source: Dataquest May 1989

A Case of Overcapacity

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

Table 1

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

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

Source: Dataquest
May 1989

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

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

FORECAST METHODOLOGY AND ASSUMPTIONS

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

- The worldwide DOS PC market will continue to grow through the period at a CAGR of about 14 percent.
- As a general trend, discrete chips will be displaced by very large scale integration. In personal computers specifically, discrete logic chips will be replaced by logic chip sets. Because of the advantages of chip sets for the systems manufacturers—lower cost, better performance, faster time to market—this displacement has happened very rapidly.

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

Table 2

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

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

N/A = Not Available

Source: Dataquest
May 1989

DATAQUEST ANALYSIS

Critical Success Factors for Participants

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

- Systems Expertise—Systems designers are looking for vendors that can work with them from the beginning of the board design to integrate and sometimes customize a chip set into the system. Chip set vendors with board design and systems expertise will be able to provide this capability.
- Design Tools—Fast chip design turnaround will be required because of short product life cycles. Access to design tools will allow vendors to offer products as a core that can be modified to allow customers some degree of differentiation.

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

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

Opportunities

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

Embedded DOS Market

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

Personal Workstation Market

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

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

DATAQUEST CONCLUSIONS

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

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Jennifer Berg
Ken Pearlman

Dataquest

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Research *Newsletter*

ESAM Code: Volume II, Newsletters
1989-11
0004016

WILL THE JAPANESE OWN THE 3.5-INCH RIGID MARKET?

SUMMARY

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

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

BACKGROUND

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

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

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

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

SO WHAT'S THE ALARM?

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

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

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

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

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

THE DOMINOS WILL FALL

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

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

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

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

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

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

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

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

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

DATAQUEST CONCLUSIONS

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

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

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

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

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Research *Newsletter*

ESAM Code: Volume II, Newsletters
1989-10
0003915

CT2—A RISING STAR IN EUROPE

SUMMARY

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

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

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

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

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

CORDLESS STANDARDS

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

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

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

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

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

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

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

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

APPLICATIONS

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

Table 1

Suitability of CT2 Compared with Other Technologies by Application and Environment

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

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

Source: Dataquest
July 1989

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

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

TELEPOINT FOR ALL

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

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

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

CT2 at Home

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

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

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

CT2 in the Office

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

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

DATAQUEST ANALYSIS

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

- The CAI standard must succeed in becoming a European interim standard. This is a vital step toward the European PTTs recognizing and adopting it for telepoint use before DECT is finalized.
- The cost of a telepoint call compared with a normal call is significant. In the United Kingdom, with heavy competition likely between the four licensed consortia, we expect telepoint to cost roughly twice as much as a normal telephone call. It is less clear if similar low tariffs will be adopted by the PTTs in the other European countries.
- Handset prices must fall to about $140 by 1993 to make them affordable on a wide scale. The interest shown by many potential handset manufacturers, coupled with the several possibilities to reduce IC costs, suggests that this is achievable (as discussed later in this newsletter).

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

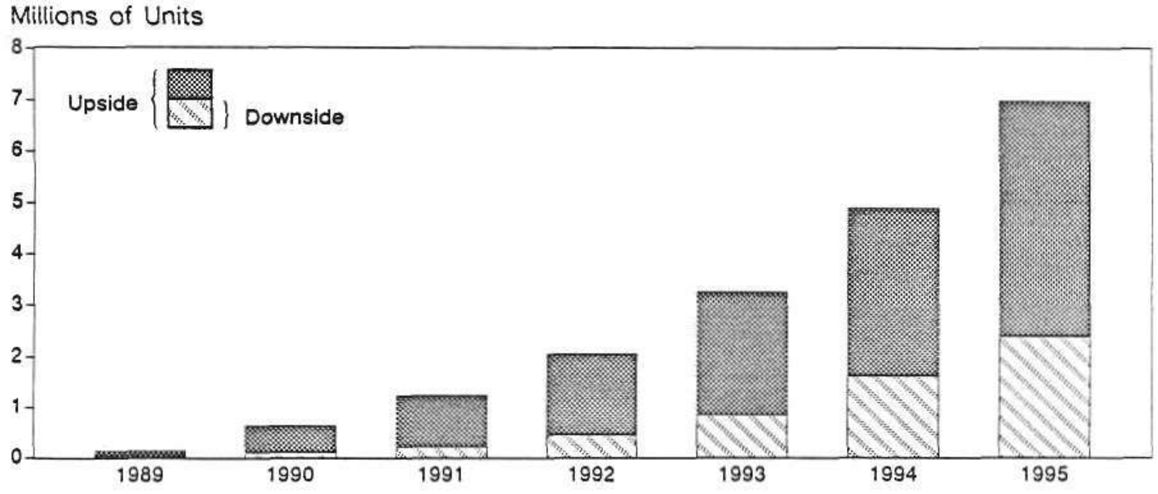
The Upside Scenario

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

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

Figure 1

Estimated CT2 Hardset Shipments for Europe
Upside and Downside Scenarios



0003915-1

Source: Dataquest
July 1989

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

The Downside Scenario

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

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

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

SEMICONDUCTOR CONSUMPTION

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

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

Table 2

Estimated Semiconductor Content for an Early CAI CT2 Handset

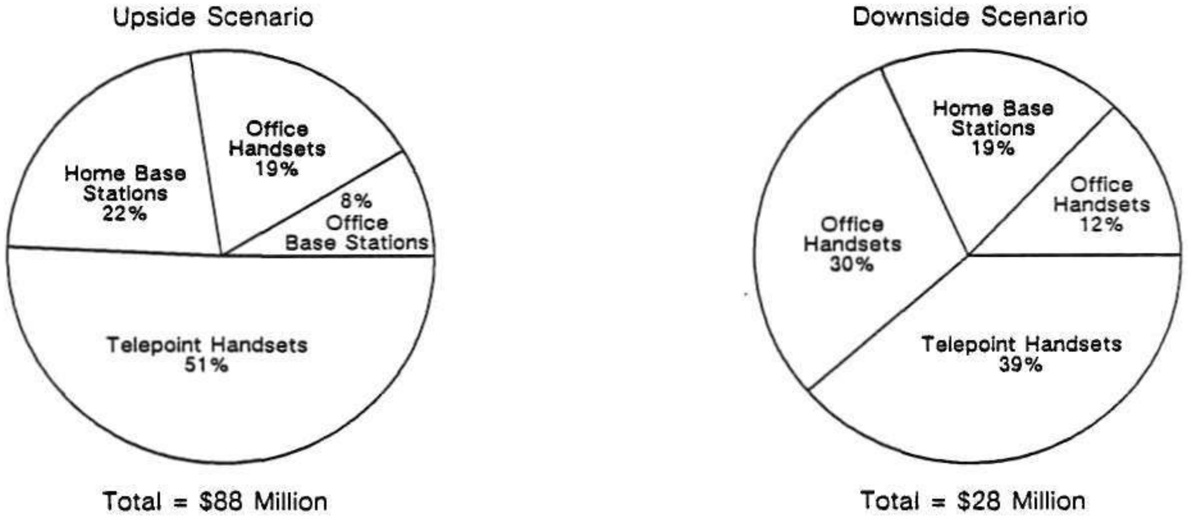
Function	Technology	Cost
4-bit microcontroller with special features	Standard CMOS	$ 3.50
27256 UV EPROM	Standard CMOS	4.00
Burst mode logic	CMOS ASIC(s)	3.50
RF receive circuit	Bipolar hybrid	20.00
G.721 ADPCM	Standard CMOS	14.00
CODEC	Standard CMOS	3.00
RF front end	RF MOSFET discretes	1.70
7-segment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

Source: Dataquest
July 1989

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

Figure 2

Estimated IC Consumption Breakdown by CT2 Equipment Type—1992



0003915-2

Source: Dataquest July 1989

The Players

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

- First movers: Expected product announcements from second quarter of 1989 to second quarter of 1990—Ferranti Creditphone, GEC-Plessey Telecommunications, Shaye Communications, STC Telecommunications

- Later entrants: Possible announcements from third quarter of 1990—Alcatel, Autophon, Bosch, Crouzet, Ericsson, Matra, Motorola, NEC, Nokia-Mobira, Orbitel, Panasonic, Philip, Samsung, Sony, Uniden

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

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

DATAQUEST CONCLUSIONS

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

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

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

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

Jonathan Drazin

Dataquest
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EISA—WILL IT BE AN ALTERNATIVE FOR MCA?

SUMMARY

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

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

BACKGROUND

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

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

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

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

EISA

EISA Delivery Time

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

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

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

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

EISA Backward Compatibility

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

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

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

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

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

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

EISA Second Sources

Many companies selecting PCs prefer to have multiple sources for the same product. The number of PC manufacturers supporting the EISA bus makes the EISA PC attractive for this reason. Dataquest believes that this is an especially critical area to watch—to ensure that the EISA bus is identical from one PC to another.

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

MCA

MCA Delivery Time

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

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

MCA Backward Compatibility

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

MCA Second Sources

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

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

MARKET PARTICIPANTS

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

IBM

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

- EISA may not be available from PC manufacturers for 9 to 18 months. This gives IBM time to introduce products that can take advantage of MCA, and to establish a user base. The sooner useful MCA applications hit the market, the greater the market share MCA will capture.
- Although it has stated that the royalty structure will remain in place, IBM always has the option of changing its mind, if it becomes beneficial.
- Companies that have a universal cross-licensing agreement in place with IBM may not be required to pay the same royalty fees as companies that do not. This makes it more attractive for those companies to manufacture MCA-based PCs.
- It is being debated whether EISA or MCA, in the current configurations and environment, is technically superior. We believe that the issue is really which architecture will perform best in the future.
    - An expected requirement is the ability to expand to a 64-bit data path and handle processing speeds above 40 MHz.
    - ESIA will have problems with both the physical accommodation of a 64-bit bus and the electrical noise associated with high-speed processors.
    - IBM has the time and the option to redesign the current MCA to eliminate the debate and to clearly differentiate performance before the first EISA machine is even shipped.
- Most importantly, whereas MCA exists now, EISA is, at present, vaporware.

Compaq

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

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

EISA Consortium

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

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

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

The Winners and the Losers

The Winners

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

The Losers

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

DATAQUEST CONCLUSIONS

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

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

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

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

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

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

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

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Jennifer Berg
Robert Charlton

Dataquest

Conference Schedule

1989

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

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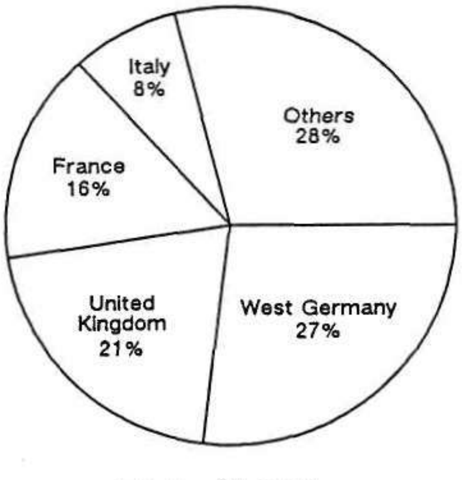
EUROPE—A HEALTHY MARKETPLACE FOR UNIX

INTRODUCTION

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

Figure 1

European UNIX Computer Shipments
by Country
1987



Total - $2.6 Billion

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Source: Dataquest
April 1989

Background

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

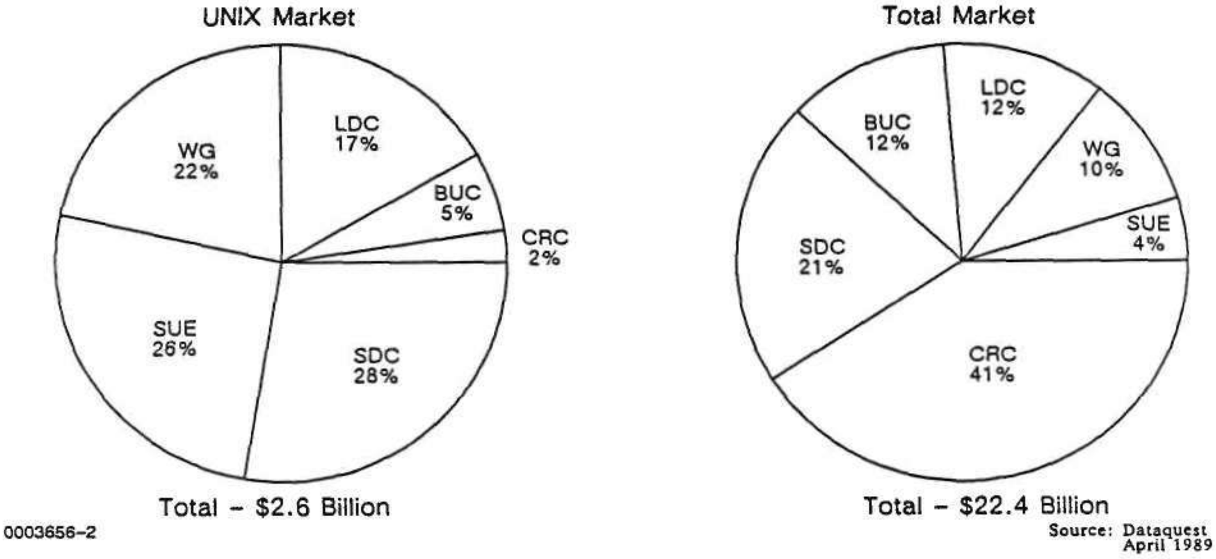
MARKET OVERVIEW

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

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

Figure 2

European Computer Market and UNIX Market by Segment
1987



Source: Dataquest
April 1989

Major Participants

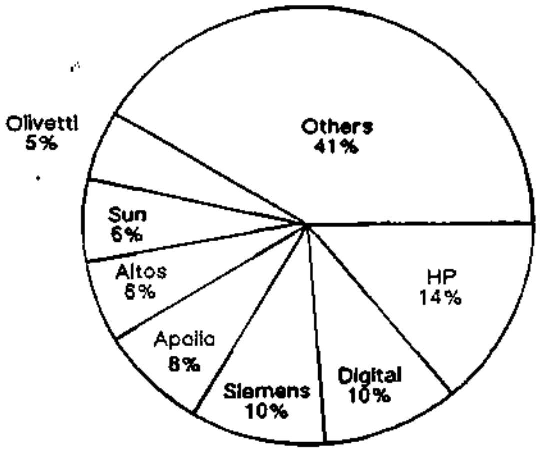
Figure 3 shows the major participants in the UNIX market. The largest vendor is Hewlett-Packard (HP), mainly because of its technical workstation sales. In this category, HP has a 36 percent share. HP's sales of large department computers (LDCs) are also significant; its market share is twice the size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

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

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

Figure 3

European UNIX Computer Shipments by Vendor Market Share
1987



Total - $2.6 Billion

0003656-3

Source: Dataquest
April 1989

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

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

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

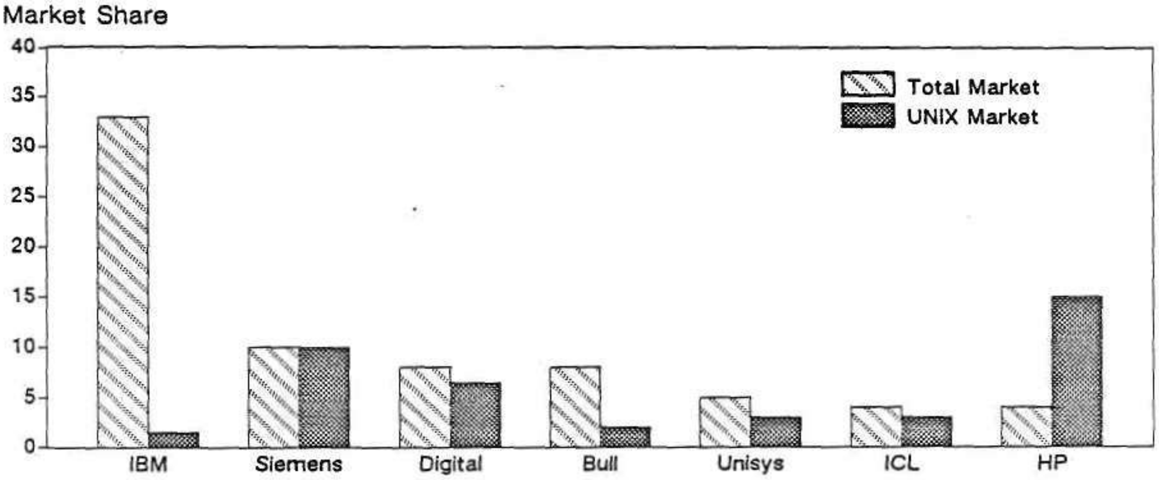
NCR, like Altos and Siemens, is prominent mainly in the SDC and WG sectors of the UNIX market. Its presence in the SDC market is particularly significant in Scandinavia where the Tower system is selling well. In the WG market, it is the largest UNIX supplier in France, Italy, and the United Kingdom.

A GROWING MARKET

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

Figure 4

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

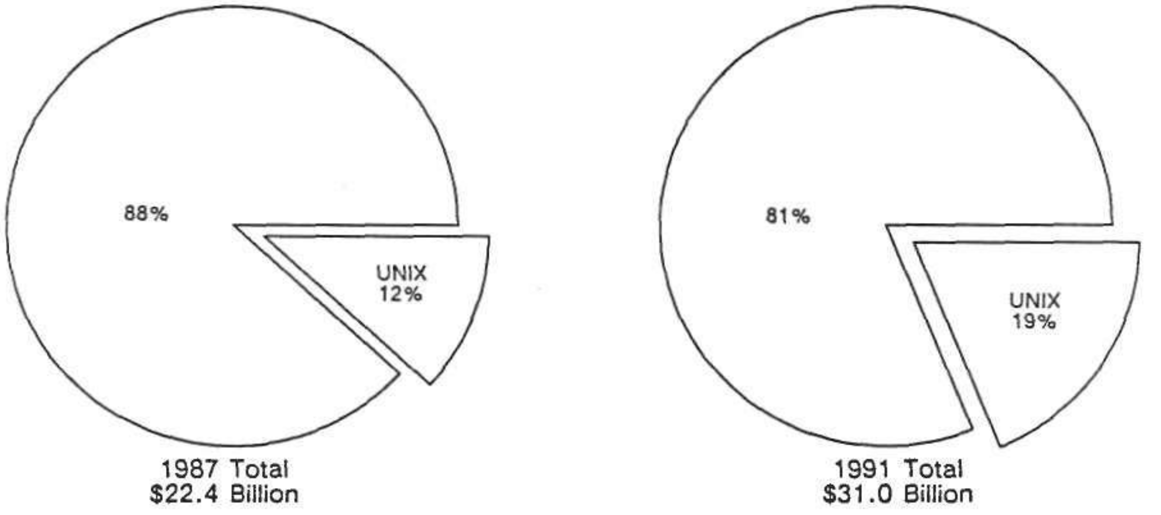


0003656-4

Source: Dataquest
April 1989

Figure 5

UNIX Systems' Share of Total Systems Market
1987 and 1991



0003656-5

Source: Dataquest
April 1989

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

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

Sales Channels

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

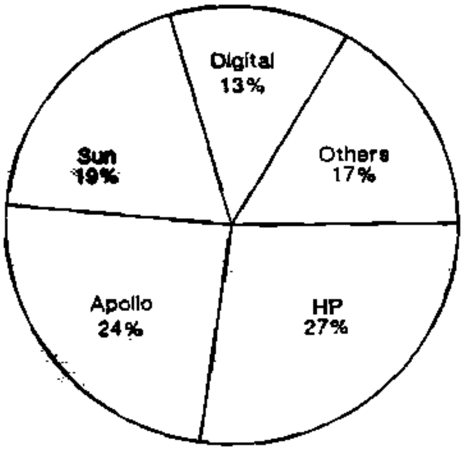
TECHNICAL WORKSTATIONS

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

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

Figure 6

Western European Technical Workstation Market
by Vendor Market Share
1987



Total - $0.8 Billion

0003656-6

Source: Dataquest
April 1989

DATAQUEST ANALYSIS

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

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

DATAQUEST CONCLUSIONS

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

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Bipin Parmar
Philippe de Marcillac

Attachment A

The Dataquest market segment definitions are as follows:

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

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

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

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

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

Dataquest

Conference Schedule

1989

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

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Research *Newsletter*

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EUROPEAN PERSONAL COMPUTER PRODUCTION AND ITS IMPACT ON THE SEMICONDUCTOR MARKET

SUMMARY

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

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

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

INCREASED PRODUCTION DESPITE MEMORY SHORTAGES

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

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

Table 1

Estimated Unit PC Production in Europe
(Thousands of Units)

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

NA = Not Applicable

Source: Dataquest
March 1989

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

HIVE OF VENDOR ACTIVITY

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

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

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

Table 2

Total Estimated 1988 European PC Unit Production by Leading PC Manufacturers

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

NA = Not Applicable

Source: Dataquest
March 1989

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

The Japanese Absence

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

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

ANALYSIS OF SEMICONDUCTOR CONTENT

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

Table 3

Average Semiconductor Content by PC Model

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

NA = Not Applicable

Source: Dataquest
March 1989

Semiconductor Consumption by PC Sector

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

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

Table 4

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

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

NA = Not Applicable

Source: Dataquest
March 1989

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

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

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

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

FUTURE TRENDS

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

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

CONCLUSIONS

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

Bipin Parmar

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Research *Newsletter*

ESAM Code: Newsletters
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0002293

REGIONAL REVIEW 1989—A YEAR OF CONSOLIDATION

SUMMARY

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

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

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

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

Table 1

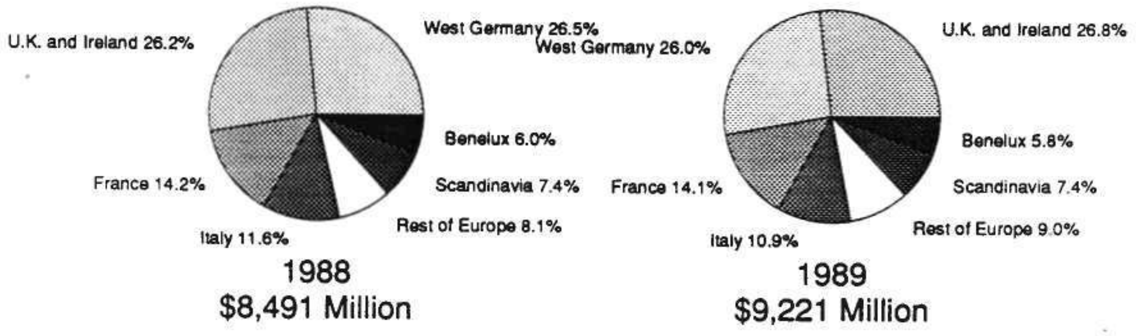
European Regional Growth Analysis
(Millions of Dollars)

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

Source: Dataquest
March 1989

Figure 1

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



Source: Dataquest
March 1989

REGIONAL SEMICONDUCTOR ANALYSIS

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

Benelux

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

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

France

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

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

Italy

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

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

Scandinavia

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

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

United Kingdom and Ireland

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

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

West Germany

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

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

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

Rest of Europe

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

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

CONCLUSIONS

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

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

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

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

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

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

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Research *Newsletter*

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

EXECUTIVE SUMMARY

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

The Origin Rules

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

The New Interpretation

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

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

Impact on European Diffusion Plants

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

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

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

Local Content

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

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

DATAQUEST CONCLUSIONS

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

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

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

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Research *Newsletter*

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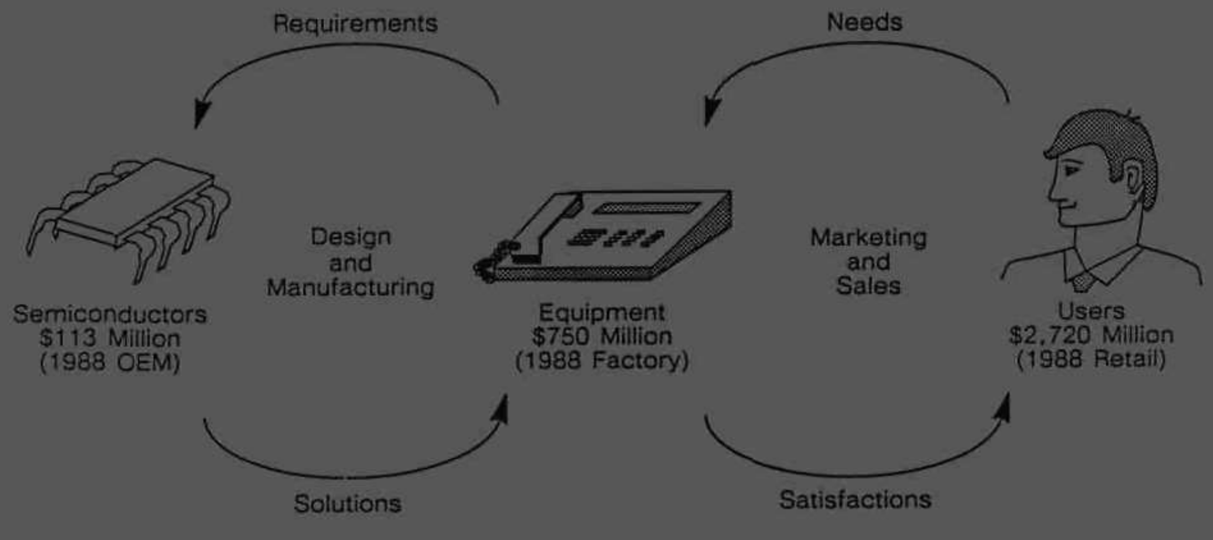
FACSIMILE MACHINES: TERMINALS TODAY, TOOLS TOMORROW

EXECUTIVE SUMMARY

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

Figure 1

Linking European Market and Product Evolution



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Source: Dataquest
April 1989

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

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

THE MARKETING SIDE OF FACSIMILE MACHINES

Market Estimates

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

Table 1

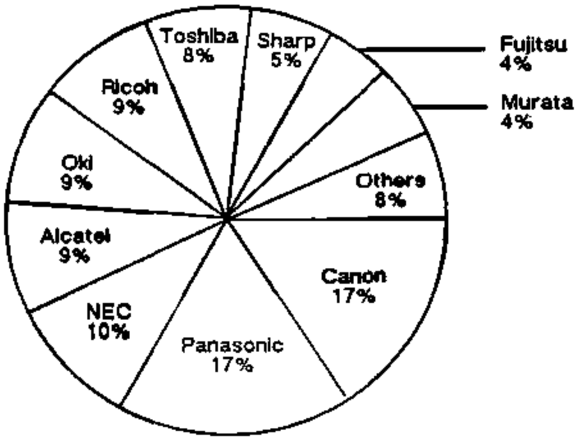
Estimated Sales of Facsimile Machines in Europe

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

Source: Dataquest
March 1989

Figure 2

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



Total = 433,900 Units

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Source: Dataquest
April 1989

User Base Expansion is Under Way

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

THE MANUFACTURING SIDE OF FACSIMILE MACHINES

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

Table 2

Estimated Semiconductor Content of Group III Facsimile Machines

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

Source: Dataquest
March 1989

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

Component Prices Continue to Decline

The negative 11 percent CAGR reduction in facsimile machine prices is made possible in part by the reduction in numbers and prices of the components used to make the facsimile machine. For example, the facsimile modem component was a complete card in 1983, with an estimated OEM-volume price of approximately $300, and it was supplied only by Rockwell. In 1988, Dataquest estimates that this same circuit function is implemented as either one or two semiconductor components with an OEM-volume price in the $80 to $100 range, and that more than six component manufacturers have entered the market. (The facsimile modem suppliers include Hitachi, Hycom/Sharp, Matsushita, Oki, Rockwell, Toshiba and Yamaha. Dataquest believes that SGS-Thomson will enter the facsimile modem market soon.) In 1989, Dataquest estimates that the OEM-volume price of the facsimile modem component will be reduced to the $40 to $50 range, as these component manufacturers attempt to grow their sales by competing for more design wins.

Component Functionality Continues to Increase

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

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

Component Technology Continues to Advance

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

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

Production in Europe

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

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

DATAQUEST CONCLUSIONS

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

Facsimile Machine Sales Expected to Continue

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

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

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

Opportunities in Niche Markets

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

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

The following two segments have emerged within the office market:

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

Long-Term Implications of Present-Day Developments

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

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

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

Jonathan Drazin
Anne Barbançon
Roger Steciak

Dataquest

Conference Schedule

1989

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

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Research Newsletter

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HIGH-DEFINITION TV IN EUROPE—AN INCREMENTAL APPROACH

EXECUTIVE SUMMARY

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

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

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

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

THE STANDARDS: MAC VERSUS MUSE

Europe: MAC

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

Japan: MUSE

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

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

POLITICAL FORCES

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

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

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

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

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

THE SPIN-OFFS

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

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

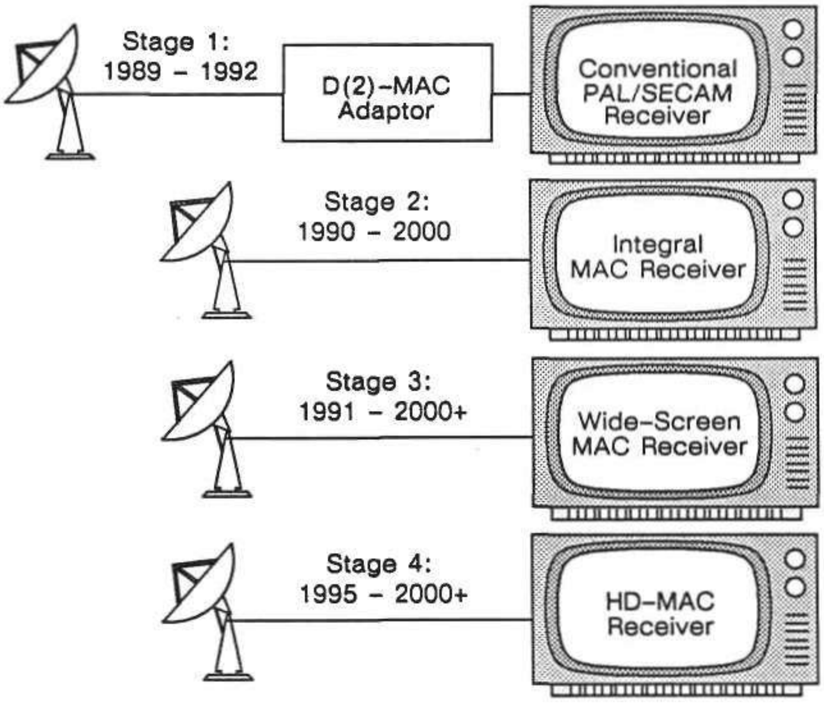
These secondary markets will be strongly synchronized with the emergence of reasonably priced HDTV receivers, and each is likely to equal the receiver market in size.

Evolution of MAC

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

Figure 1

MAC Development Path



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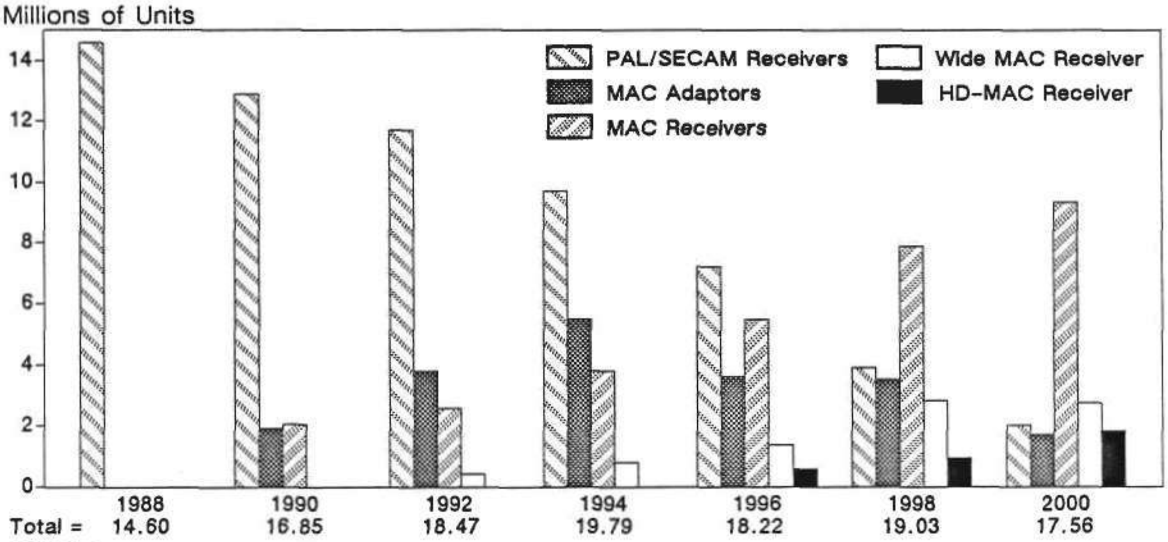
Source: IBA

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

Figure 2

Estimated European Television Receiver Production



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Source: Dataquest
February 1989

Impact on the Semiconductor Market

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

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

Table 1

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

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

*Digital PAL/SECAM receiver

Source: Dataquest
February 1989

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

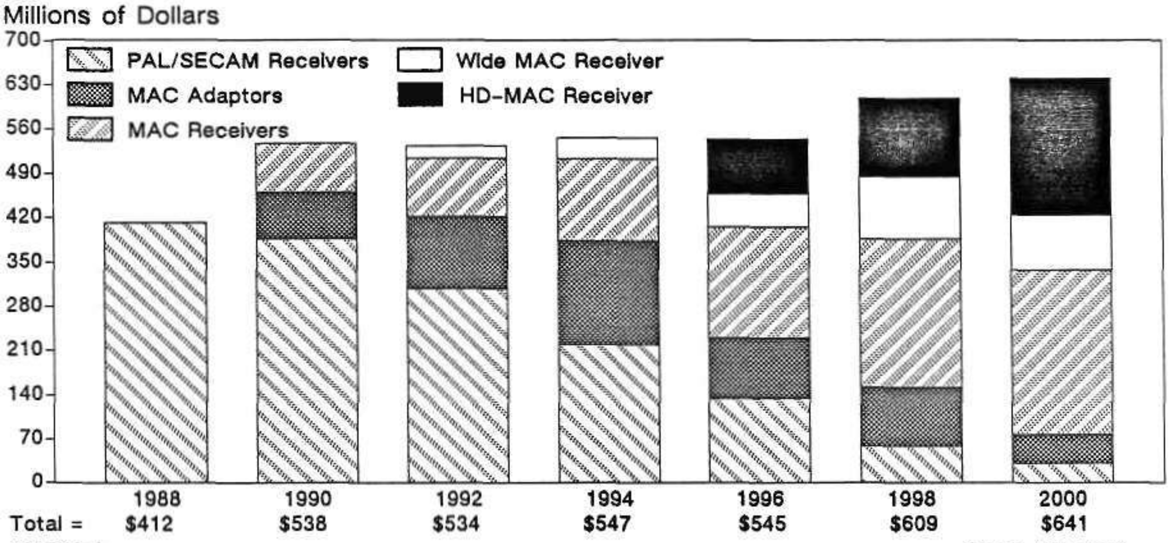
Figure 3 presents our forecast for European TV receiver IC consumption by receiver type. We estimate a 5 percent overall compound annual growth rate (CAGR) between 1988 and 1994 due to the following major factors:

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

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

Figure 3

Estimated European TV Receiver IC Consumption



Source: Dataquest February 1989

DATAQUEST CONCLUSIONS

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

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

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

Jonathan Drazin
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PART II
ISDN—THE EARLY MARKETS, 1988-1992

EXECUTIVE SUMMARY

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

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

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

A SERIES OF THREE NEWSLETTERS

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

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

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

TOO MANY HURDLES?

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

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

- Rival technologies
- Conflicting standards
- Unclear tariffs

Rival Technologies

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

Conflicting Standards

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

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

Unclear Tariffs

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

THE EARLY MARKET: 1988-1992

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

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

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

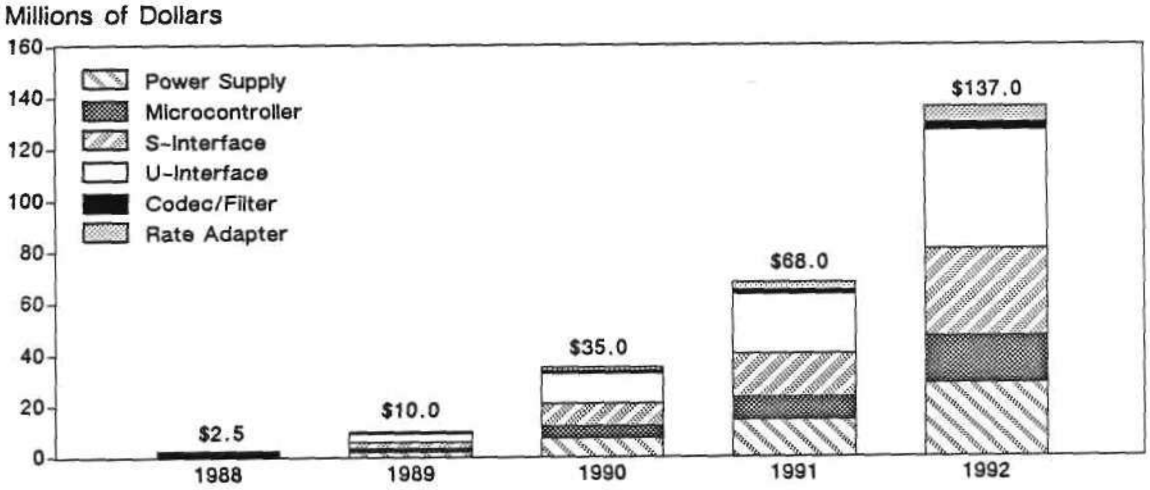
We expect public Basic Rate services to represent most of the demand for ISDN transceiver ICs. Although the volume of S-interface chips will far exceed that for U-interface ICs, we expect the U-interface to have greater dollar market share (34 percent) than S-interface ICs (25 percent). This is due to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

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

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

Figure 1

Estimated European ISDN IC Markets
(Millions of Dollars)



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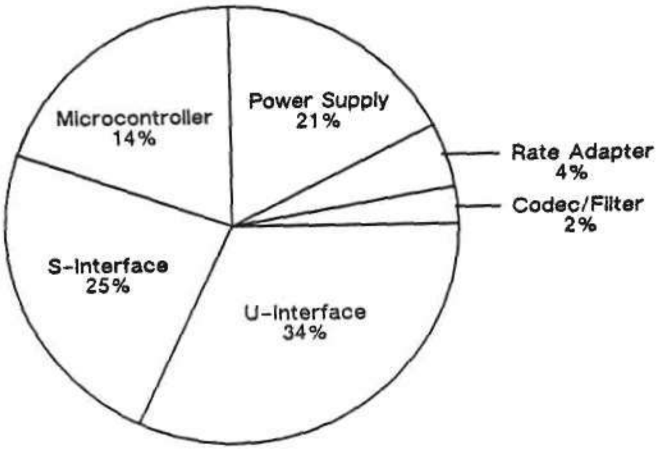
Source: Dataquest
January 1989

Figure 2

Estimated European ISDN Market Share by Chip Type
1992



Total = $137 Million

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Source: Dataquest
January 1989

DATAQUEST CONCLUSIONS

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

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

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

ACKNOWLEDGEMENT

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

Jonathan Drazin

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PART I
ISDN—THE ICs AND THEIR APPLICATIONS

EXECUTIVE SUMMARY

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

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

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

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

A SERIES OF THREE NEWSLETTERS

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

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

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

INTRODUCTION

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

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

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

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

ISDN ACCESS AND REFERENCE POINTS

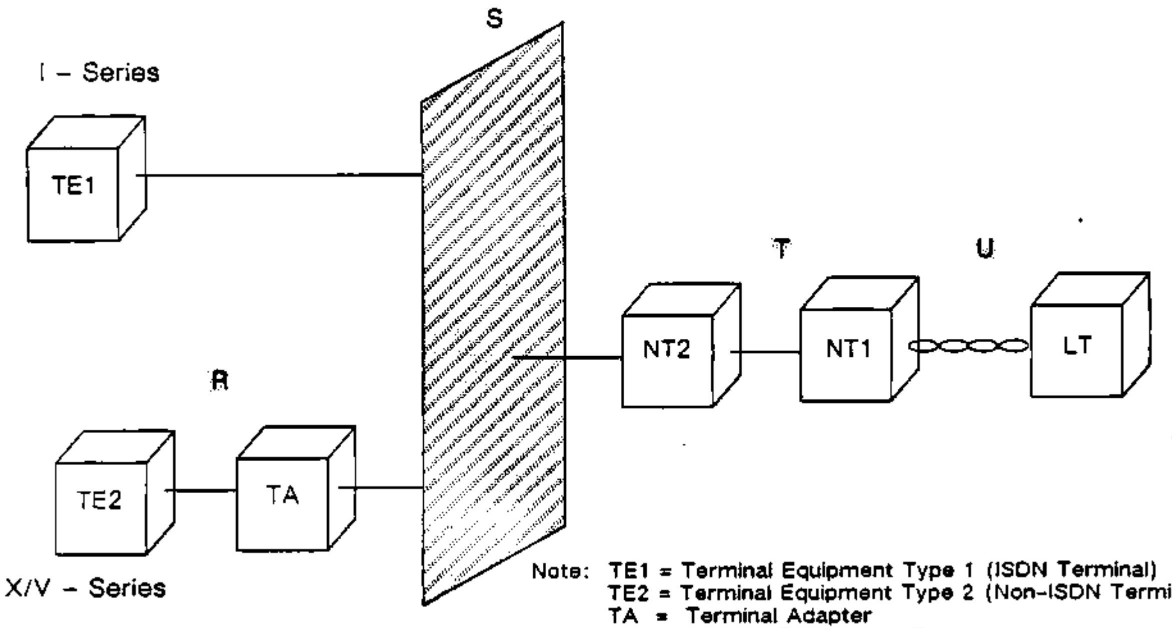
The existing I series recommendations define the following two forms of ISDN access:

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

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

Figure 1

ISDN Functional Entities



Note: TE1 = Terminal Equipment Type 1 (ISDN Terminal)
TE2 = Terminal Equipment Type 2 (Non–ISDN Terminal)
TA = Terminal Adapter
NT1 = Network Termination Type 1
NT2 = Network Termination Type 2 (mainly Primary Rate)
U = European Basic Rate Digital Subscriber Line
LT = Local Exchange Termination

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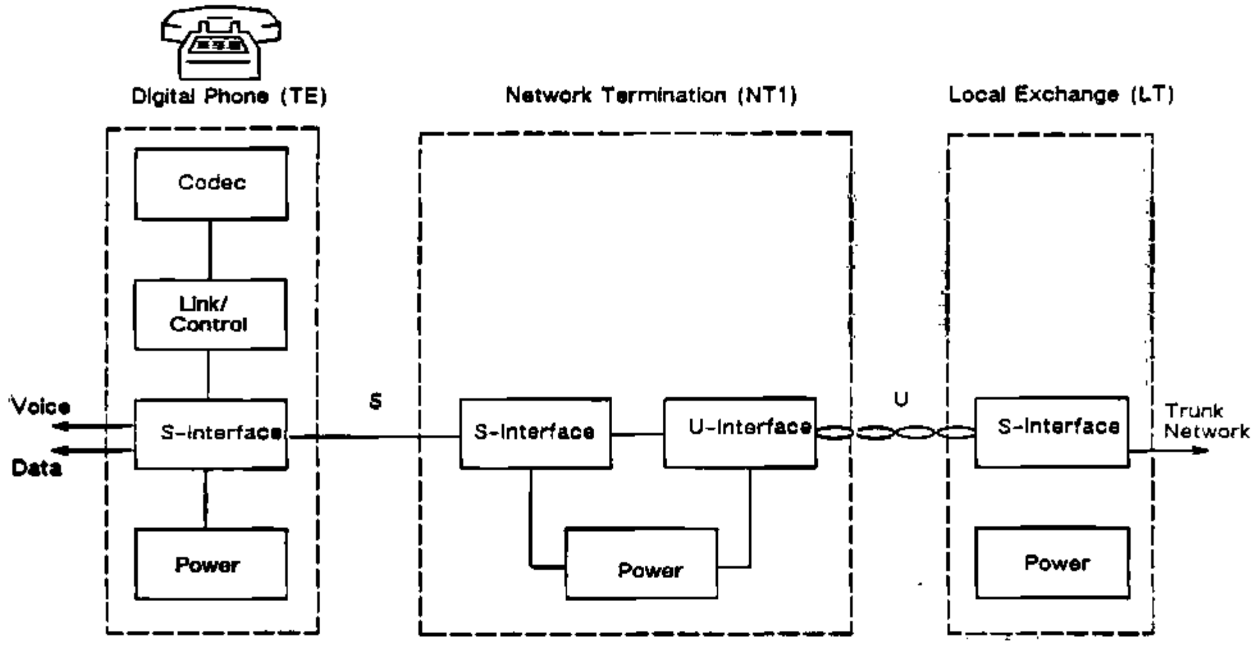
Source: Dataquest
January 1989

THE CHIP SETS

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

Figure 2

Main ISDN Chip Functions



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Source: Dataquest
January 1989

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

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

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

Table 1

Bus Formats Adopted by the Major ISDN IC Vendors

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

Source: Dataquest
January 1989

ISDN IC FUNCTIONS

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

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

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

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

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

Table 2

ISDN IC Use by Application

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

*Please see glossary for terminology

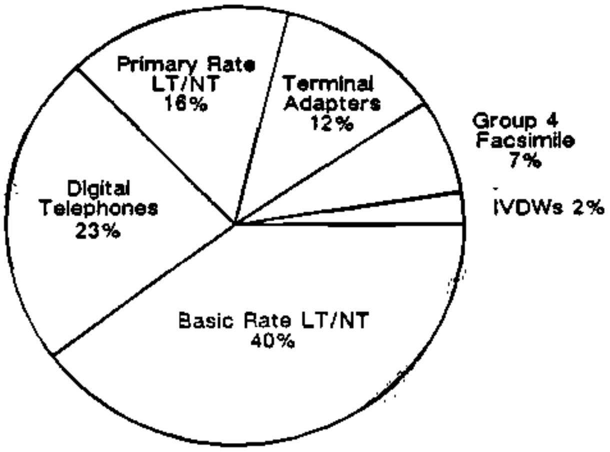
Source: Dataquest
January 1989

DEMAND BY APPLICATION

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

Figure 3

ISDN Semiconductor Demand by Application



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Source: Dataquest
January 1989

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

DATAQUEST CONCLUSIONS

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

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

Jonathan Drazin

GLOSSARY

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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EUROPE REFRESHES ITS STAGNANT WHITE GOODS MARKET

SUMMARY

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

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

MARKET ESTIMATES

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

Table 1

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

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

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

Source: Dataquest
November 1988

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THE SEMICONDUCTOR CHIP PROTECTION ACT IS FINALIZED

This newsletter is the first in a series of several dealing with current intellectual property issues affecting the semiconductor industry. This series is the result of joint research efforts of Dataquest's Semiconductor Industry Service (SIS) and Dr. Judith K. Larsen, senior industry analyst for Dataquest's Research Operations Group.

SUMMARY

The U.S. Patent and Trademark Office recently announced the finalization of regulations concerning the Semiconductor Chip Protection Act (SCPA), a distinct form of intellectual property law that protects mask works fixed in semiconductor chips. Although originally created in 1984, the SCPA has up until now granted protection to mask works from foreign countries only on an interim basis.

The newly enacted regulations describe the procedures the U.S. government will follow in granting permanent protection to chips from foreign countries. As a result, while the finalized version of the SCPA will have only an indirect impact on U.S. chipmakers, foreign semiconductor manufacturers will be affected directly by the ruling.

This newsletter provides a basic description of the Semiconductor Chip Protection Act, discusses the background of the new regulations, outlines the steps that Dataquest's international clients must take if they believe that this unique piece of intellectual property law applies to their business operations in the United States, and, lastly, considers the SCPA's implications for non-U.S. manufacturers.

WHAT IS THE SCPA?

The Semiconductor Chip Protection Act of 1984 extends copyright protection to semiconductor mask works, making it illegal for companies to reproduce and distribute mask works based on protected chip architectures without the permission of the copyright holder. However, in the strictest sense, the SCPA is neither a traditional patent law nor a traditional copyright law; rather, it is termed a sui generis law—a one-of-a-kind law that is created for a specific purpose. It came about because the traditional intellectual property protection awarded through patents and copyrights did not adequately cover semiconductors.

Because chip architectures are not always original, meeting the criteria for novelty required by the U.S. Patent and Trademark Office has often made patents difficult to obtain. From a more pragmatic consideration, the time required to obtain a patent often exceeds the product life of a semiconductor device, limiting the amount of useful protection that patents can offer. Traditional copyright law has not applied to semiconductors at the mask level because these were considered to be "utilitarian" in nature and, therefore, outside the bounds of copyright protection. Although copyright law prohibits unauthorized persons from copying actual drawings of chip designs, it does not prevent someone from copying the mask-level design itself. As a result, an important intellectual property asset fell through the cracks of a legal system created long before the invention of semiconductors.

Although the SCPA is neither patent nor copyright, it is most similar to copyright law, with the following significant differences:

- It provides protection for only 10 years, compared with 75 years for corporate copyright.
- It requires mandatory registration in which applicants must submit a simple form describing their chip architectures. Protection follows as soon as the form has been filed.
- It permits reverse engineering as a method for getting at the ideas expressed in a mask design, although outright copying of the design itself is prohibited.
- It does not apply to chips that are "commonplace or familiar."

EXTENSION TO NON-U.S. SUPPLIERS

At the time the U.S. Semiconductor Chip Protection Act was passed, few other countries had comparable protection for mask works. Before granting long-lasting protection to mask works from foreign suppliers, the U.S. government wanted to ensure that foreign countries would protect U.S. chips. Non-U.S. semiconductor manufacturers could apply for interim protection under Section 914 of the SCPA, provided they entered into a chip protection treaty with the United States or enacted legislation of their own that would protect U.S. semiconductor devices.

In the years since the passing of the SCPA, all major U.S. trading partners have enacted chip protection legislation. Japan actually passed its own chip protection act in 1984, followed by the 12 member states of the European Economic Community (EEC) plus Sweden, Australia, Canada, Switzerland, and Finland. Naturally, once other nations passed legislation protecting mask works, they thought that they should receive permanent protection in the United States under Section 902 of the SCPA, which grants protection to foreign mask works under any of three conditions:

- The mask work owner's nation is party to a chip protection treaty with the United States.
- The foreign mask work is first commercially exploited in the United States.
- The foreign mask work comes within the scope of a presidential proclamation (which could be made if the mask owner's nation protects U.S. intellectual property owners on substantially the same basis as the SCPA).

The United States was slow in responding to the requests of trading partners to grant chip protection under Section 902, partly because the language of that section was unclear. It referred to rules establishing more binding protection, but the rules proved impossible to implement until clarified.

Earlier this year, the U.S. Patent and Trademark Office began to work on the problem of clarifying Section 902. Comments from the public were invited, and two groups—the Commission of the European Communities and the Semiconductor Industry Association (SIA)—responded. On June 29, 1988, the Patent and Trademark Office announced the final rules, thus clearing the way for Section 902 protection to be granted to mask works from foreign countries.

Protection Procedures

The procedures for applying for mask work protection for non-U.S. companies are covered in Subchapter C, Section 150, of the Code of Federal Regulations. The rules describe how to begin the process of obtaining protection, what information is required, how the review process is to proceed, and how the decision is to be announced. These steps may be summarized as follows:

- The protection process can be initiated by request from a foreign government, from the U.S. Secretary of Commerce (through the Commissioner of Patents and Trademarks), or from an international intergovernmental organization (such as the EEC). It is important to note that individual companies cannot make request for protection.
- Extensive documentation regarding the country's mask protection must accompany the request, including copies of laws, legal rulings, regulations, and administrative orders. If a country has already received interim protection through Section 914, the information gathered in that examination will be considered again in the review for Section 902 protection.

- Once a country has requested protection under Section 902, or once the Commissioner of Patents and Trademarks begins an assessment, a notice will be published in the Federal Register. At that time, the public will have the opportunity to submit written comments, and a hearing may be scheduled if issues are raised that cannot be settled informally.

- The commissioner then reviews all the information and prepares a draft recommendation, which is sent to the Secretary of Commerce. The Secretary of Commerce submits a recommendation to the president, who makes a Section 902 proclamation.

There are certain limitations included in the new regulations. The rules state that the proclamation may contain conditions regarding its duration. In addition, procedures are described for considering suspension or revocation of the Section 902 protection. This essentially states that even when Section 902 protection is obtained, intellectual property rights must continue to be respected.

Who is Affected?

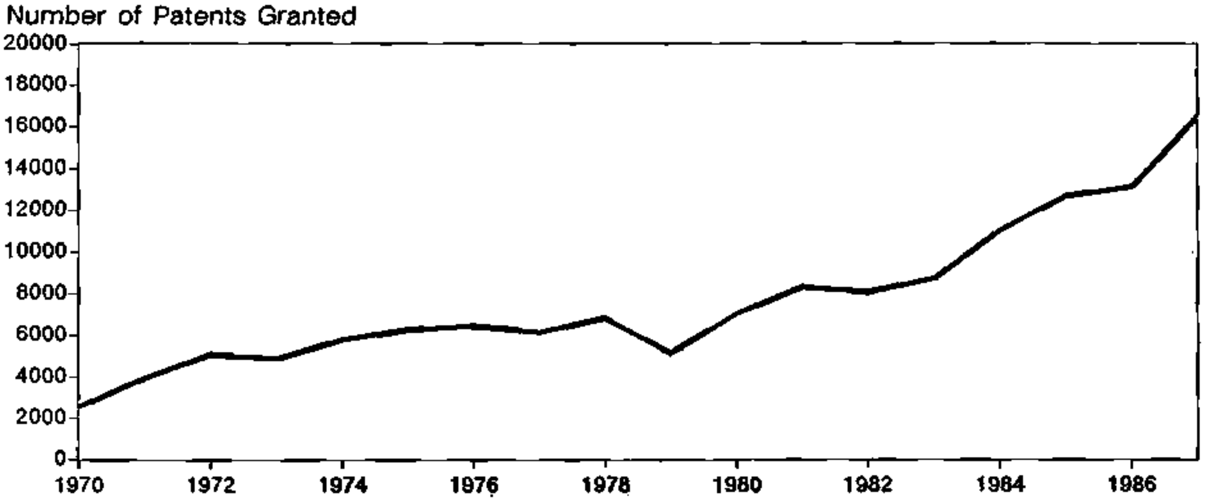
The countries most immediately affected by the new regulations are those that already have effective chip protection acts in place and that currently have interim protection under Section 914. These countries are eligible to apply for Section 902 protection immediately. Countries that do not have chip protection legislation but are moving in that direction would be affected by these rules only when they apply for protection in the United States.

For Japan, the importance of extending permanent protection to the mask works of its semiconductor manufacturers is that it acknowledges Japan's transition from price-cutting copycat to technology innovator. With the Japanese becoming leaders in many technologies (such as ICs, optoelectronics, robotics), protection of intellectual property will be as much an issue in the 1990s as avoiding lawsuits has been in recent times. The pace of Japan's U.S. patent filings alone underscores this trend, as is illustrated in Figure 1. As Japan looks over its shoulder at the newly industrialized countries (NICs) of the Pacific Rim, securing intellectual property assets marks a transition from a defensive to a more aggressive legal posture.

For the Asian NICs, the finalized SCPA may seem more like an obstacle than an opportunity. Although the SCPA has never been tested in court, it is one more legal reef that Pacific Rim competitors will have to avoid as they navigate an increasingly litigious U.S. market. Just as intellectual property law protects the interests of U.S. and Japanese chipmakers, Asian manufacturers eventually will find it working to their advantage as well. In the meantime, a certain amount of education on the intricacies of intellectual property law unfortunately will be attained through lawsuits.

Figure 1

U.S. Patents Granted to Residents of Japan
1970–1987



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Source: Dataquest
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DATAQUEST CONCLUSIONS

The main impact of the new Semiconductor Chip Protection Act regulations may be to underscore international awareness that intellectual property is a valuable resource. All major trading nations have enacted legislation protecting mask works in the last few years. The fact that Section 902 regulations were finally defined indicates that the United States recognizes the actions of other countries. The regulations also illustrate the continuing efforts of the U.S. government to protect intellectual property and to firm up agreements with countries sharing that concern.

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EUROPE REFRESHES ITS STAGNANT WHITE GOODS MARKET

SUMMARY

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

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

MARKET ESTIMATES

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

Table 1

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

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

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

Source: Dataquest
November 1988

Table 2

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

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

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

Source: Dataquest
November 1988

COMPANY ANALYSIS

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

AB Electrolux

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

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

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

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

AEG Aktiengesellschaft

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

Bosch-Siemens Hausgerate

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

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

GEC

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

Hoover U.K.

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

Merloni

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

Miele

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

NV Philips

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

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

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

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

Thomson SA

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

Others

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

FUTURE OUTLOOK

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

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

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

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

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EXCHANGE RATE QUARTERLY NEWSLETTER

THIRD QUARTER 1988

Dataquest exchange rate tables involve data from many countries, each of which has different and variable exchange rates against the U.S. dollar. As much as possible, Dataquest estimates are prepared in terms of local currencies before conversion (when necessary) to U.S. dollars. Dataquest uses International Monetary Fund (IMF) average foreign exchange rates for historical data.

All forecasts are prepared assuming no changes in any exchange rate from the last complete historical year—in this case, 1987. During the course of the current year, as local currency exchange rates vary, the appropriate U.S. dollar value changes accordingly. To maintain consistency across all its analyses, Dataquest does not make ongoing adjustments to its forecasts for these currency changes during the current year. As a result of this policy, as the year progresses the forecast numbers could become distorted, in dollars, should the European currencies deviate substantially from the previous year's rates.

Dataquest monitors the exchange rates on a weekly basis using IMF exchange rates, supported by Financial Times exchange rates when IMF data are not yet available. (Financial Times is the accepted U.K. newspaper giving daily updates.) Effective exchange rates for the current year are calculated each month. This information is then used to assess the local currency's impact on U.S. dollar forecasts.

The purpose of this newsletter, which will be updated quarterly, is to record these changes, thus allowing the reader to make any necessary adjustments when interpreting regional data. For each European region, Table 1 gives the local currency per U.S. dollar for 1987, second quarter 1988, and third quarter 1988 together with the latest estimate for the whole of 1988. Also shown, for reference purposes, are the same figures for the Japanese yen. As can be seen from this table, the weighted average for all the European currencies for 1988 has decreased 1.9 percent with respect to the U.S. dollar, compared with 1987. This represents an increase of 8.5 percent in the exchange rate from second quarter 1988 to third quarter 1988. Table 2 shows the 1988 quarterly values for the same regions.

Table 3 illustrates the effect of currency shifts on the Dataquest forecast numbers and how to interpret these shifts. For example, the table shows that the constant dollar forecast of $6,805 million for the 1988 total European semiconductor market becomes $6,937 million when adjusted for changes in European currencies.

Table 4 shows the 1988 monthly values of local currency per U.S. dollar for each European region and Japan.

Included in the tables is the European Currency Unit (ECU). This unit, established in March 1979, is a weighted average of the currencies of all member countries of the European Economic Community (EEC). It is calculated by the IMF from each country's gross national product (GNP) and foreign trade.

Also included is the Semiconductor Industry Weighted Average (SIWA). This unit is based on the semiconductor consumption of each European country featured here (EEC and non-EEC members) and uses the base year 1980 equal to 100 as a reference point. The SIWA is useful for interpreting the effect of European currency fluctuations with respect to the U.S. dollar, specifically for the European semiconductor industry.

Byron Harding

Table 1

European Currencies—1987 to 1988
(Local Currency per U.S. Dollar)

Region	1987	Q2 1988	Percent Change Q2-Q3 1988	Q3 1988	Latest Estimate 1988*	Percent Change 1987-1988
Austria	12.64	12.00	8.6	13.12	12.51	(1.1)
Belgium	37.34	35.66	8.6	39.02	37.20	(0.4)
Denmark	6.84	6.52	8.5	7.12	6.81	(0.5)
Finland	4.40	4.05	8.3	4.42	4.24	(3.7)
France	6.01	5.77	8.6	6.31	6.02	0.2
Ireland	0.67	0.64	8.3	0.69	0.66	(1.3)
Italy	1,296.1	1,267.2	8.5	1,385.0	1,319.8	1.8
Luxembourg	37.34	35.66	8.6	39.02	37.20	(0.4)
Netherlands	2.03	1.92	9.0	2.11	2.00	(1.1)
Norway	6.74	6.25	8.5	6.84	6.59	(2.3)
Portugal	140.88	139.28	8.6	152.38	145.61	3.2
Spain	123.56	112.89	8.5	123.33	118.39	(4.4)
Sweden	6.34	5.96	7.2	6.42	6.20	(2.2)
Switzerland	1.49	1.42	9.4	1.56	1.48	(0.8)
United Kingdom	0.61	0.54	8.3	0.59	0.57	(7.0)
West Germany	1.80	1.70	8.8	1.87	1.78	(1.1)
ECU	1.15	1.23	(0.3)	1.23	1.23	6.6
Semiconductor Industry Weighted Average (Base 1980 = 100)	125.52	117.74	8.5	128.70	123.13	(1.9)
Japan	144.51	125.49	6.1	133.63	130.18	(11.0)

*Estimate

Source: IMF
Dataquest
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Table 2

European Currencies—1988 by Quarter (Local Currency per U.S. Dollar)

Region	Q1	Q2	Q3*	Q4*	Total Year 1988*
Austria	11.78	12.00	13.12	13.13	12.51
Belgium	35.06	35.66	39.02	39.08	37.20
Denmark	6.42	6.52	7.12	7.16	6.81
Finland	4.06	4.05	4.42	4.43	4.24
France	5.67	5.77	6.31	6.34	6.02
Ireland	0.63	0.64	0.69	0.69	0.66
Italy	1,235.25	1,267.20	1,384.97	1,391.90	1,319.83
Luxembourg	35.06	35.66	39.02	39.08	37.20
Netherlands	1.88	1.92	2.11	2.11	2.00
Norway	6.36	6.25	6.84	6.91	6.59
Portugal	137.03	139.28	152.38	153.75	145.61
Spain	113.09	112.89	123.33	124.25	118.39
Sweden	5.99	5.96	6.42	6.45	6.20
Switzerland	1.38	1.42	1.56	1.57	1.48
United Kingdom	0.56	0.54	0.59	0.60	0.57
West Germany	1.68	1.70	1.87	1.87	1.78
ECU	1.23	1.23	1.23	1.23	1.23
Semiconductor Industry Weighted Average (Base 1980 = 100)	116.91	117.74	128.70	129.18	123.13
Japan	127.85	125.49	133.63	133.76	130.18

*Estimate

Source: IMF
Dataquest
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Table 3

Effect of Changes in European Currencies per U.S. Dollar on Dataquest Forecasts—1987 versus 1988 (Millions of U.S. Dollars)

	1987	1988	Percent Change 1987-1988
European Semiconductor Consumption (At constant 1987 exchange rates)	$6,355	$6,805	7.1%
Weighted European Currency (Assumed) (Base 1980 = 100)	125.52	125.52	N/M*
Weighted European Currency (Latest Estimates)	125.52	123.13	1.9%
Effective Consumption (At September YTD exchange rates)	$6,355	$6,937	9.2%

*N/M = Not Meaningful

Source: IMF
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Table 4

European Currencies—1988 by Month
(Local Currency per U.S. Dollar)

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.*	Nov.*	Dec.*	1987*	1987	Percent Change 1986/87
Austria	11.62	11.92	11.79	11.76	11.91	12.32	13.01	13.22	13.13	13.13	13.13	13.13	12.51	12.64	1.1
Belgium	34.57	35.50	35.10	35.01	35.40	36.56	38.69	39.30	39.08	39.08	39.08	39.08	37.20	37.34	0.4
Denmark	6.34	6.49	6.43	6.42	6.49	6.65	7.03	7.18	7.16	7.16	6.81	6.84	6.81	6.84	0.5
Finland	4.03	4.11	4.04	4.00	4.02	4.14	4.38	4.45	4.43	4.43	4.43	4.43	4.24	4.40	3.5
France	5.58	5.74	5.69	5.68	5.73	5.91	6.24	6 36	6.34	6.34	6.34	6.34	6.02	6.01	(0.2)
Ireland	0.62	0.64	0.63	0.63	0.63	0.65	0.69	0.70	0.69	0.69	0.69	0.69	0.66	0.67	1.3
Italy	1,214.10	1,250.30	1,241.40	1,242.20	1,258.70	1,300.70	1,370.50	1,392.50	1,391.90	1,391.90	1,391.90	1,391.90	1,319.83	1,296.10	(1.8)
Luxembourg	34.57	35.50	35.10	35.01	35.40	36.56	38.69	39.30	39.08	39.08	39.08	39.08	37.20	37.34	0.4
Netherlands	1.86	1.91	1.88	1.88	1.90	1.97	2.09	2.12	2.11	2.11	2.11	2.11	2.00	2.03	1.1
Norway	6.34	6.41	6.34	6.21	6.18	6.37	6.72	6.88	6.91	6.91	6.91	6.91	6.59	6.74	2.2
Portugal	135.04	138.63	137.42	136.76	138.27	142.81	150.31	153.08	153.75	153.75	153.75	153.75	145.61	140.88	(3.4)
Spain	112.27	114.43	112.56	110.93	112.08	115.66	122.45	123.30	124.25	124.25	124.25	124.25	118.39	123.56	4.2
Sweden	5.97	6.05	5.95	5.89	5.90	6.08	6.36	6.45	6.45	6.45	6.45	6.45	6.20	6.34	2.2
Switzerland	1.35	1.39	1.39	1.38	1.41	1.46	1.54	1.58	1.57	1.57	1.57	1.57	1.48	1.49	0.8
United Kingdom	0.56	0.57	0.55	0.53	0.53	0.56	0.59	0.59	0.60	0.60	0.60	0.60	0.57	0.61	6.5
West Germany	1.65	1.70	1.68	1.67	1.69	1.75	1.85	1.88	1.87	1.87	1.87	1.78	1.78	1.80	1.1
ECU	1.25	1.22	1.23	1.24	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.23	1.15	(7.1)
SIWA (Base 1980 = 100)	115.53	118.58	116.62	115.54	116.67	120.99	127.70	129.22	129.18	129.18	129.18	129.18	123.13	125.52	1.9
Japan	127.63	129.50	126.43	124.48	124.83	127.20	133.75	133.37	133.76	133.76	133.76	133.76	130.18	144.51	9.9

*Estimate

Source: IMF
Dataquest
November 1988
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STRAW POLL OF 1992: REGIONAL ATTITUDES

SUMMARY

Dataquest held its annual IC Outlook Seminars during the last week of September 1988. The seminars took place in major cities of Europe: Paris, Milan, Munich, Stockholm, and London. An integral part of each seminar was a team workshop devoted to the topic of 1992. This newsletter summarizes the different opinions, attitudes, and solutions developed in the 1992 workshops by the teams representing the European regions.

TOWARD 1992

Common Aspects

A recurrent theme voiced by the seminar attendees was that of technical standards. The overall opinion was that tremendous time and resources are squandered in Europe in discussing standards that seek to please the individual wishes of the member states. Therefore, rather than each reinventing the wheel, member states should consider the following points:

- Europe should adopt any U.S. and Japanese technical standards that already exist in order to allow European vendors to broaden their horizons and compete effectively in these markets.

- Where standards do not exist, new standards must be Pan-European in order to take advantage of a barrier-free European market.

Another recurrent theme was the proposed harmonization of tax rates and fiscal policies across Europe. Continental Europeans feel that without such harmonization across all member states, individual countries risk being severely economically disadvantaged in a barrier-free Europe. The only remaining country not to join the EMS (European Monitory System—a method for fixing the currency fluctuation-rates of major European countries) is Great Britain.

In all regions of Europe, we found two distinct groups. One group is the industry watchers, who have a "hands-off" attitude and are waiting to see what happens in 1992. The other group is the participators, concerned about "barrier-free Europe" and its impact on their current business strategies and plans. The latter group is likely to represent companies that have set up task forces/working parties to advise and, where necessary, influence their company and governmental agencies toward 1992.

Regional Differences

Many people in Europe remain ill informed of the principles behind the 1992 unification of the European Market. Misconceptions and examples of prejudged ideas (not forming part of the 1992 legislation program) exist. These range from the idea that language and cultural differences will disappear to the thought that the British will be forced to drive on the "wrong" side of the road. Obviously, national governments, trade ministries, and institutions face major challenges in educating and informing industrial executives regarding the impact of current legislation going through the European Economic Community (EEC).

Scandinavia

Ironically, the best-informed executives reside outside the EEC. Attendees at Dataquest's seminar in Stockholm were well aware of the principles behind the 1992 legislation and already have taken steps to benefit from the unification of the European Market.

A positive step taken so far by Scandinavians includes the purchase of EEC-based manufacturing companies in order to participate in the unified market. Examples of such activities include the following:

- Nokia (Finland)—purchase of ITT Consumer Division (West Germany)
- Electrolux (Sweden)—equity stake in Zanussi (Italy)
- Ericsson (Sweden)—partnership with Matra (France) and full ownership of the joint Thorn-EMI System Y manufacturing plant in the United Kingdom

In addition, Scandinavians have negotiated with the EEC to participate in all standards-setting institutes in order to align their products behind EEC countries.

West Germany

In West Germany, the United European Market is seen as a prerequisite before Europe becomes a significant competitor to the United States and Japan in high-technology industries. The executives believe that steps ought to be taken to gradually remove or harmonize government subsidies that distort competition. They feel strongly that the EEC should readily impose antidumping measures in order to protect local industries (i.e., automotive and consumer) from disappearing.

Major economic benefits are envisioned in central warehousing for the distribution network, with fast-moving items stored locally. Sales and marketing still ought to be decentralized, as they are dependent on local culture and business style.

Unified standards will have major benefits for switching subcontractors very easily. The free flow of capital and competitive interest rates are seen as major benefits to German industry to counterbalance the burden of high labor costs.

Overall, the West German executives were well informed on the issues facing 1992.

France

The number one item of concern in France was the language barrier. The proposed solution was to adopt French as the official EEC language, although the participants admitted that adopting English was a more practical solution.

The French are strong believers in a united European Market, and they see it as the only alternative to the domination by U.S. and Japanese companies in the global markets. They believe that new standards should be extensions of existing U.S. and Japanese standards in order to help with competition in these markets. The French also think that financial policies across Europe ought to be harmonized if the current barriers are to be eroded.

Overall, the French executives were the most flexible in their approach to 1992, willing to compromise in order to guarantee its success.

Italy

The Italian group seemed to feel the most vulnerable to 1992, due to the fact that their industry is made up of many small companies. They strongly believe in a protectionist-free Europe, and they believe that protectionist policies hurt rather than protect European industries.

The Italian proposal was to set up a Central European community organization similar to MITI in Japan and DOC in the United States. The purpose of this organization would be to collect relevant trade statistics on imports, exports, and production of key technology products. It would also provide guidance on new investments, R&D collaboration, and future direction for the industry to become globally competitive.

The Italians believe in a decentralized sales and marketing organization to serve markets with local flavors. Their concern was that public monopolies in Italy (such as PTT, airlines, and railways) have hindered growth with their inefficiencies. It was pointed out that well-managed, efficient bodies serving the public sector (e.g., the German rail system) already exist within Europe. The goal is to pass the operating knowledge from the more able concerns to the less able. Some people see 1992 as a chance to deregulate some of these industries, allowing Italy to compete on a par with its European neighbors.

Great Britain

The British group summarized its perceptions of the situation by reinforcing the point that the breaking down of the legal barriers within Europe was the beginning NOT the end of the process toward an economically unified Europe.

They saw the challenge of unifying Europe was as one divided into three sections: governmental, technical, and environmental.

On the environmental front, the latest challenge was perceived to be cross-border education on the specific environmental issues. The consensus of the discussion was that a solution to these problems could be found only when Europeans became aware of one another's problems. This awareness should be accomplished through education and healthy debates. Problems to be identified and addressed included exhaust emission standards and toxic waste disposal.

In the technical realm, there was a realization that existing standards would remain for the more mature existing systems (i.e., electricity transmission) but that a great opportunity is afforded for common agreement on new standards such as cellular radio and high-definition television.

Finally, on the governmental front, disbelief was expressed toward the necessity of harmonizing tax rates across Europe. The concern expressed was that centralized pronouncements on regionally sensitive areas might well work against the common goals of the EEC instead of supporting it.

In the end, local problems will always need local solutions. This was the final point driven home by the British team.

DATAQUEST CONCLUSIONS

Dataquest believes that electronics industry executives across Europe need to make concerted efforts to gather more information and become more involved in the current and intended legislation on 1992. We were impressed by the way that the Italian executives saw 1992 as an opportunity to overhaul their state monopolies. For the Scandinavian executives, 1992 has already started; they are well informed of the implications. Recognition by West German and French executives that 1992 presents an unrivaled opportunity to become regional partners in the global marketplace represents a great step forward in thinking. U.K. executives who have already experienced deregulation in key areas such as telecommunications and finance have a head start in barrier-free markets, but they must take practical steps toward European harmonization to benefit from the unified European Market.

Bipin Parmar
Jim Beveridge

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DRAM ALLIANCE: THE UNITED STATES TALKS, THE BRITISH ACT

SUMMARY

While American systems companies continue to debate the pros and cons of forming alliances that will assure their supply of critical memory devices, the British have taken action. Amstrad plc, a fast-growing maker of personal computers and home entertainment products based in Brentwood, England, agreed on October 3 to make a $75 million equity investment in Micron Technology Inc. of Boise, Idaho. The deal will allow Micron to accelerate its development of new facilities that will at least double its manufacturing capacity in DRAM and other memory products. As part of the agreement, Amstrad will receive an option to buy up to approximately 9 percent of Micron's semiconductor production over the next three years.

MICRON'S ALLIANCE STRATEGY

Micron Technology, one of only three United States-based semiconductor manufacturers still producing DRAMs, has made no secret of its interest in lining up alliance partners to help fund expansion, develop new products, and enhance its marketing clout. Micron used funding from Digital Equipment Corporation to develop video RAM (VRAM) technology, which is now its fastest-growing product area. Earlier this year, Micron gave Intel Corporation a warrant to buy 600,000 shares of its stock for approximately $11.6 million in return for an agreement to market Micron products through Intel's sales network.

In joining forces with Amstrad, Micron hopes to achieve multiple objectives. Most important initially is the infusion of cash, which may allow the company to cut as much as a year from its two-year plan to build and equip a 100,000-square-foot wafer fabrication plant and a 250,000-square-foot assembly and test building. Investment in the new facilities will increase from a planned $180 million to $250 million, according to Micron.

The three-year purchase agreement also encourages Micron to accelerate its expansion plans. Although Amstrad is not required to take all of the production it is entitled to buy under the agreement, it already accounts for approximately 9 percent of Micron's sales and still needs additional memory supply. Micron clearly expects the relationship to tighten as the company tries to improve its penetration of the European market.

WHAT DOES AMSTRAD GAIN?

Founded by chairman and managing director Alan Sugar in 1968, Amstrad has about doubled its sales every year since 1980. It crossed the $1 billion mark in the year ended last June. Personal and home computers, word processors, and software account for about three-quarters of Amstrad's sales volume. Company officials claim that the recent DRAM shortage has cut Amstrad's shipments by 10,000 to 30,000 units per month.

The agreement provides Amstrad with assured access to memory products that could be worth more than $50 million per year when Micron's new production facility comes on stream next year. Unlike the 20-plus Micron customers who recently signed two-year noncancellable DRAM supply contracts, Amstrad does not have to commit to a fixed delivery schedule. In addition to negotiating prices on a quarterly basis, Amstrad is able to start with a ceiling price that is based on the weighted average of all other noncancellable contracts for the previous 90 days.

The investment also gives Mr. Sugar a seat on Micron's board and, presumably, some say in future product and marketing decisions. Micron officials stress, however, that the deal will not reduce product allocations to present customers. Under terms of the agreement, Amstrad has a claim on no more than 9.03 percent of any Micron part type. This will prevent Amstrad from using its position to monopolize Micron's output of high-performance devices or others in short supply.

DATAQUEST ANALYSIS

The era of "virtual vertical integration," in which producers and users of critical technology components join forces, has clearly arrived. Assuming that it receives government approval, this agreement provides an excellent example of the benefits to both sides that can flow from such alliances. Dataquest has heard credible rumors that one Japanese chipmaker is floating a business plan to the investment community that would fund a wafer fab jointly owned by itself and several U.S. computer manufacturers.

The irony in all this is that, with the Micron/Amstrad alliance, we have a U.S. semiconductor company reserving a significant share of its much-needed capacity for an aggressive European company, while other rumors suggest a somewhat similar arrangement between U.S. systems manufacturers and a Japanese semiconductor supplier. The Amstrad/Micron arrangement should be a clear signal to U.S. systems and device companies that the alliance dance has started, and it is time to choose partners.

Bipin Parmar
John W. Wilson
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WEST GERMANY: FACING UP TO THE ECONOMIC CHALLENGE

SUMMARY

West Germany's current economic performance does not reflect the country's place as the third-largest economy in the Western world. West Germany is no longer getting rich as quickly as it used to. Its competitiveness is strongly affected by high costs, insufficient investment, and unfavorable exchange rates. In addition, the West German government is very conservative. It has done very little to deregulate the economy.

In Dataquest's opinion, West German companies need to invest heavily in research, product development, and plant modernization or expansion to sharpen their technological edge.

This newsletter presents an overview of West Germany's economic, political, and technological prospects.

ECONOMIC PROSPECTS

By 1990, West Germany will have a full decade of economic underperformance behind it. Between 1980 and 1987, West Germany's output grew by only 1.5 percent per year, the slowest growth rate of the five largest OECD economies (France, Germany, Japan, United Kingdom, and United States).

But growth prospects for 1988 are not as gloomy as they seemed after 1987's stock market crash. The country's well respected Kiel Economic Research Institute now expects a GNP rise of more than 2 percent in 1988 after a rise of 1.7 percent in 1987. But in 1989, the institute anticipates economic growth of only 1.3 percent, less than the OECD forecast of 1.75 percent.

Consumer spending, boosted by low inflation and falling interest rates, is expected to remain strong in 1988. The stock market crash did not have an economic effect, since shareholdings account for only 6 percent of households' financial assets in West Germany compared with 25 percent in America. Consumer spending in 1989 is expected to increase less than in 1988 due to reduced working hours and lower nominal income growth.

Investment is sluggish, though business confidence has been improving since the beginning of 1988. Because the West German economy is so export oriented, investment is closely linked to exports. West Germany is trapped in a vicious circle; weak exports lead to low investment, which leads to slow growth, which in turn leads to low investment.

Exports held up better than expected in spite of upward pressure on the deutsche mark. West Germany's economy still relies heavily on exports, which are 33.0 percent of its GNP compared with Japan, whose exports are only 12.0 percent of its GNP. West Germany is now less reliant on U.S. exports; only 10.0 percent of its exports went to the United States in 1987. Its export economy is now truly integrated within the European Community, where its share of exports has risen to 52.7 percent and level of imports has risen to 52.6 percent.

Exports in information and communications technology account for only 7 percent of West Germany's foreign sales, compared with 17 percent in the United States and Japan.

COMPETITIVENESS

West German labor costs place second in the world after the Swiss, according to the Cologne-based Institut der Deutschen Wirtschaft. West German workers cost an average of DM 32.67 an hour in 1987 compared with the Swiss at DM 33.03 an hour. The reasons are not so much direct wage costs, but additional costs of insurance, social security, and paid leave, where West Germany leads the world.

Because of the high wages in West Germany, the scope for competitive production is limited. Demands for a 35-hour work week do not help either. Though trade unions think a shorter work week will help some of the 2.15 million unemployed (May 1988 statistics), this is only approximately 8.4 percent of the work force).

Because of high costs and the inflexibility of labor, West Germany is considered unfavorable for new investments in manufacturing and plants. West German businesses are seeking ways to cut costs by purchasing materials outside of Germany and creating partnerships, mergers, and acquisitions in foreign markets where the strong deutsche mark makes exporting difficult.

The reality of a significant export of capital and labor-intensive jobs is beginning to make its mark on West Germany's trade unions. They are under pressure to restart Saturday working.

Failure to rapidly deregulate the monopoly telecommunications operator (Bundespost) has resulted in very high costs being paid for communications equipment and services compared with other EC countries.

GOVERNMENT POLICIES

Some politicians are concerned about the rising costs of manufacturing in West Germany and are aware of the need for more deregulation and flexibility.

Economists have attacked regulation, excessive taxation, and petrification of social structures, leading to lack of sufficient growth, dynamism, and competitiveness.

The government's tax package, which comes into effect in 1990, is a central part of its efforts to secure medium-term economic growth.

The West German government has been criticized by the OECD for its inability to reduce subsidies and speed up deregulation. In all fairness, the West German government structure is made up of a coalition between different political parties, and this is not best suited to make major economic/social changes. It is unlike the United Kingdom, where a single-party government is able to carry out some radical changes in socioeconomic policies.

TECHNOLOGICAL RESOURCES

West Germany will be among the main beneficiaries of a single European market for telecommunications in 1992. Siemens owns GTE Telecommunications, which is well represented in Belgium and Italy, while Bosch has purchased Schneider, which is well represented in France.

West German and French telecom authorities plan to join forces to compete against IBM and other multinational computer groups. They want to supply the growing market for value-added telecom services. The two countries' authorities are expected to launch a jointly controlled commercial company offering high value-added telecom services involving voice and data communications. This is the first such venture by two state-owned public telecom authorities.

West German office automation equipment manufacturers have lost world market share this decade. According to the Institut der Deutschen Wirtschaft, West German companies in the office and information technology sector had to face higher import penetration due to increased competition from Japan, Singapore, and Taiwan.

Siemens has started delivering its new 4-megabit DRAM for sampling to its key customers. It could go into volume production in 1989. Siemens is investing just under DM 3 billion in its megabit chip project, while the West German Research Ministry has put in DM 240 million of the DM 700 million development costs for the 4-megabit chip. The 1-megabit DRAM has gone into high-volume production. The major benefit of the megaproject is that it has narrowed the technological gap between Siemens and the U.S. and Japanese companies to a few months. This compares favorably with four years ago, when Siemens lagged well behind the equivalent U.S. and Japanese companies.

Siemens and Advanced Micro Devices have signed a pact in an attempt to win a major share of the world market for the newly emerging market for ISDN chips. Siemens has also acquired the automotive division of Allied Signal of the United States in order to be a significant world player in the automotive electronics market.

In the United Kingdom, Siemens is expanding with the creation of 600 jobs at a new development center in Manchester. The £15 million project will comprise offices, laboratories, a service center, and a customer training school.

DATAQUEST ANALYSIS

There are three large imbalances in the West German economy: the high unemployment rate, the huge gap between private sector savings and investment, and the large current account surplus. (In 1987, West Germany achieved a surplus of Ecu 206 million in its trade with the European Community). Efforts to even out these imbalances have been insufficient due to the structure and very conservative nature of the government.

Increasingly inflexible labor and social policies have driven up corporate costs and lowered investment. Germans will have to accept more flexible working conditions, work longer hours, and accept a less generous health and social security system to preserve West Germany's international competitiveness in the 1990s.

The West German employers' organization, Bundesverband der Deutschen Industrie (BDI), recommends: "We must prepare Germany for a more competitive Europe without trade barriers and we must therefore overcome defensive mentalities and strategies."

Dataquest expects a shift in labor-intensive electronic assembly lines to low-rate EC countries like Spain, Portugal, and Greece. We expect an increasing trend for West German corporations to expand their investments in the industrial automation area to preserve or increase productivity rates.

Jim Beveridge

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COMPONENT DISTRIBUTION IN 1992

INTRODUCTION

With the move toward breaking down European regional barriers in 1992, many distributors are setting their sights on true Pan-European operations. This will mean managing outlets in one or more countries in order to supply customers throughout Europe.

In achieving this, familiar operational issues take on a new dimension of complexity. Management techniques, such as centralized warehousing, setting inventory levels, supporting customer just-in-time (JIT) delivery requirements, and controlling all of this with computer management systems, must be applied at a Europewide level. The distributor will also have to cope with export controls and multiple currency transactions.

This newsletter reviews these topics in a European context.

INVENTORY MANAGEMENT ISSUES

Centralized Warehousing

Centralized warehousing is gaining in popularity as a method of reducing the cost of inventory holdings. Many distributors split their inventory into A, B, and C categories, using some form of Pareto's Law, based on sales turnover by device. The central warehouse is stocked with all three types, and branch or local warehouses hold fast-moving A- and B-class devices. Exceptions to this may arise because of local requirements of certain industries or specific customers. In a Pan-European context, a distributor would limit the volume of stock for his entire range of franchises to one major location and invest in an increased number of smaller satellite warehouses for holding faster-moving devices instead of keeping money tied up in slow-moving inventory in each European country.

Setting Inventory Levels

Inventory level is always a point of contention between vendors and distributors. Distributors would like to see their stock rotate four or five times per year at resale price. Suppliers believe that it should turn more like three or three-and-one-half times per year. At any rate, holding inventory costs money. A balance must be struck between the cost of financing inventory and the "service level" (usually defined as the number of line items that can be shipped from stock and expressed as a percentage of total line items ordered). Recent research indicates that distributors are moving toward a service level of 90 percent and adjusting inventory levels to meet this requirement.

Supporting JIT Delivery Requirements

JIT deliveries are being requested by an increasing number of customers. Some customers are prepared to place long-term orders (6 to 18 months) for production programs with the expectation that the distributor will guarantee to meet the required call-offs, irrespective of the current lead-time situation.

In order to support the customer, the distributor's stock must be adequate and located near the customer. Earning the customer's trust is vital—the distributor must establish a close personal relationship with each customer. To offer this level of service, again, suggests that a distributor must provide local branch distribution.

Computer Issues

Some suppliers regard unsold inventory as a contingent liability. They want to know how much potential liability there is and where it is located. Also, inventory movements and resale bookings and billings are important pieces of market intelligence for the supplier. He needs to have real-time access to this information.

The distributor's computer software may need to be changed to meet all the reporting and control requirements. Obviously, each branch must be using the same software package. If the distributor is working on a computer-to-computer basis with his supplier(s), this will introduce other software and hardware compatibility requirements.

Export Control and Currency Considerations

Many devices are considered to be strategic and, as such, are under strict export control regulations. These may be imposed by local authority or NATO. The distributor must be able to comply with the regulations and demonstrate tight administrative control of the movement of such devices. In some cases, it may be necessary to establish a bonded warehouse. A bonded location can also be used for stock imported from outside the EEC while the distributor waits for a final delivery point to be established. This warehouse would form part of a central stocking location for the Pan-European distributor.

The valuation of stock held in two or more locations using different currencies may be handled based on the currency of the country where the main stock is held. However, tax considerations in the branch countries may involve valuing the inventory in two currencies.

DATAQUEST ANALYSIS

Centralized warehousing has both pluses and minuses for the distributor.

On the plus side, he can realize better control of inventory costs and even reduce them. He can offer better service to the customer, since the A and B stock is located where it is most likely to be needed. He can shift stock around as needed, and this results in faster stock rotation. An additional benefit would be that suppliers would have better visibility of their inventory holdings.

The other side of the coin is the need for a highly sophisticated control system, which will lead to an increase in administrative costs.

For the supplier, the advantages are fewer ship-to points, fewer small orders, and a single bill-to point. Selling time and cost are reduced, too. The supplier could lose some visibility on where the stock inventory is located, what the market is using, and pricing in local markets. These points require closer cooperation between the distributor and the supplier, but they can be resolved.

Centralized warehousing for multicountry distributors is on the way. The distributor will need to develop effective internal control techniques, satisfy the demands of his suppliers, and comply with export control regulations. All of this requires planning and execution, but the majority of participants believe it will be worth it.

Jim Beveridge
Jim Eastlake

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CAN CALIFORNIA MICRO DEVICES INJECT NEW LIFE INTO AMI?

Gould Inc. and California Micro Devices Corp. (CMD) have signed a definitive agreement whereby CMD will purchase Gould's Semiconductor Division, the former American Microsystems Inc. (AMI). CMD will acquire all of the ongoing semiconductor operations of AMI at the approximate cost of $70 million in cash. This acquisition includes the name; a 310,000-square-foot wafer fab in Pocatello, Idaho; a 64,000-square-foot test and assembly facility in the Philippines; AMI's ASIC design software; and a total worldwide work force of approximately 1,500 employees.

According to Dataquest market share figures, Gould/AMI's 1987 semiconductor revenue totaled $100 million, while CMD's revenue for the same fiscal year was approximately $10 million. During this period, CMD acquired the Microcircuits Division of GTE Communications, which would have doubled its fiscal 1987 sales figure. In the case of both CMD and AMI, application-specific IC (ASIC) related business accounted for the majority of 1987 revenue. Table 1 provides a breakout of the ASIC revenue for AMI and CMD.

Table 1

CMD/AMI ASIC Revenue Analysis
Fiscal 1987
(Thousands of Dollars)

	Gate Array	Cell-Based IC	Other	Total
CMD	$ 4,000	$ 2,000	$ 4,000	$ 10,000
GTE	1,000	0	7,000	8,000
AMI	6,000	20,000	74,000	100,000
Total	$11,000	$22,000	$85,000	
Combined CMD/AMI ASIC Revenue				$118,000

Source: Dataquest
September 1988

Although the full-custom design and foundry work have produced a significant portion of AMI's total semiconductor revenue, the preceding table reveals that cell-based ICs (CBICs) comprise the single largest ASIC segment of the combined CMD/AMI. Dataquest's market share figures indicate that the total CBIC revenue of the two companies puts them among the world's top ten CBIC suppliers.

There are a number of promising aspects regarding a combined CMD/AMI. AMI should benefit from a management team (Chan M. Desaigoudar, chairman, chief executive officer; Handel H. Jones, president, chief operating officer) with a more focused approach to the semiconductor market than that of more diversified Gould. Under Messrs. Desaigoudar and Jones, CMD has given a good accounting of itself. During a period of industry recession in 1985 and 1986, CMD's revenue grew by 45 percent. Although it had fiscal 1987 revenue growth of only 3 percent, the company increased its gross margin to nearly 49 percent and concluded the acquisition of GTE's semiconductor division.

Besides its management strengths, CMD presents a compelling mix of technologies. Starting out as a supplier of thin-film components in 1976, CMD created its ASIC division in 1983. With the introduction two years later of a proprietary, high-density, ultrastable thin-film material (SX), the company became capable of integrating the two technologies. In 1987, approximately 40 percent of CMD's ASIC designs utilized on-board, thin-film components, representing a high-margin product line for military markets. The company also has a development contract from a major computer manufacturer to provide prototypes of an ink-jet color printhead with approximately 50 jets.

Once the AMI acquisition is approved, CMD will find itself propelled into the ranks of the top 40 semiconductor companies of the world (based on 1987 market share data). The challenge will be one of marketing this newfound muscle. The nature of CMD's products and technology have placed it in the low-volume, high-margin world of military niche markets. This contrasts with the majority of AMI's business in commercial data processing and communications segments.

To swallow an entity that went nowhere in 1987, the team of Desaigoudar and Jones will have to take on additional debt during a period of business conditions that Dataquest believes have crested. CMD will then have to demonstrate the same propensity for profit in a market more competitive and less familiar than those in which it has demonstrated its strengths. The fact remains, however, that CMD has gotten where it is today by virtue of sound management and gutsy moves—attributes that its management team will now apply to a greatly expanded potential.

Jennifer Berg
Michael J. Boss

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HARRIS CORPORATION TO ACQUIRE GE SOLID STATE

Since GE's acquisition of RCA in mid-1986, there has been much speculation regarding its intentions in the merchant semiconductor market. Over the past year, the company frequently intimated its willingness to sell its semiconductor business. These rumors were put to bed, with the August 15 announcement of an agreement for Harris Corporation to acquire GE Solid State.

Specific details of the agreement have not been released. However, it was announced that GE's dedicated facility, the Microelectronics Center in Research Triangle Park, North Carolina, will be excluded from the deal, along with certain other military semiconductor operations that were acquired from RCA and are part of GE's aerospace business.

Harris

Dataquest estimates that Harris' 1987 semiconductor revenue of $277 million increased marginally over 1986. Semiconductor revenue represented 13 percent of the company's total revenue for calendar year 1987. If GE Solid State's 1987 semiconductor revenue were added to this, the percentage would jump to about 31 percent of total company revenue, giving the combined entity a number-16 ranking worldwide.

What Do the Numbers Mean?

Three primary areas—military, linear, and standard logic—seem to emerge as the significant items in this proposed transaction. Harris' main strength within the semiconductor market stems from its position in the military market segment where it is one of the leading suppliers. Sources at GE claim that the GE/Harris businesses are very complementary from a military perspective. The venture probably would rank Harris as one of the top two suppliers to the military market. National Semiconductor, the current leader, had estimated 1987 military revenue of $250 million. The deal also would result in the consolidated supply of super radiation-hardened devices by Harris, already a leading supplier.

Harris concentrates its linear business on amplifiers, whereas GE distributes its linear products fairly evenly over the areas of amplifiers, interface, data conversion, consumer, and other linear products. More than one-fourth of GE Solid State's semiconductor revenue is derived from sales of discrete products, while Harris has no presence in this market. Often this product area is considered a good source of steady revenue, so it may be Harris' intention to benefit from GE's established position in this market.

GE's solid standard logic business, which it inherited from RCA, would be another area of appeal to Harris. GE Solid State ranked among the top 10 standard logic suppliers in 1987, with revenue of $110 million, and was the leading MOS logic supplier to the military market. We note that Harris pulled out of the bipolar gate array market in 1987, but the companies' combined MOS gate array revenue would move Harris up toward a top-10 spot. However, the more significant development would occur with respect to cell-based ICs: Revenue amalgamation, viewed in terms of 1987 revenue, would place the company as the second target supplier worldwide. Although Harris currently participates in the MOS PLD market, it does not do so to any great extent, and it retreated from the bipolar PLD market in 1985.

Why the Merger?

One has to wonder about Harris' objectives in undertaking this acquisition. Harris certainly would expand its presence in the semiconductor market, but more importantly, would expand its presence in the military semiconductor market. Harris reported fiscal 1988 sales and earnings showing a fourth-quarter decline in sales of 4 percent, to $538.4 million, and a 93 percent decline in income to $1.8 million. Sales were flat at $2.1 billion, and without the adoption of FAS No. 96 to offset a $33.1 million charge for asset revaluations and restructuring costs, the company would have reported a 23 percent decline in income for fiscal 1988, as opposed to the reported 19 percent increase.

From GE's perspective, its semiconductor operations did not fit into its long-term strategy of focusing on jet engines and major household appliances—markets where it is a leading supplier. This view is consistent with the company-stated goal of remaining among the top two suppliers in the markets that it serves. GE's semiconductor operations constituted one of the company's smaller support operations. Apparently, GE had decided that it needed only research, design, and limited manufacturing capability to support its aerospace and medical equipment businesses. GE's acquisition of RCA presented the challenge of integrating both captive and merchant operations. However, morale at GE, and more particularly at RCA, suffered somewhat as a result of the takeover.

Now Harris will face the challenge of integrating GE Solid State to its semiconductor sector reporting to Vice President Jon Cornell. Negotiations are not expected to be completed until year end. Many questions are still outstanding, such as: What are the implications of this transaction for GE's gate array agreement with VLSI Technology and for the agreement to cooperate with IBM on ASICs and power BICMOS products?

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Jennifer Berg
Patricia Galligan

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ASIC MIDYEAR UPDATE

Dataquest has incorporated the latest industry trends in producing a new application-specific integrated circuit (ASIC) forecast. In 1987, ASICs accounted for 59.1 percent of the worldwide logic market. By 1992, we now estimate that ASICs will be a $13.5 billion market, accounting for 66.5 percent of the worldwide logic market. As this growth indicates, ASICs are transforming the IC industry.

Prevailing trends incorporated in the new ASIC forecast include:

- Standard logic to ASICs—ASICs continue to impact the mature bipolar standard logic families such as LSTTL. We believe that there is an unrelenting migration of applications moving from standard logic to ASICs.
- PLDs—CMOS PLDs continue to gain popularity from suppliers and users. There are now 19 CMOS PLD suppliers. While CMOS PLDs only accounted for 18.7 percent of the 1987 PLD market, they are expected to account for 50.0 percent of the 1992 PLD market.
- BICMOS ASICs—Seven suppliers have now entered the BICMOS ASIC market, so we are forecasting both BICMOS gate arrays and BICMOS CBICs.
- Slowdown in 1990—Analysis of the forces at work in the global electronics industry lead us to conclude that ASICs will experience a slowdown in 1990.

Table 1 shows the total ASIC consumption forecast segmented by product and technology. Dataquest forecasts include NRE, device production, CAD software, and intracompany sales (internal sales). Dataquest forecasts do not include captive manufacturing by companies such as Digital Equipment, IBM, and Unisys that do not sell semiconductors to the merchant market.

Table 1

Estimated Worldwide ASIC Consumption (Millions of Dollars)

	1985	1986	1987	1988	1989	1990	1991	1992	CAGR 1987-1992
Total Application-Specific	4,065.5	4,923.6	5,943.9	7,267.4	8,259.7	9,199.2	11,139.3	13,531.1	17.9%
MOS	3,130.0	3,778.4	4,537.9	5,462.8	6,117.9	6,858.8	8,307.0	10,007.0	17.1%
Bipolar	930.5	1,127.2	1,375.0	1,744.8	2,033.7	2,120.4	2,429.6	2,801.1	15.3%
BICMOS	5.0	18.0	31.0	59.8	108.1	220.0	402.7	723.0	87.7%
Gate Arrays	1,284.3	1,783.1	2,288.3	2,909.2	3,601.5	4,028.4	5,051.6	6,323.1	22.5%
MOS	718.3	1,092.6	1,478.2	1,935.3	2,436.2	2,677.5	3,353.2	4,156.6	23.0%
Bipolar	561.0	672.5	779.1	915.1	1,062.2	1,149.9	1,346.7	1,568.5	15.0%
BICMOS	5.0	18.0	31.0	58.8	103.1	201.0	351.7	598.0	80.7%
Programmable Logic	234.8	305.7	452.6	699.4	910.7	913.0	1,135.2	1,384.1	25.1%
MOS	9.8	32.3	84.7	156.0	274.6	336.3	511.2	689.1	52.1%
Bipolar	225.0	273.4	367.9	543.4	636.1	576.7	624.0	695.0	13.6%
Cell-Based ICs	484.8	674.4	919.4	1,263.7	1,542.6	2,109.7	2,836.8	3,736.3	32.4%
MOS	471.7	640.3	859.1	1,171.0	1,426.6	1,943.8	2,598.4	3,372.4	31.5%
Bipolar	13.1	34.1	60.3	91.7	111.0	146.9	187.4	238.9	31.7%
BICMOS	0	0	0	1.0	5.0	19.0	51.0	125.0	-
Full Custom	2,061.6	2,160.4	2,283.6	2,395.1	2,204.9	2,148.1	2,115.7	2,087.6	(1.8%)

Source: Dataquest
September 1988

During early 1987, Dataquest had forecast the ASIC market to reach $6 billion. The 1987 year-end historical shipment data indicate that it was a $5.9 billion market.

Gate arrays became the largest ASIC market during 1987. Dataquest believes that gate arrays will be the dominant design methodology through 1992. High-complexity CMOS array designs (greater than 20,000 gates) and high-complexity ECL array designs (greater than 10,000 gates) are experiencing major growth. CMOS CBICs are narrowing the gap on CMOS gate arrays, but will not catch them by 1992. There are an increasing number of CBIC designs with compilable cells and megacells that provide increased functionality over and above that of gate arrays.

There are now more than 100 worldwide merchant ASIC suppliers. The ASIC market has grown from infancy to $5.9 billion in 10 years. ASICs have now matured, and we believe that they will play the leading role in the future electronics industry. Applications for ASICs are pervasive, ranging from talking toy bears to the world's fastest and most powerful computers.

Jim Eastlake
Bryan Lewis
Andy Prophet

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EXCHANGE RATE QUARTERLY NEWSLETTER

SECOND QUARTER 1988

Dataquest exchange rate tables involve data from many countries, each of which has different and variable exchange rates against the U.S. dollar. As much as possible, Dataquest estimates are prepared in terms of local currencies before conversion (when necessary) to U.S. dollars. Dataquest uses International Monetary Fund (IMF) average foreign exchange rates for historical data.

All forecasts are prepared assuming no changes in any exchange rate from the last complete historical year—in this case, 1987. During the course of the current year, as local currency exchange rates vary, the appropriate U.S. dollar value changes accordingly. To maintain consistency across all its analyses, Dataquest does not make ongoing adjustments to its forecasts for these currency changes during the current year. As a result of this policy, as the year progresses the forecast numbers could become distorted, in dollars, should the European currencies deviate substantially from the previous year's rates.

Dataquest monitors the exchange rates on a weekly basis using IMF exchange rates, supported by Financial Times exchange rates when IMF data are not yet available. (Financial Times is the accepted U.K. newspaper giving daily updates.) Effective exchange rates for the current year are calculated each month. This information is then used to assess the local currency's impact on U.S. dollar forecasts.

The purpose of this newsletter, which will be updated quarterly, is to record these changes, and thus allow the reader to make any necessary adjustments when interpreting regional data. For each European region, Table 1 gives the local currency per U.S. dollar for 1987, first quarter 1988, and second quarter 1988, together with the latest estimate for the whole of 1988. Also shown, for reference purposes, are the same figures for the Japanese yen. As can be seen from this table, the weighted average for all the European currencies for 1988 has decreased 6.0 percent with respect to the U.S. dollar, compared with 1987. This represents an increase of 0.3 percent in the exchange rate from first quarter 1988 to second quarter 1988. Table 2 shows the estimated 1988 quarterly values for the same regions.

Table 1

European Currencies—1987 to 1988
(Local Currency per U.S. Dollar)

Region	1987	Q1 1988	Percent Change Q1-Q2	Q2* 1988	Latest Estimate 1988*	Percent Change 1987-1988
Austria	12.64	11.78	1.4	11.94	12.03	(5.1)
Belgium	37.34	35.06	1.1	35.46	35.71	(4.6)
Denmark	6.84	6.42	1.2	6.50	6.53	(4.9)
Finland	4.40	4.06	(0.5)	4.04	4.08	(7.7)
France	6.01	5.67	1.4	5.75	5.78	(4.0)
Ireland	0.67	0.63	0.8	0.63	0.64	(5.3)
Italy	1,296.10	1,235.27	2.1	1,262.37	1,268.11	(2.2)
Luxembourg	37.34	35.06	1.1	35.46	35.71	(4.6)
Netherlands	2.03	1.88	1.2	1.91	1.92	(5.4)
Norway	6.74	6.36	(2.4)	6.22	6.31	(6.9)
Portugal	140.88	137.03	1.3	138.77	139.70	(0.8)
Spain	123.56	113.09	(0.7)	112.33	113.58	(8.8)
Sweden	6.34	5.99	(1.0)	5.93	6.00	(5.8)
Switzerland	1.49	1.38	2.8	1.42	1.42	(4.9)
United Kingdom	0.61	0.56	(3.1)	0.54	0.55	(10.8)
West Germany	1.80	1.68	1.4	1.70	1.71	(5.2)
Weighted Average (Base 1980 = 100)	125.52	116.91	0.3	117.29	118.41	(6.0)
Japan	144.51	127.85	(2.2)	125.10	126.24	(14.5)

*Estimated

Source: IMF
Dataquest
September 1988

Table 2

European Currencies—1988 by Quarter
(Local Currency per U.S. Dollar)

Region	Q1	Q2*	Q3*	Q4*	Total Year 1988*
Austria	11.78	11.94	12.19	12.19	12.03
Belgium	35.06	35.46	36.17	36.17	35.71
Denmark	6.42	6.50	6.59	6.59	6.53
Finland	4.06	4.04	4.11	4.11	4.08
France	5.67	5.75	5.85	5.85	5.78
Ireland	0.63	0.63	0.65	0.65	0.64
Italy	1,235.27	1,262.37	1,287.40	1,287.40	1,268.11
Luxembourg	35.06	35.46	36.17	36.17	35.71
Netherlands	1.88	1.91	1.95	1.95	1.92
Norway	6.36	6.22	6.32	6.32	6.31
Portugal	137.03	138.77	141.50	141.50	139.70
Spain	113.09	112.33	114.45	114.45	113.58
Sweden	5.99	5.93	6.03	6.03	6.00
Switzerland	1.38	1.42	1.45	1.45	1.42
United Kingdom	0.56	0.54	0.56	0.56	0.55
West Germany	1.68	1.70	1.73	1.73	1.71
Weighted Average (Base 1980 = 100)	116.91	117.29	119.71	119.71	118.41
Japan	127.85	125.10	126.00	126.00	126.24

*Estimated

Source: IMF
Dataquest
September 1988

Table 3 illustrates how to interpret the effect of the currency shifts on the Dataquest forecast numbers. For example, the table shows that the constant dollar forecast of $6,544 million for the 1988 total European semiconductor market becomes $6,937 million when adjusted for changes in European currencies.

Table 4 shows the 1988 monthly values of local currency per U.S. dollar for each European region and Japan.

Note: The European currency weighted average exchange rate is calculated by weighting each country according to its estimated semiconductor consumption for the current year. The year 1980 is used as a base reference. This is similar in methodology to the calculation of the European Currency Unit (ECU).

Byron Harding

Table 3

Effect of Changes in European Currencies per U.S. Dollar On Dataquest Forecasts—1987 versus 1988 (Millions of Dollars)

	1987	1988	Percent Change 1987-1988
European Semiconductor Consumption (At constant 1987 Exchange Rates)	$6,355	$6,544	3.0
Weighted European Currency (Assumed) (Base 1980 = 100)	125.5	125.5	N/M
Weighted European Currency (Latest Estimates)	125.5	118.4	5.7
Effective Consumption (At June YTD Exchange Rates)	$6,355	$6,937	9.2

N/M = Not Meaningful

Source: IMF
Dataquest
September 1988

Table 4

European Currencies—1988 by Month
(Local Currency per U.S. Dollar)

	Jan.	Feb.	Mar.	Apr.*	May*	June*	July*
Austria	11.62	11.92	11.79	11.72	11.92	12.19	12.19
Belgium	34.57	35.50	35.10	34.85	35.36	36.17	36.17
Denmark	6.34	6.49	6.43	6.42	6.49	6.59	6.59
Finland	4.03	4.11	4.04	3.99	4.02	4.11	4.11
France	5.58	5.74	5.69	5.66	5.74	5.85	5.85
Ireland	0.62	0.64	0.63	0.63	0.63	0.65	0.65
Italy	1,214.10	1,250.30	1,241.40	1,239.80	1,259.90	1,287.40	1,287.40
Luxembourg	34.57	35.50	35.10	34.85	35.36	36.17	36.17
Netherlands	1.86	1.91	1.88	1.87	1.90	1.95	1.95
Norway	6.34	6.41	6.34	6.15	6.18	6.32	6.32
Portugal	135.04	138.63	137.42	136.42	138.40	141.50	141.50
Spain	112.27	114.43	112.56	110.43	112.11	114.45	114.45
Sweden	5.97	6.05	5.95	5.86	5.90	6.03	6.03
Switzerland	1.35	1.39	1.39	1.38	1.42	1.45	1.45
United Kingdom	0.56	0.57	0.55	0.53	0.53	0.56	0.56
West Germany	1.65	1.70	1.68	1.67	1.70	1.73	1.73
Weighted Average (Base 1980 = 100)	115.53	118.58	116.62	115.23	116.94	119.71	119.71
Japan	127.63	129.50	126.43	124.48	124.83	126.00	126.00

*Estimated

(Continued)

Table 4 (Continued)

European Currencies—1988 by Month
(Local Currency per U.S. Dollar)

	Aug.*	Sept.*	Oct.*	Nov.*	Dec.*
Austria	12.19	12.19	12.19	12.19	12.19
Belgium	36.17	36.17	36.17	36.17	36.17
Denmark	6.59	6.59	6.59	6.59	6.59
Finland	4.11	4.11	4.11	4.11	4.11
France	5.85	5.85	5.85	5.85	5.85
Ireland	0.65	0.65	0.65	0.65	0.65
Italy	1,287.40	1,287.40	1,287.40	1,287.40	1,287.40
Luxembourg	36.17	36.17	36.17	36.17	36.17
Netherlands	1.95	1.95	1.95	1.95	1.95
Norway	6.32	6.32	6.32	6.32	6.32
Portugal	141.50	141.50	141.50	141.50	141.50
Spain	114.45	114.45	114.45	114.45	114.45
Sweden	6.03	6.03	6.03	6.03	6.03
Switzerland	1.45	1.45	1.45	1.45	1.45
United Kingdom	0.56	0.56	0.56	0.56	0.56
West Germany	1.73	1.73	1.73	1.73	1.73
Weighted Average (Base 1980 = 100)	119.71	119.71	119.71	119.71	119.71
Japan	126.00	126.00	126.00	126.00	126.00

*Estimated

(Continued)

Table 4 (Continued)

European Currencies—1988 by Month
(Local Currency per U.S. Dollar)

	1988*	1987	Percent Change 1987-88
Austria	12.03	12.64	4.9
Belgium	35.71	37.34	4.4
Denmark	6.53	6.84	4.6
Finland	4.08	4.40	7.2
France	5.78	6.01	3.9
Ireland	0.64	0.67	5.0
Italy	1,268.11	1,296.10	2.2
Luxembourg	35.71	37.34	4.4
Netherlands	1.92	2.03	5.1
Norway	6.31	6.74	6.4
Portugal	139.70	140.88	0.8
Spain	113.58	123.56	8.1
Sweden	6.00	6.34	5.5
Switzerland	1.42	1.49	4.7
United Kingdom	0.55	0.61	9.8
West Germany	1.71	1.80	5.0
Weighted Average (Base 1980 = 100)	118.41	125.52	5.7
Japan	126.24	144.51	12.6

*Estimated

Source: IMF
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DATAQUEST'S EUROPEAN SEMICONDUCTOR INDUSTRY CONFERENCE: "PLANNING AND POSITIONING FOR THE '90s"

SUMMARY

Dataquest's seventh annual European Semiconductor Industry Service Conference was held recently at the Gleneagles Hotel, Auchterarder, Scotland. The theme of the conference, "Planning and Positioning for the '90s," provided an excellent opportunity for discussing how to succeed in the European marketplace at the start of an era in which Europe will truly begin to operate as a united community and a unified marketplace.

Many key issues were discussed, including:

- ASICs
- Distribution
- Trade agreements
- Deregulation
- Mergers

This newsletter summarizes the information presented at the conference.

SPEAKER HIGHLIGHTS

The following extracts are highlights from the conference presentations.

- **"World Economic Overview"—Joseph Duncan, Corporate Economist and Chief Statistician, Dun & Bradstreet Corporation**

  - There will not be a recession this year, but unless the United States corrects the federal deficit in the first two quarters of 1989, there will be economic problems later next year.

  - However, there are "realistic scenarios" in which a recession could develop as early as this summer, e.g., massive divestment of dollars by foreign investors, a drop in consumer confidence, or a jump to $30 a barrel of oil.

  - The Dun and Bradstreet projection for economic growth in the United States is 3.6 percent for this year and 2.2. percent for next year.

- **"Planning and Positioning for Partnerships"—Pat Brockett, Managing Director Europe, Vice President, Semiconductor Division, National Semiconductor Corporation**

  - Between 1982 and 1986, the growth rate of major Japanese electronics companies was three times that of the major European electronics companies. In the same period, the Japanese companies maintained a semiconductor content in their end products worth 16 percent of the overall equipment. The semiconductor content of Europe-produced equipment was only 5 percent in this period.

  - Consequently, it is a fair assumption that there is a connection between usage of semiconductors and growth in the electronics equipment market.

  - Accordingly, companies without their own semiconductor capability should get closer together with semiconductor vendors to maximize the competitive advantage they can gain through innovative use of semiconductors.

- **"Manufacturing Excellence for Total Consumer Satisfaction"—George Bennett, General Manager (MOS 9), Motorola Semiconductors Limited**

  - Total customer satisfaction means taking care of the customer's requirements from the time he identifies a need until that need is completely satisfied.

  - A vital element in this is manufacturing excellence, to which the key is cycle time, i.e., the time from when a customer expresses a need for a product to the point at which that need is satisfied.

  - Motorola has mapped the manufacturing cycle in detail and by so doing has eliminated non-added-value activities, previously invisible administrative inventory banks, and other delaying factors to cycle time.

- **"Procurement in the 1990s"—Peter V. Durant, European Vendor Engineering Manager, Digital Equipment Company Ltd.**
  - Purchasing will become more of an automated function in the 1990s with the use of more advanced technology tools making procurement more of a performance-driven function.
  - Digital Equipment Corporation has an artificial intelligence system that evaluates whether a customer is ordering the best solution to his problem. The system often identifies better ways of doing things than the customer realizes exist.
  - As a "multinational citizen," Digital Equipment Corporation will buy products wherever in the world it builds or sells them. Supplier-customer relationships will get closer in several respects: sharing technology road maps, linking plans on product migration, matching their quality program, and sharing data.
  - Such relationships will be longer and fewer than previous supplier/customer relationships.
- **"ASIC Technologies Are Catching up with European Application"—G. Wesley Patterson, Executive Vice President, Xilinx Incorporated**
  - Standard off-the-shelf logic has not kept up with the integration levels achieved by memories and microprocessors. Hence the increased use of application specific integrated circuit (ASIC) as a way of bridging the technology gap. Europe has lagged behind America and Japan in ASIC usage. While Europe uses more standard logic than ASIC, the United States and Japan use more ASIC than standard logic. A reason for this is the predominant use of ASIC in data processing and consumer electronics, which are U.S. and Japanese, but not European, areas of strength.
  - Europe's strength is in telecommunications and industrial applications, and conventional ASICs have not addressed the ASIC needs of these market areas. ASICs have risks attached to them compared to standard products: higher design costs, increased design change costs, longer development times, delays, and inflexibility of response to changes in production requirements.
  - Ideal ASIC products for Europe would be standard off-the-shelf products that can be tailored by the user—so long as these devices could provide equivalent speed and density to other ASIC solutions and be cost competitive with them. Emerging technologies are solving these problems to the extent that user-programmable ASICs could take 80 percent of the gate array market by 1992.

- **"Automotive Electronic Systems"—Peter Thoma, Manager, Electronics Department, BMW AG**
  - Semiconductor vendors are unable to fulfill the requirements of the automotive manufacturers. The semiconductor industry is geared to the needs of the data processing industry, not the automotive industry, which is why 50 percent of the components in automotive electronics systems are discrete components.
  - The automotive industry needs more integrated silicon solutions capable of handling a power supply that varies from 6V to 16V, can jump start to 25V, and offers protection to withstand +/-150V surges. MOSFETs seem to be the best way of achieving that goal.
  - Special timer structures, A/D converters, special I/O, improved CPU performance, and enlarged RAM and ROM are what the automotive industry wants to see.
  - Two things are needed to move ahead:
    - Close collaborations between semiconductor vendor, car manufacturer, and electronic subsystems manufacturer
    - Faster, more economical, and more flexible development vehicles for chip development (A four-month delay for ROM masks is unnecessary.)
- **"Positioning Internationally"—Tsuyoshi Kawanishi, Senior Vice President and Director of the Board, Toshiba Corporation**
  - Positioning internationally involves cooperation, respect, and trust for each other in trying to reach the goal of globalization. "Culture will last longer than civilization," he said. Understanding each other's culture is necessary to achieve harmony in the industry.
  - An important cultural difference between the U.S. semiconductor industry and the Japanese semiconductor industry is the relative importance given to the role of the operator. Whereas in the United States the managers and engineers are very strong in internal decision making, in Japan the operators have a strong role.
  - The U.S. system works in good times but exacerbates problems during a recession. "In good times, there are no complaints from the SIA. In recession times, many many complaints come from the SIA to Japan," he added.
  - Toshiba seeks international horizontal and vertical alliances; the former with other semiconductor companies, the latter with suppliers and customers. It is establishing worldwide design centers and a worldwide computer network for just-in-time manufacturing.

- **"Personal Computing in the '90s"—Dennis W. Andrews, Laboratory Director, Entry Systems Division, IBM Corporation**

  - The PC is the "window of the information age," and the window is constantly being upgraded. The target set for the IBM PS/2 was that is should be five times more reliable than the IBM PC. The trend is toward more mips, more memory, and more bandwidth.

  - The PC business is "waiting on technology"—the applications are there waiting for the technology to come along. Exponential increases in memory, size, data path, clock speed, memory speed, storage, and graphics can all be expected.

  - The PC of tomorrow will be a mainframe on a desk. It will be a multienvironment, multiprocessor machine with complex connectivity, improved reliability, and enhanced human interface. Storage devices will be intelligent controllers. Erasable optical memories will not replace magnetics but will address new applications.

  - Improved communications will mean higher bandwidth (using fiber) and ISDN applications. Improved human interface will involve better resolution, more colors, vector assists, image compression, graphics subsystems, full-motion video, sound, speech recognition, handwriting/gesture recognition, eye tracking, and artificial intelligence.

- **"Outlook for 1992"—Christopher Wilkinson, Head of Division Strategy for Information Technology and Telecommunications, Commission of the European Communities**

  - The cost of maintaining national domestic rather than European standards and practices is ECU 77 billion. It represents a significant reservoir of unexploited growth that the 1992 unified market could tap.

  - The EEC is trying to help with the necessary Europe-wide process of standardization. Three years ago, it began a major program of third-party testing that will be recognized throughout the Community.

  - The EEC direction in the telecommunications industry is toward liberalization of terminal equipment, liberalization of services, and open network provisions to allow anyone to provide services to the network.

  - An EEC initiative in semiconductors is asking member states to adopt legislation recognizing the rights of ownership over the topography on a chip.

- **"Closing the Application Gap; Bringing ASICs to the Mass Market"—Cees W.M. Koot, Managing Director and Chief Executive Officer, Integrated Circuits Business Unit, Philips International BV**

  - How can manufacturers speed up the hitherto sluggish adoption of ASICs? Philips has identified five areas that ASIC vendors should address:

    - There is a shortage of applications know-how among ASIC suppliers. Customers need to be spoon-fed with ASIC product knowledge at the function level—not at the gate design level.

    - ASIC projects take a lot of time and money; therefore, supplier stability is vital to the success of ASIC business in Europe.

    - There is no clear migration path from programmable logic to gate arrays and beyond, and little help for migrating from, for example, 1.5 microns to 1.2 microns.

    - There is a need for more vendor responsiveness, which means more effort in setting up design centers and technical support centers where customers can get easy access to ASIC services.

    - The customers are concerned about three things: the quality of the building blocks and library cells on offer; the quality of the design processes; and the quality of the manufacturing processes. All affect the quality of the final product.

  - To solve these five problems, Philips recommends cooperation among ASIC vendors. Cooperation should be in offering cells based on common design rules and processes, in providing design tools that let customers start with low-end workstation vendors, and in encouraging a proliferation of new small design houses in Europe.

- **"Planning a Road Map for Distribution"—Gary Kibblewhite, Managing Director, LEX Electronics U.K.**

  - Sales through distribution represent a significant portion of the total sales in the three major semiconductor markets in Europe. In the last five years, distribution sales in these markets have accounted for between 29 percent and 34 percent of total sales.

  - Larger players are dominating the market: in the U.K., six companies have 75 percent of total sales; in Germany, four companies have 45 percent; in France, six companies have 76 percent; and in Italy, four companies have 60 percent. More mergers are on the way.

  - These larger companies will be suitable vehicles for providing sophisticated added-value services, particularly for ASIC distribution. The growing need for more technical support from distributors has resulted in there being 60 field application engineers in the United Kingdom, each costing more than $400,000 per year.

  - The questions facing distributors are: Will they become pan-European? Can they adopt an entrepreneurial, highly skilled, highly rewarded management style?

- **"The Future of the Semiconductor Industry"—Bujirou Kobyashi, Senior Managing Director Electronic Devices Group, Mitsubishi Electric Corporation**

  - Forecasting of the demand and supply in the semiconductor industry and the rate of return on investment (now about 0.7 percent) must be improved.

  - Between 1988 and 1997, about $292 billion will be invested worldwide in semiconductor R&D and production. That figure does not include investments in all the ancillary support industries like wafer production, masking, packaging, chemicals, gases, metals, photoresists, manufacturing equipment, cleanrooms, water, and power supplies—all for a market not expected to reach $132 billion until 1997. The investment must be made effectively. In the past, demand and investment have not been in sync. The only way to get it into sync would be to establish an authority that would coordinate international cooperation to achieve controlled growth instead of the boom/bust cycle.

- **"ASICs in the '90s"—Tony Holbrook, President and Chief Operating Officer, Advanced Micro Devices**

  - Programmable logic devices (PLDs) are the "ultimate ASIC" because they allow customers to tailor the devices precisely to their own use. They will make major inroads into the gate array market.

  - Why haven't they already done so? Because of insufficient density and the slower system speeds associated with PLD compared with gate arrays. This year, Xilinx produced a device with 9,000-gate density, which should increase to 50,000 gates in the 1990s.

  - The primary constraint on achieving the system speeds of gate arrays is the delay inherent in the signal routing circuitry. A solution to that is being sought.

  - Incorporating memory blocks on a PLD is a necessary innovation before high gate counts can be achieved. Although this is not technically possible at the moment, it will be in the future.

- **"Consumer Electronics"—Sven Markelin, General Manager of Euro Unit, Nokia-Mobira OY**
  - The cellular radio market has been bedeviled by lack of standardization. The world has seven different standards: NMT, TACS, AMPS, NETC C, R 2000, NTT, and RTMS. Nonetheless, the cellular radio market has had annual growth of 85 percent in unit terms for the past six years. However, eroding prices have meant little growth in terms of money.
  - The cheapest place in the world to get onto the network is the United Kingdom, where you can have an installation for $700. It is almost twice as expensive in Germany. A cheap installation boosts the market because the cost of the initial investment is seen as the biggest barrier to expansion. In the United Kingdom, equipment makers make their profits on the kickbacks from the operators, not from the equipment sales.
  - The United Kingdom also has cheapest cost of use—$1,500 compared with $2,500 in the United States. This is because there are 20 manufacturers in the United Kingdom and two competitive network operators.
  - The market for cellular mobile telephones is expected to double to 2.5 million analog units by 1991. There is talk of a digital system based on a common European standard after 1992, which would mean that by 1995 it may be possible to use a pan-European cellular phone from one corner of Europe to the other.
- **"Managing the Mergers"—Pasquale Pistorio, President and Chief Executive Officer, SGS-Thomson Microelectronics**
  - More mergers between semiconductor companies are inevitable because of the structure of the industry. The current structure sees the top 50 companies divided into three layers:
    - A top group of 11 large companies that have 63 percent of the market; each of the 11 has a market share of around 4 percent.
    - A middle layer of nine companies that are "too big to be small and too small to be big." They are AMD, Siemens, SGS-Thomson, Sharp, General Electric of the United States, Sanyo, Oki, Rohm, and Sony.
    - A bottom layer of 30 companies, each of which has a market share of around 1 percent.
  - It is from the third group that the new wave of mergers will come. The result will be that in 1997 the industry will have between 11 and 14 companies. These companies will account for 70 percent of the world market, processing a market share of between 5 and 6 percent on average, and each of them above 4 percent market share.

- Factors such as the high intrinsic cost of research will make it almost impossible for small companies to survive. Small specialist companies are not likely to get above a 0.5 percent (worth $500 million) share of the 1997 market.

- As for SGS's own merger with Thomson, the past year has seen the closure of five factories and the transfer of 100 production processes. This has been achieved without loss of market share. The loss for the first quarter of 1988 will be one-third the loss for the first quarter of 1987, and there will be an operational profit in the second half of 1988, when sales will exceed $1 billion.

Jennifer Berg

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1992—WHAT'S IN A NUMBER?

SUMMARY

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

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

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

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

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

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

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

(Slide 1)

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

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

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

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

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

(Slide 2)

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

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

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

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

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

(Slide 3)

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

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

(Slide 4)

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

(Slide 5)

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

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

(Slide 6)

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

- First, trade and the fact that this has become now largely deficit driven. Large regional trade imbalances are no longer politically or commercially an acceptable way of life.
- Second, macroeconomic policy—it ripples around the world. We worry about the size of the U.S. budget deficit, the fact that Germany remains unwilling to stimulate internal demand, and whether or not Japan really will open up its markets.
- Third, currency fluctuations are a real wild card. How do you plan where to build new factories in an environment where an exchange rate variance can render them uncompetitive overnight, even before they have come on stream?
- Fourth, international competition. That situation will continue to intensify.
- Fifth, direct and indirect investment. Do I manufacture or buy the component or service I need? Will this be via an outsourcing agreement or via a joint venture?
- Sixth, foreign capital flows. The excess liquidity at the global level slopping around the world seeking the best interest level or return is 26 times bigger than the total of all world trade put together. It is no longer trade factors that determine exchange rate values today—it is excess liquidity.
- And, finally, information transfer. It is far easier than ever before, since financial transactions etc. are knitted together by instantaneous communications.

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

(Slide 7)

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

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

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

(Slide 8)

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

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

(Slide 9)

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

(Slide 10)

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

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

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

(Slide 11)

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

(Slide 12)

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

(Slide 13)

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

(Slide 14)

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

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

(Slide 15)

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

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

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

(Slide 16)

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

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

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

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

(Slide 17)

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

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

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

(Slide 18)

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

(Slide 19)

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

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

(Slide 20)

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

(Slide 21)

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

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

(Slide 22)

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

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

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

(Slide 23)

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

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

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

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

(Slide 24)

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

(Slide 25)

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

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

(Slide 26)

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

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

(Slide 27-29)

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

(Slide 30)

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

(Slide 31)

I mentioned this briefly earlier in my talk, but the implication of the previous slide is that as a result of the changing supplier/manufacturing relationships, foreign companies operating in Europe will progressively move down the so-called "value added" manufacturing chain, from sales, moving rapidly through pure assembly (or screwdriver operations) down to design, development, real local manufacturing, and local procurement, to eventual export of original European conceived and manufactured products. IBM is probably the best established in this regard at the present time, though other foreign companies, notably Digital and Sony, are catching up fast—the trend is inevitable. Given the 1992 deadline, we expect an acceleration of this trend as foreign companies strive to become good Europeans before the internal trade barriers fall.

(Slide 32)

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

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

(Slide 33)

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

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

(Slide 34)

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

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

(Slide 35)

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

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

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

(Slide 36)

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

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

(Slide 37)

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

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

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

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

Malcolm Penn

(Slide 1)

1992: HAS EUROPE GOT IT?

MALCOLM G. PENN

VICE PRESIDENT

DATAQUEST EUROPE

(Slide 2)

1992

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

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

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

JACQUES DELORS - EEC PRESIDENT - 20 JANUARY 1988

(Slide 3)

POSTWAR WORLD ECONOMIC RECOVERY

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

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

The Single European Act will turn the tide

(Slide 4)

TRADE BARRIERS -- EUROPE

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

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

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

(Slide 5)

1992 IMPACT

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

(Slide 6)

NEW ECONOMIC ERA - GLOBALIZATION

Seven factors on global economy

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

(Slide 7)

THREE PHASES OF SEMICONDUCTOR INDUSTRY

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

(Slide 8)

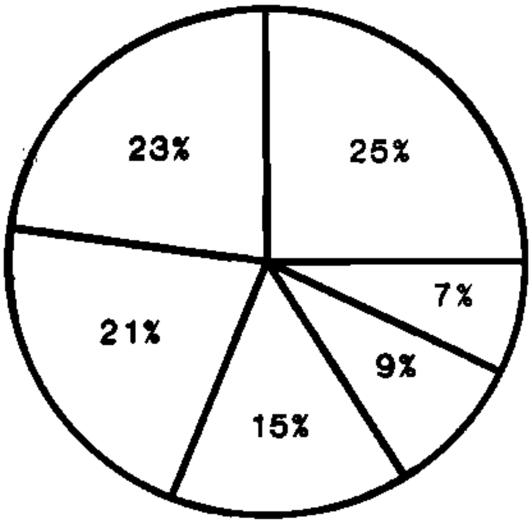
POSITIONING INTERNATIONALLY

Means sharing internationally

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

(Slide 9)

EUROPEAN SEMICONDUCTOR MARKET BY END-USE SEGEMENT - 1987



☐ Communications
☐ Data Processing
☐ Industrial
☐ Consumer
☐ Military
☐ Transportation

Total = $6,355 Million

Source: Dataquest

(Slide 10)

EUROPEAN COMPONENTS GROUP

Telecommunications

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

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

Source: Dataquest

(Slide 11)

EUROPEAN COMPONENTS GROUP

Computers

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

(Slide 12)

EUROPEAN COMPONENTS GROUP

Industrial

- Medical
  - GEC/Philips venture abandoned

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

(Slide 13)

EUROPEAN COMPONENTS GROUP

Consumer

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

(Slide 14)

EUROPEAN COMPONENTS GROUP

Military

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

(Slide 15)

EUROPEAN COMPONENTS GROUP

Transportation

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

(Slide 16)

EUROPEAN END-USE VENDOR RANKINES - 1987

(Millions of US Dollars)

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

Source: Dataquest

(Slide 17)

EUROPEAN END-USE VENDOR MARKET SHARES - 1987

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

TOP 5 EUROPEAN COMPANIES CONTROL 38% OF THE MARKET

Source: Dataquest

(Slide 18)

JAPANESE PRINTER MANUFACTURER SURVEY

Expected Offshore Printer Production (Thousands of Units)

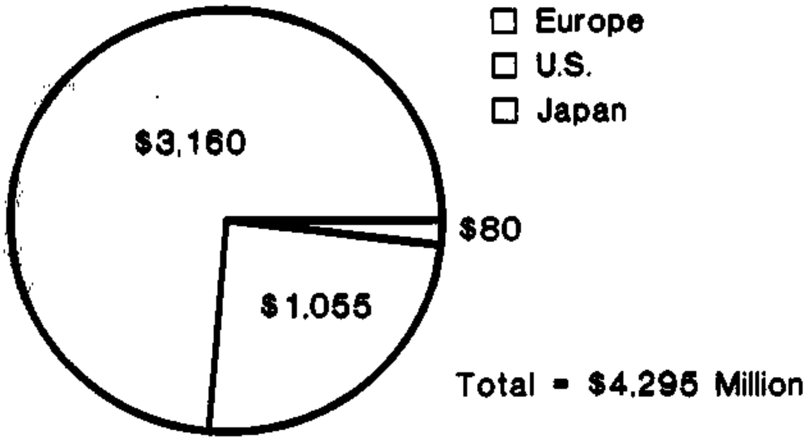
	1987	1988	1990
North America	205	500	850
Western Europe	92	1,245	1,740
Rest of World	3	5	10
Total	300	1,750	2,600

Source: Dataquest

(Slide 19)

ESTIMATED EUROPEAN SEMICONDUCTOR PRODUCTION IN 1987

(Millions of U.S. Dollars)



Source: Dataquest

(Slide 20)

1987 REGIONAL MARKET SHARES

(Billions of US Dollars)

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

Source: Dataquest

(Slide 21)

1987 EUROPEAN EXPORTS

(Millions of US Dollars)

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

Source: Dataquest

(Slide 22)

IN THE BEGINNING - ESPRIT

Of the 227 projects in first phase

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

(Slide 23)

EUROPEAN SEMICONDUCTOR MERGEOVERS

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

(Slide 24)

CELLULAR RADIO - SCANDINAVIAN EXAMPLE

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

(Slide 25)

stack

STANDARD COMPUTER KOMPONENTEN GmbH

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

(Slide 26)

VENDORS - USERS
CLOSER CO-OPERATION - TO ACHIEVE

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

(Slide 27)

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

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

(Slide 28)

FORMAL MEETINGS

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

(Slide 29)

SUPPLIER/CUSTOMER RELATIONSHIP

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

(Slide 30)

VALUE ADDED MANUFACTURING CHAIN

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

(Slide 31)

MULTINATIONAL CITIZEN PROFILE

Buy where we build and sell

- Products
- Services
- Technology
- Jobs
- Export

(Slide 32)

MAJOR MARKET OPPORTUNITIES

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

* Measured in dollars

Source: Dataquest

(Slide 33)

EUROPEAN ELECTRONICS INDUSTRY

Future Trends

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

(Slide 34)

EUROPEAN ELECTRONICS INDUSTRY

Future Trends

- Europe will have state-of-the-art processing capability
  - Esprit, Eureka, Megaproject, Jessi

- European Community will ensure:
  - Multinationals sourcing components locally
  - Collaborative R & D on all fronts
  - Maintaining strong manufacturing base

- Europe
  - Still strong in consumer, automotive
  - Telecommunications will get stronger
  - Stability in military market

(Slide 35)

ARE WE FACING EVOLUTION OR REVOLUTION?

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

(Slide 36)

HOW TO ORGANISE A REVOLUTION

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

Source: Marx, Lein, Mao

(Slide 37)

THE 1992 CHALLENGE

HIGH STAKES FOR EUROPE -

THE PRIZE WITHIN THE GRASP

ESIS Code: Vol. IV, Newsletters
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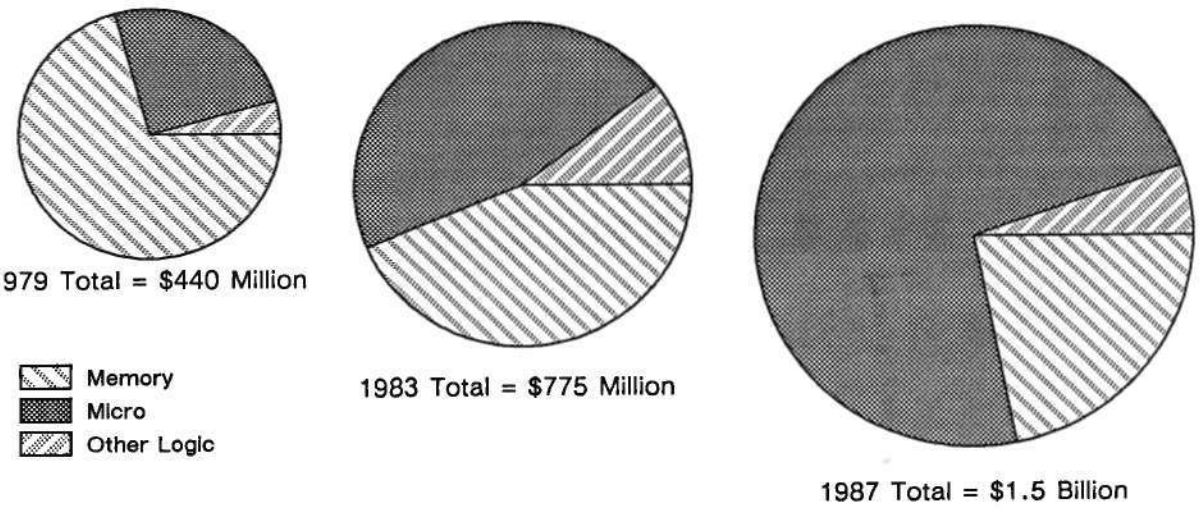
INTEL TURNS TWENTY: IS THERE LIFE AFTER DOS?

SUMMARY

The past 20 years for Intel Corporation have been characterized by technological leadership and product innovation. During this period, however, the company has changed dramatically in scope and structure. A quick look at Figure 1 reveals the changes that Intel has experienced in terms of product mix—changes wrought by a watershed event in the history of Intel and the entire semiconductor industry: the development of the personal computer market.

Figure 1

Intel's Semiconductor Revenue by Product Category



Source: Dataquest
June 1988

From its position today of worldwide microcomponent preeminence, Intel is now formulating its strategy for a future that looks very different from the past—a future in which the company will face increasing challenges to its market share in standard microprocessor platforms, and in which the ownership of the DOS market may not imply the same rewards as it has in the past.

This newsletter provides an update on Intel through a summary of the following factors:

- Current financial standing
- Capital spending plans and changes in production capabilities
- Positioning in key product areas

More importantly, this newsletter looks at some significant challenges that face Intel in the rapidly changing microcomponent market and at ways in which the company is addressing these challenges. Some of the information was obtained at the company's recent shareholders' meeting in Albuquerque, New Mexico.

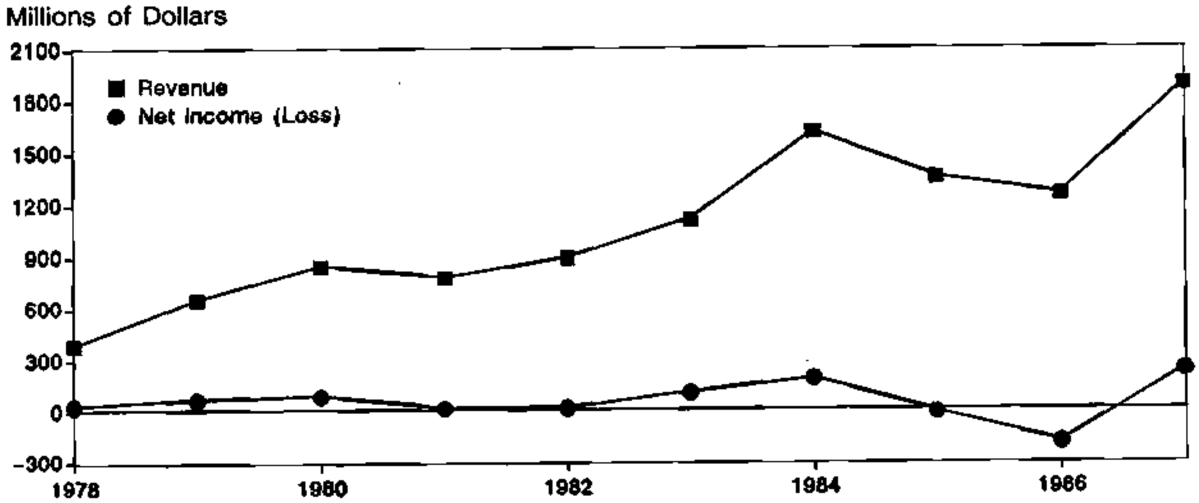
FINANCIAL SUMMARY

Having just weathered two difficult years, Intel is enjoying the fruits of a very bountiful 1987. Financial results for 1987 marked the fifth year in a row the company reported net revenue of more than $1 billion as shown in Figure 2. With 1987 total net revenue of $1.907 billion, Intel is now poised on the brink of the $2 billion mark. The company's 1987 semiconductor revenue of $1.5 billion ranked it as the eighth largest semiconductor supplier in the world.

Intel's business continues to accelerate. With record revenue of $636 million for the most recent quarter ended in March 1988, the year ahead promises to be a banner one. Revenue per employee for 1987 was $100,000, and first quarter 1988 results put this figure at $132,000. (Between 1978 and 1986, Intel's revenue per employee averaged $55,000.)

Figure 2

Intel's Net Revenue and Net Income (Loss)
10–Year History



Source: Intel Corporation

CAPITAL SPENDING PLANS

Over the past 10 years, Intel's R&D expenditures have consistently been more than 10 percent of revenue. Capital expenditure in 1987 was approximately $302 million, almost double the amount in 1986. Capital expenditure in 1988 is pegged at $450 million, which will put this investment above 1984's record spending of $388.5 million for the first time.

Intel's pioneering effort to facilitize Fab 7 in Rio Rancho (Albuquerque), New Mexico, as the world's first 6–inch fab was an expensive activity. The selection of Albuquerque for the annual shareholders' meeting was significant. It is not only the site of Fab 7, now the company's largest silicon–producing fab, but is also the location of its newest fab, Fab 9.1, which is on the verge of producing the lucrative 80386 microprocessors.

Current investments are directed at upgrading Fab 7 and completing Fab 9.1, the first module of Fab 9. At the annual shareholders' meeting, the company announced that it has approved plans to complete work on the next module at Fab 9, Fab 9.2. Thus, 1989 is expected to be another big year for capital investment. Fab 9.2 is estimated to require $95 million to cover facility and equipment costs and is expected to be complete and producing by the end of 1989.

PRODUCTION PLANS

Each of the four modules at Fab 9 will comprise 25,000 square feet of Class 1 clean room. The phased–capacity approach promulgated by Intel means that a module a year could be added over the next few years. The equipment in Fab 9.1 has been qualified for production and is expected to be running at volume levels by late this year. The target by the end of the year is about 800 wafer starts per week, less than one-third of the final target when the fab is fully facilitized. The process for producing the 80386 has been fully characterized and debugged at Fab 4 in Aloha, Oregon, where there is a duplicate model of Fab 9.1.

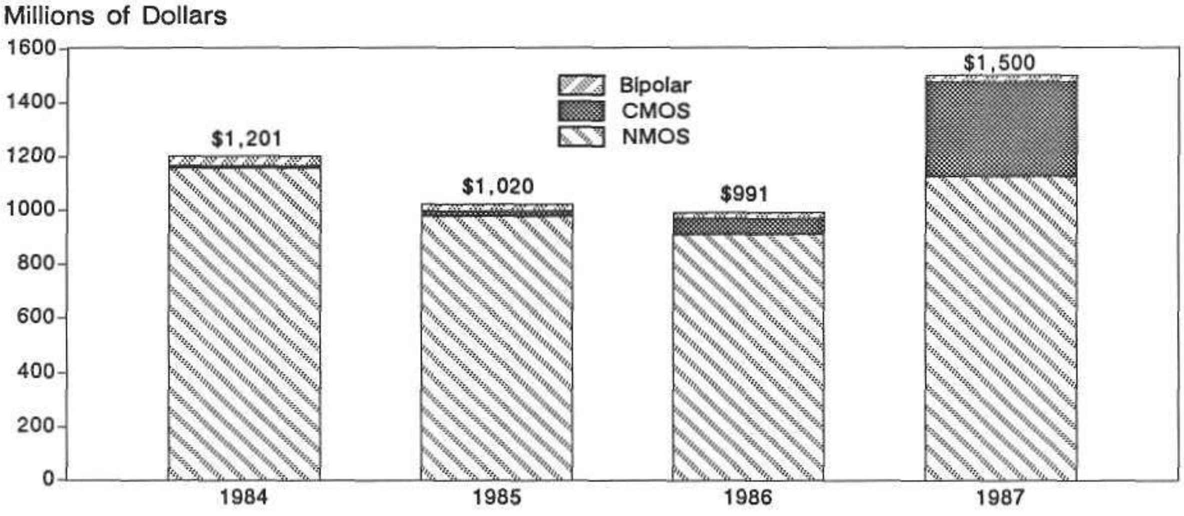
Currently, Fab 7 at Albuquerque accounts for 25 percent of Intel's total silicon output. It has 36,000 square feet of Class 10 clean room and boasts 1-micron CMOS technology. Revenue based on CMOS products only became a significant contributor to Intel's business in 1987, as illustrated by Figure 3.

About 75 to 80 percent of Intel's production capacity is at the 1.5-micron feature size, less than 5 percent is at 1 micron, and the remainder is at 2 microns or greater. Future generations of technology will be developed at the company's Development Center in Santa Clara now under construction.

Intel's manufacturing focus emphasizes total quality control. One element of this effort to achieve greater reliability and productivity is the implementation of integrated automation solutions. The importance being accorded to statistical process control at Intel signals a change in attitude for the company and is an indicator that it is working towards its goal of being a world-class manufacturer.

Figure 3

Intel's Estimated Semiconductor Revenue Based on Process Technology (1984-1987)



Source: Dataquest
June 1988

KEY PRODUCT AREAS

Microcomponents—Still the Leader

Intel continues to be the world's leading supplier of microcomponents. Revenue from Intel's microcomponents business is estimated to be $1,098 million for 1987, reflecting growth of approximately 75 percent over the prior year. Its nearest competitor, NEC, has 1987 estimated microcomponent revenue of $629 million, which is equal to Intel's 1986 microcomponent revenue. Figure 4 shows Intel's market share in microcomponents over the past nine years.

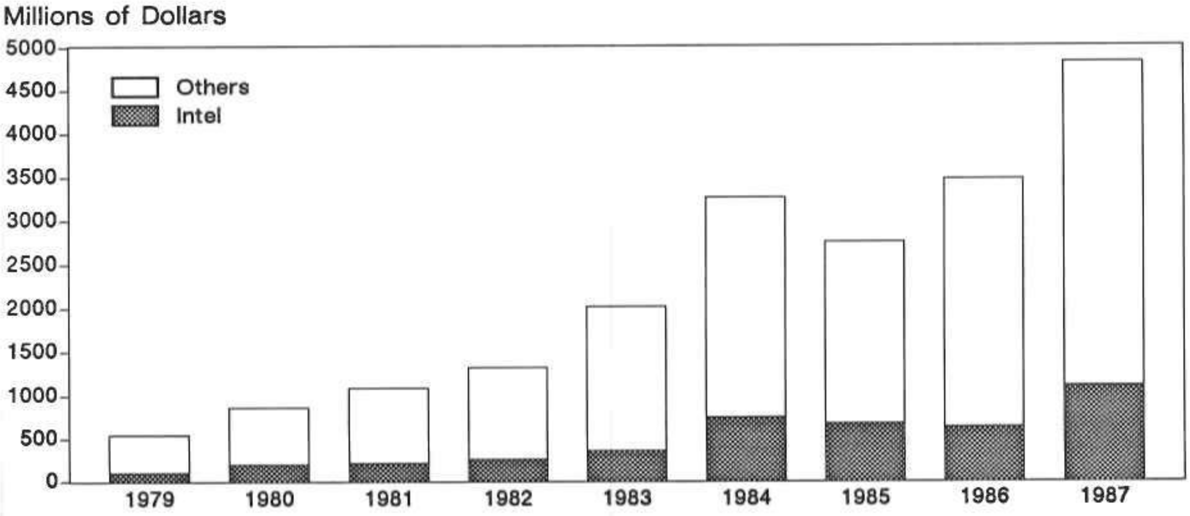
To generate growth in 1988, the company plans to increase the pace of its product introductions, and continue its efforts to become more streamlined and automated. New product announcements in 1988 will include six new 32-bit microprocessors (MPUs), four of which have already been unveiled. One more of these is due in the summer, and the last one is anticipated in the fall.

Intel plans three strategic thrusts that relate to the microcomponent portion of its business. The targets of these thrusts are:

- Embedded control
- Super chip sets
- Computer platforms (systems perspective)

Figure 4

Intel's Share of Total Worldwide Microcomponent Market



Source: Dataquest
June 1988

The targeting of these segments is predicated on Intel's extremely strong position in microcomponents. The 80286 has become a real workhorse of the personal computer (PC) industry. Intel's fortunes have been tied to the fate of the PC to the point that none of its traditional competitors has the same stake in the PC market as Intel does. According to Dataquest estimates, Intel shipped 4.7 million units in 1987, or approximately 60 percent of the total 80286 market. According to the company, shipment volumes are still holding up, and in fact, shipments in the first quarter of 1988 were as high as they had ever been. Figure 5 provides Dataquest's PC forecast, highlighting the proportions of the PC market that we expect to be claimed by the 80286 and the 80386.

Microprocessors: Life After DOS?

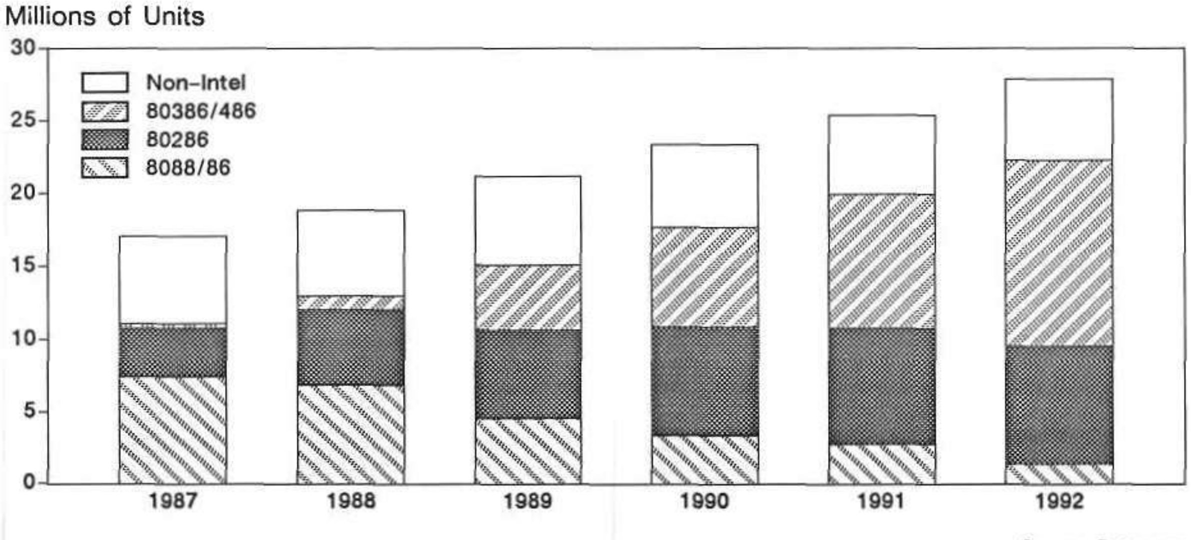
With four new 32-bit microcomponent products and two more major announcements to be made this year, how far can Intel take this architecture and still add value?

IBM's future architectural plans will certainly impact Intel's future microprocessor development strategy. Currently, it is widely claimed that IBM is not manufacturing the 80386, and its agreement with Intel requires that it buy the lion's share of its 80386 needs from Intel. However, IBM does have rights to modify the 80386 core. IBM's desire to defend its market share position from the clone makers might create a dilemma for Intel. If a modified 80386 chip were proprietary to IBM, this might impact the future 80486, which Intel would presumably wish to sell to as wide a market as possible. Intel sources claim that the 80486 is not slated for introduction this year.

This is part of the larger question that Intel faces in looking forward; namely, is there life after DOS and what does it look like? Of growing interest, therefore, is the emergence of software emulation products that allow DOS applications to run on previously non-DOS-compatible platforms. With these products, users can make their system selections based on need without sacrificing DOS compatibility.

Figure 5

Five-Year Worldwide PC Shipment Forecast



Source: Dataquest
June 1988

This trend takes on increased importance in the nebulous and merging world of PC–meets–workstation. Dataquest observes that technical workstation technology is destined to decline in price to the PC range within approximately three years. Moreover, if one considers what Intel's competition is doing, we see a host of companies lining up for the most part along RISC–based architectural platforms that offer a standard operating system environment such as UNIX. In the past, the necessity of DOS compatibility benefited Intel by keeping systems engineers on an upward migration path from one generation of Intel MPU to the next. Current trends in the high–end PC/workstation market would make the question of upward architectural compatibility a moot point, in light of increasing software independence of hardware.

Intel could effectively respond to the frantic ongoing RISC activity in the marketplace by leapfrogging the competition with a performance solution. This could mean exploring options such as BICMOS or ECL implementations of products. Additionally, we believe that the company's experience in the systems side of the business could also stand it in good stead.

Leveraging Its Strengths. Clearly in the DOS–based world, Intel has the advantage, not just because DOS is a standard for PCs, but also because the PC market is a volume market. Although this market has become more volatile than it used to be, we expect that Intel will continue to reap dividends from it in the future. Intel believes that it can achieve increased levels of penetration in both the domestic and international PC markets.

Intel president Andrew Grove promotes the notion of the "Volkscomputer." He has indicated a desire to achieve in the computer world what was achieved by the Volkswagen (car of the people) in the automotive world—a machine for the masses. With pricing for the 80286 in the $25–$45 range and for the 80386 in the $250 to $300 range, the company certainly has a wide variety of product prices. In fact, it needs more products at different price points in its MPU product portfolio if it intends to be the instigator of the "Volkscomputer." Development of the "PC–as–commodity" market relies heavily on Intel's approach, and the current pricing of the 80386 does not support such a strategy. With limited second–sourcing on the 80286, none for the 80386 (and possibly likewise for future product introductions), Intel has nimbly sidestepped the issue of having to choose between market share and profits.

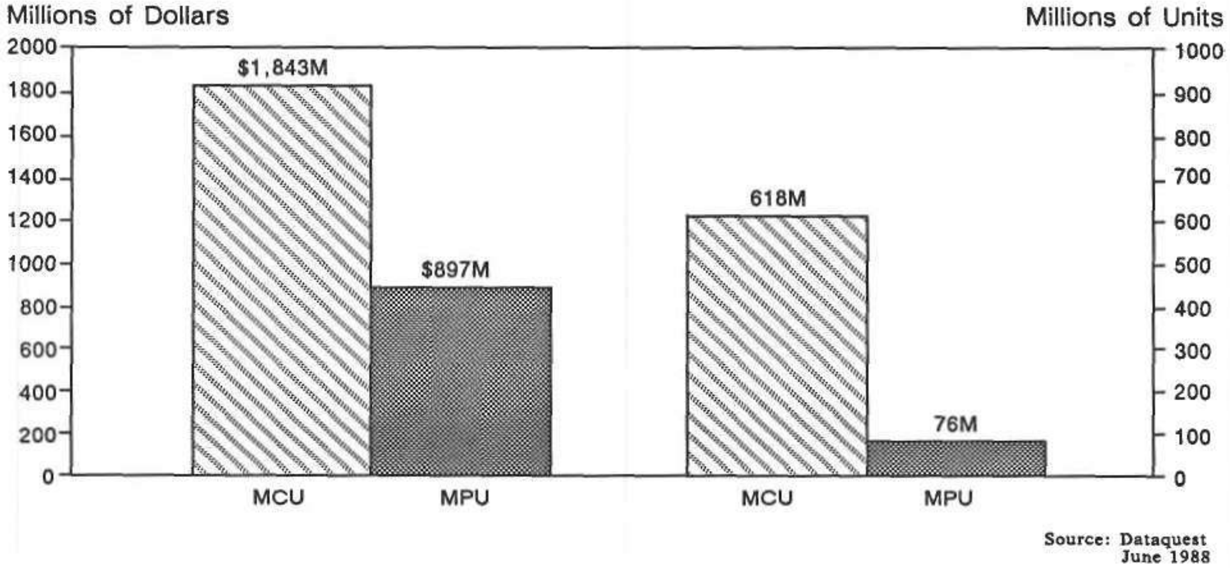
Microcontrollers—A New Strategic Significance

Intel has seen both the boom and the bust sides of the PC market. Realizing that so many of its eggs are in an increasingly volatile basket, the company has recently been emphasizing the embedded controller market. Although, seemingly less visible, this market is much larger than the reprogrammable market. The relative sizes of these two markets are compared in Figure 6.

Intel has spawned architectural standards in the microcontroller (MCU) market. However, its second sources have often surpassed it in the marketplace by delivering more cost–effective products. Apparently, this was not initially disconcerting to Intel, as it simply moved on to the next–generation product, which commanded higher ASPs. What became evident though, was that this strategy essentially limited Intel's growth by ignoring large chunks of business. Intel's participation in the 8048 market, as shown in Figure 7, illustrates this point.

Figure 6

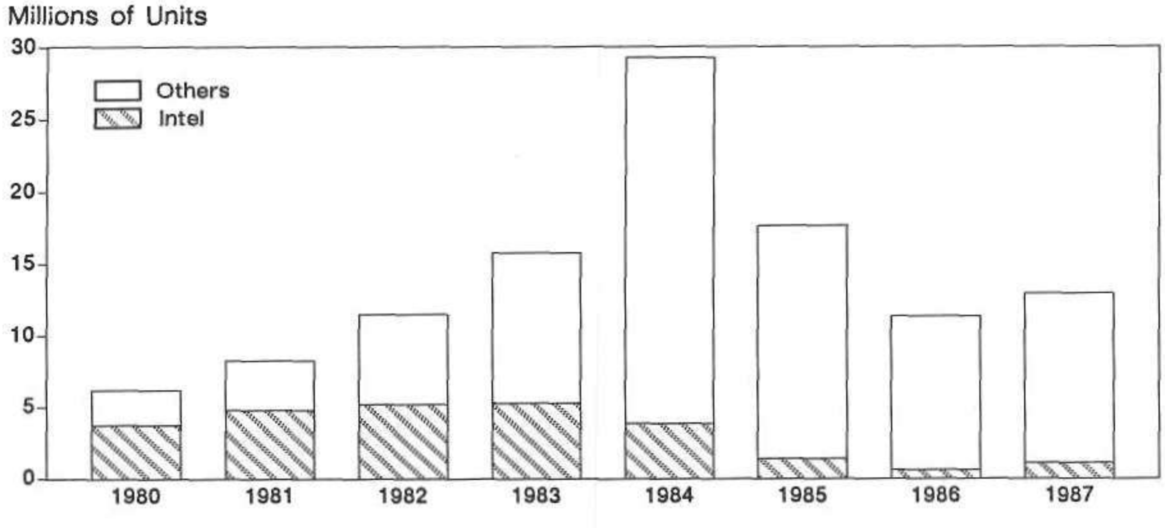
1987 MPU/MCU Comparison



Source: Dataquest
June 1988

Figure 7

Intel's Share of 8048 Market versus Competitors' Share (1980–1987)



Source: Dataquest
June 1988

The 8-bit MCU market is in a high-growth phase. Although two-thirds of the shipments are still in NMOS, Japanese suppliers now dominate the growing CMOS 8-bit MCU market segment. MCU devices can have very long product life cycles, as is evidenced by the continuing large sales of 4-bit microcontrollers.

To succeed in the MCU market, manufacturing capability is key. Embedded control design wins are usually extremely cost sensitive. Hence, Intel's objective of increasing its penetration in this market segment necessitates very strong manufacturing capability. To this end, the company did decide to subcontract out production of some of its 8048/8049 production to a low-cost Korean supplier.

Besides lowering costs, another component of Intel's MCU strategy emphasizes the targeting of specific applications. Because of this, a microcontroller design win often dictates a close supplier/vendor relationship. As an example, development of the 8096 emerged from the company's relationship with Ford, Intel's second largest customer.

Another trend in MCUs has become evident—powerful microprocessors with even greater on-chip functionality, such as the 80186, are penetrating sophisticated nonreprogrammable applications. To carry this to its next logical step, microprocessor and microcontroller cores can be made more application-specific depending on the choice of on-board functions. We now see a proliferation of products based on this approach. In April, Intel introduced three devices based on a 32-bit core architecture; known as the 80960 series, which incorporates RISC design techniques; and the 80376 embedded processor, a non-DOS-compatible derivative of the Intel 386 microprocessor.

We now see emerging from Intel a multitiered strategy that differentiates on one level between DOS and non-DOS applications. This differentiation is borne out organizationally in that Intel's non-DOS products are gathered under the designation ECO or Embedded Control Operations. This represents a stronger emphasis on Intel's part to diversify away from its traditional image of dependency on the PC market. Within the embedded control area there is further stratification of MCUs that target different types of activities described as system control (an 80286 controlling an 8096 and 80186), data control (an 80186 with on-chip peripherals to speed up data handling), and event control (an 8096 doing real-time control).

Simultaneously then, Intel is putting in place the resources to serve a high-volume, cost-conscious market while providing MCU-based products offering greater functionality. In the MPU arena, the complete solution usually takes the form of chip sets. It is equally clear that a complete solution approach in MCUs is also needed. We expect to see this from Intel as it concentrates on delivering solutions.

Microperipherals—The Weaker Link

The enormous success of the PC market engendered a market opportunity, quickly capitalized on by companies such as Chips and Technologies, which offered chip sets for standard PC configurations. Intel was slow to react to emerging trends in the chip set business. So lucrative is the microperipheral (MPR) segment that the prevailing wisdom advises giving away the CPU to get the peripheral business that goes with it.

One would have expected that no company could have had been better placed than Intel to exploit the MPR market or better placed to reap the benefits of the synergy between MPU and MPR product offerings. Peripherals offer great potential for value-added product differentiation. Intel did secure a second-source agreement with

ZyMOS for its 80286 AT-compatible chip set, and subsequently announced its intention to enter the market with its own Micro Channel-compatible chip set. These are steps in the right direction, and from Intel's stated intentions, we expect the company to place greater emphasis on this market segment in the future. Dataquest analysts speculate that Intel may leverage its strength in MPUs to increase its MPR business by seeking additional opportunities to promote sales of these products together in the future.

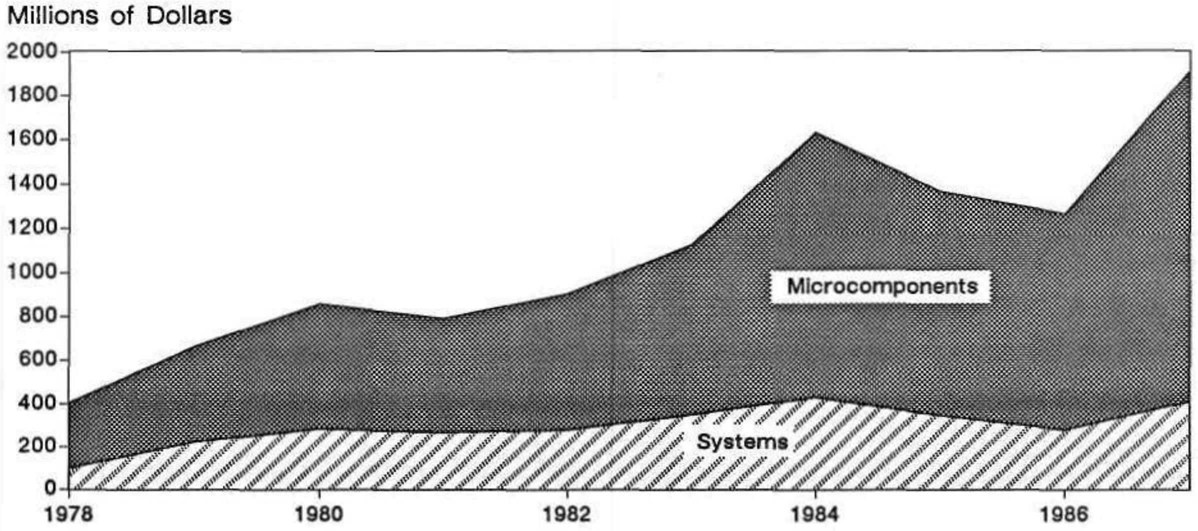
Systems—Increased Forward Integration

Intel's systems business operates with a very low profile, but with sales of almost half a billion dollars the business is of growing significance. Tribute was perhaps paid to this fact by announcing at the shareholders' meeting that Les Vadasz, senior vice president and general manager of the Systems Group, had been appointed to the Board of Directors. Figure 8 illustrates estimated systems revenue as a proportion of total company revenue. Because of this division's potential to impact future microprocessor decision making, it can be expected to play a more visible role in the company's future direction. Intel intends to grow this piece of the business so that by 1992, it will comprise about 50 percent of the company's total revenue.

As a delivery vehicle for Intel's chip technology and as a generator of value-added systems solutions, there is considerable synergy between the Microprocessor Components Division and the OEM Platforms Operation, as the Intel Systems Group is now called.

Figure 8

Intel's Estimated System versus Microcomponent Revenue



Source: Dataquest
June 1988

Memories—From DRAMs to Flash

Intel, which started out by producing memories, phased out of the DRAM portion of this market in 1986 and currently entertains no further DRAM aspirations.

What DRAM business it does participate in is generated by agreements with companies such as Micron Technology and Samsung to package and resell its memory parts. Intel's memory business is mostly in EPROMs; Dataquest estimates that the company's 1987 EPROM market share amounted to approximately 20 percent of the total, making it the leading supplier of these devices.

Intel announced two flash EPROM devices in April, a 64K and a 256K device that permit rapid bulk erase in 2 to 5 seconds, in contrast to the 15 to 20 minutes required to erase conventional EPROMs. This is an emerging area that is receiving attention from a number of vendors. Although, Intel does participate slightly in the EEPROM market, its product is based on technology from Xicor, so it is not clear at this point to what extent the company intends to offer E^2 memory capability as part of a value-added proprietary product.

ASICs

Since Jack Carsten, who headed Intel's ASIC efforts, left the company in early 1988, this area has been undergoing major reorganization. At the shareholders' meeting, Mr. Grove commented that growth in this business has been reasonable, but not as much as hoped for. Even that assessment may have been optimistic. It seems likely that the heavy demand Intel is experiencing for its standard products has had the effect of detracting from the ASIC effort, which is a very different business requiring more hand-holding and a longer gestation period before results can be seen. In light of the organizational volatility, the company may be reevaluating its strategy in ASICs, and it is possible that we could see a shifting of focus and direction within a year.

Intel's "official" entry into ASICs, through its 1986 gate array agreement with IBM, addresses one aspect of the ASIC phenomenon: logic consolidation. From the standpoint of systems integration, a higher value-added approach, Intel's MCU strategy is clearly "application specific"—a strategy that will be implemented through new generations of standard products. Dataquest believes that the extent to which Intel can harness ASIC technology to drive this thrust will be crucial to its success in the microcomponents area.

DATAQUEST CONCLUSIONS

As part of its annual meeting in Albuquerque on April 20, Intel included a brief retrospective of its 20 years in the semiconductor business. A series of slides flashed through the impressive careers of the company's founders: Robert Noyce, Gordon Moore, and Andrew Grove—a leadership nucleus that remains in place to this day.

Intel's renowned technological expertise has given it a major stake in one of the most phenomenal markets in the electronics industry: the personal computer. Intel must now address a future in which DOS compatibility may no longer be the only game in town, and in which new microprocessor architectures challenge its industry-standard products.

In facing these challenges, Intel's success equation demands that the company execute a cohesive strategy that meshes its core CPU product offering with peripheral products, addresses end-user requirements, and delivers a cost-competitive product. To achieve these ends Intel is stressing the following corporate goals:

- Continued extension of architectural and technological leadership
- Improved vendor status
- Achievement of world class manufacturer status
- Greater focus on employees

Given the enormity of its capital, technological, manufacturing, and human resources, Dataquest believes that Intel has the wherewithal to rise to these challenges, without overreaching itself.

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Jennifer Berg
Patricia Galligan

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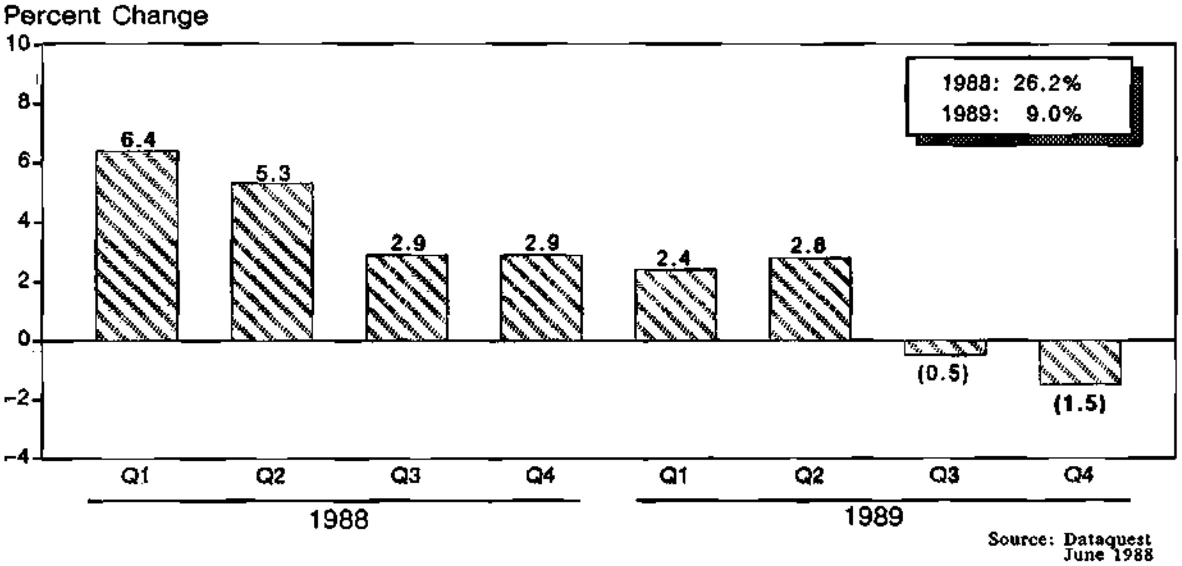
SEMICONDUCTOR RECOVERY GATHERS MOMENTUM

SUMMARY

The recovery in the worldwide semiconductor market should be stronger in 1988, as the Japanese and European markets continue to recover following the lead of the North American and Rest of World markets. Dataquest forecasts that the worldwide semiconductor market will grow 26 percent in 1988, stacked on top of the 23 percent growth in 1987. The bookings momentum and the shortages in leading-edge products suggest that the strength in shipments should continue through the first half of 1989. The Dataquest world semiconductor forecast is summarized in Figure 1 and Tables 1 and 2.

Figure 1

World Semiconductor Forecast



Source: Dataquest
June 1988

Table 1

Estimated World Semiconductor Market (Billions of U.S. Dollars)

	1987	1988	1989	1990	1991	1992	CAGR 1987-1992
North America	11.9	14.7	15.6	15.2	18.0	22.3	13.5%
Japan	14.3	18.2	19.9	18.8	21.1	25.4	12.1%
Europe	6.4	7.6	8.1	8.3	9.2	10.4	10.3%
Rest of World	3.9	5.5	6.6	7.1	8.9	11.4	23.6%
Total World	36.5	46.0	50.2	49.4	57.2	69.5	13.8%

Table 2

Estimated World Semiconductor Market (Percent Change, U.S. Dollars)

	1987	1988	1989	1990	1991	1992
North America	19%	24%	6%	(2%)	18%	24%
Japan	21%	27%	9%	(5%)	12%	21%
Europe	16%	20%	6%	2%	10%	13%
Rest of World	67%	39%	22%	7%	26%	28%
Total World	23%	26%	9%	(2%)	16%	22%

Source: Dataquest
June 1988

The short-term outlook is very strong, in spite of shortages in memory chips and increasing demand for high-end microprocessors and ASIC devices consumed in the production of data processing equipment. Overall capacity utilization is estimated to be 82 percent by the end of 1988, up from 78 percent in 1987. Capacity is tight for the leading-edge products, with capacity utilization in excess of 90 percent for the finer geometries in the 1.5-micron range. Capital spending is expected to rise 40 percent in 1988 in both the United States and Japan.

As new plants are brought on stream, capacity utilization for high-integration devices should ease a bit later this year. High-end microprocessors should soon cease to be supply limited, but microprocessor demand in 1988 is constrained by memory shortages. Although we expect demand to exceed supply for DRAMs in 1988, we expect supply to catch up in 1989 as a result of increased capacity and improved yields for 1Mb DRAMs, putting downward pressure on prices.

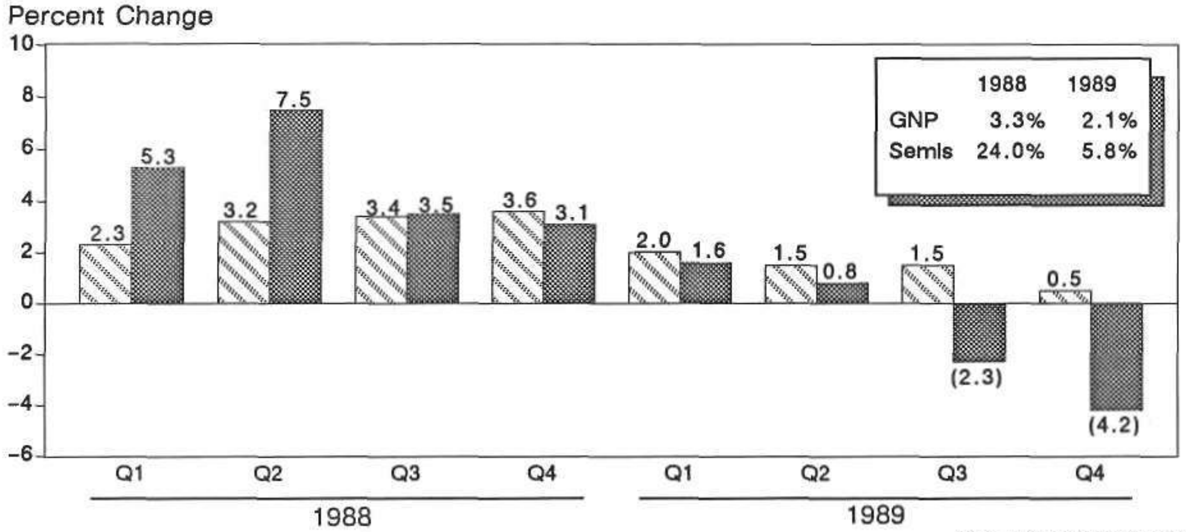
NORTH AMERICAN SEMICONDUCTOR MARKET

In the North American Semiconductor market, the strength in bookings continued in the first quarter of 1988 as confirmed by the SIA reports of robust book-to-bill ratios in the 1.15 to 1.17 range. The bookings and billings levels are now in striking range of beating the records set in 1984. The broad-based strength in data processing equipment production is driving the semiconductor demand, and demand for PCs, technical computers, and business computers continues to be strong. The resulting shortages in memory chips and high-end micros have put upward pressure on prices. Supporting the health of the industry, Dataquest's Semiconductor Application Markets (SAM) service surveys suggest that end-user inventories of semiconductors are below their target levels. Dataquest projects that the North American semiconductor market will grow 24 percent in 1988.

A mild chip recession is anticipated by mid-1989, coincident with a mild recession in the U.S. economy (see Figure 2). As the growth in U.S. real GNP slows from 3.3 percent in 1988 to 2.1 percent in 1989, worldwide electronic equipment production is expected to slow down. In particular, U.S. computer and data processing equipment production is expected to slow down from a 10.0 percent pace in 1988 to an 8.0 percent pace in 1989 and a 6.0 percent pace in 1990 (see Figure 3).

Figure 2

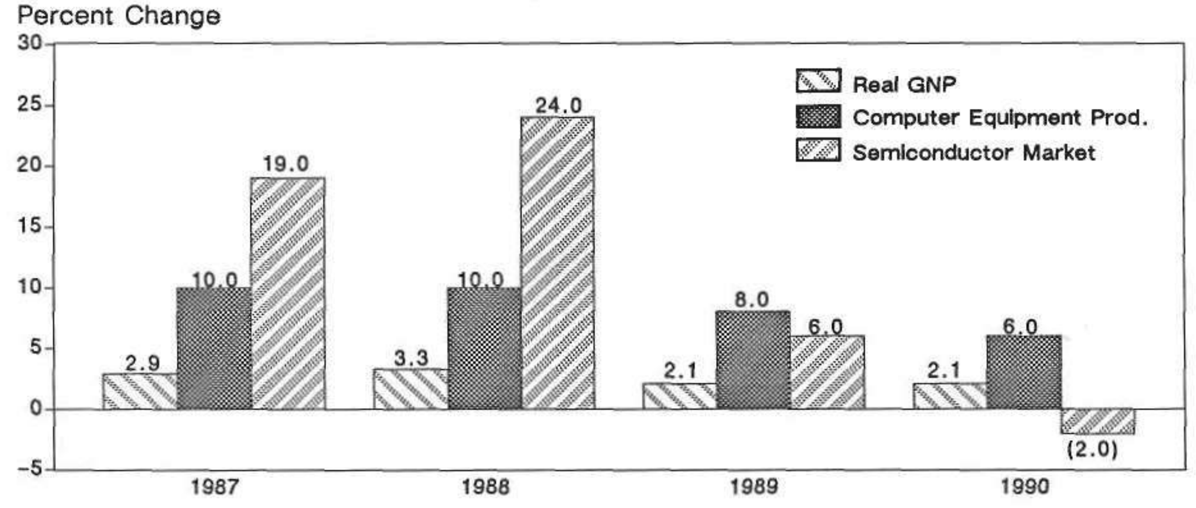
U.S. Economy versus Semiconductors



Source: Dun & Bradstreet
Dataquest
June 1988

Figure 3

U.S. Economy versus Equipment versus Semiconductors



Source: Dun & Bradstreet
Dataquest
June 1988

The chip recession is signaled by a virtually flat semiconductor market forecast for the second quarter of 1989 in North America. This should be followed by four to five quarters of mild contraction spanning the second half of 1989 and the first half of 1990, resulting in an annual growth of 5.8 percent in 1989 and a decline of 2.2 percent in 1990 in the North American semiconductor market.

The stagger chart shown in Table 3 compares our current forecast to our prior forecasts. A significant change from our prior forecast is the timing of the next chip recession. Some of the strength in 1988 is now anticipated to spill over into early 1989 because of the memory shortage. The mild downturn is now projected to span second half of 1989 and first half of 1990.

Table 3

North American Semiconductor Market
Stagger Chart
(Percent Change, U.S. Dollars)

Forecast Date	1987	1988	1989	1990
October 1986	12%	30%	(5%)	11%
January 1987	13%	23%	(5%)	11%
April 1987	15%	22%	(0%)	12%
July 1987	18%	22%	(1%)	12%
October 1987	21%	20%	(2%)	13%
January 1988		21%	(1%)	14%
April 1988		24%	6%	(2%)

Source: Dataquest
June 1988

The North American product detail forecasts are shown in Tables 4 and 5. MOS memory is the fastest growing product area in the North American market, growing 49.0 percent in 1988. MOS logic (including ASICs) and MOS microcomponents are also strong, growing 32.0 percent and 29.0 percent, respectively. The long-term forecast is for a robust 13.5 percent compound annual growth rate (CAGR) from 1987 through 1992 for the North American semiconductor market. MOS memory leads with 20.4 percent CAGR, followed by MOS logic with 17.0 percent CAGR and MOS microcomponents with 14.4 percent CAGR. High-end microprocessors and denser memories push up the average selling price of these high-integration devices. The replacement of discrete devices and standard logic by ASICs transfers value from board real-estate and wire traces to ICs. Bipolar memory is a declining market because the proportion of TTL PROMs getting replaced by MOS EPROMs and EEPROMs outpaces the growth in the high-speed ECL RAM market. Linear (analog) ICs are strong, with 11.2 percent CAGR due to fast-growing segments such as linear arrays and telecom ICs.

Table 4

Estimated Semiconductor Shipments to North America by Quarter (Millions of Dollars)

	1987	Q1/88	Q2/88	Q3/88	Q4/88	1988	Percent Change 1987-1988
Total Semiconductor	$11,869	$3,395	$3,651	$3,779	$3,895	$14,720	24.0%
Total IC	9,991	2,908	3,140	3,264	3,370	12,682	26.9%
Bipolar Digital	2,072	510	561	590	608	2,269	9.5%
Memory	279	65	72	76	84	297	6.5%
Logic	1,793	445	489	514	524	1,972	10.0%
MOS Digital	6,128	1,928	2,086	2,171	2,239	8,424	37.5%
Memory	2,347	815	862	892	916	3,485	48.5%
Micro	1,817	533	584	609	623	2,349	29.3%
Logic	1,964	580	640	670	700	2,590	31.9%
Linear	1,791	470	493	503	523	1,989	11.1%
Discrete	1,442	377	396	396	404	1,573	9.1%
Optoelectronic	436	110	115	119	121	465	6.7%

	1988	Q1/89	Q2/89	Q3/89	Q4/89	1989	Percent Change 1988-1989
Total Semiconductor	$14,720	$3,956	$3,988	$3,898	$3,734	$15,576	5.8%
Total IC	12,682	3,424	3,453	3,377	3,240	13,494	6.4%
Bipolar Digital	2,269	616	617	587	555	2,375	4.7%
Memory	297	82	77	72	70	301	1.3%
Logic	1,972	534	540	515	485	2,074	5.2%
MOS Digital	8,424	2,275	2,303	2,273	2,187	9,038	7.3%
Memory	3,485	941	950	935	895	3,721	6.8%
Micro	2,349	632	633	623	612	2,500	6.4%
Logic	2,590	702	720	715	680	2,817	8.8%
Linear	1,989	533	533	517	498	2,081	4.6%
Discrete	1,573	408	409	397	373	1,587	0.9%
Optoelectronic	465	124	126	124	121	495	6.5%

Source: Dataquest
June 1988

Table 5

Estimated Semiconductor Shipments to North America by Year (Millions of U.S. Dollars)

	1987	1988	1989	1990	1991	1992	CAGR 1987-1992
Total Semiconductor	$11,869	$14,720	$15,576	$15,236	$17,993	$22,355	13.5%
Total IC	9,991	12,682	13,494	13,079	15,655	19,762	14.6%
Bipolar							
Digital	2,072	2,269	2,375	2,245	2,528	2,924	7.1%
Memory	279	297	301	291	275	265	(1.0%)
Logic	1,793	1,972	2,074	1,954	2,253	2,659	8.2%
MOS Digital	6,128	8,424	9,038	8,664	10,582	13,794	17.6%
Memory	2,347	3,485	3,721	3,499	4,287	5,936	20.4%
Micro	1,817	2,349	2,500	2,375	2,890	3,558	14.4%
Logic	1,964	2,590	2,817	2,790	3,405	4,300	17.0%
Linear	1,791	1,989	2,081	2,170	2,545	3,044	11.2%
Discrete	1,442	1,573	1,587	1,642	1,753	1,904	5.7%
Optoelectronic	436	465	495	515	585	689	9.6%

Source: Dataquest
June 1988

WORLDWIDE SEMICONDUCTOR MARKET

The Japanese semiconductor market experienced slow growth of only 4 percent in 1987 measured in yen, although the yen appreciation translated this to 21 percent growth measured in U.S. dollars. The Japanese market is now projected to recover in 1988 to 15 percent growth measured in yen. At a constant exchange rate of 130 yen to the U.S. dollar, compared with the 1987 rate of 144 yen, this translates to 27 percent growth measured in U.S. dollars. Despite the slowdown in consumer electronics production in Japan for export to the United States due to the yen appreciation, semiconductor consumption in Japan is shifting more and more into the telecom and data processing application markets. Electronic equipment production in Japan is expected to grow 7 percent in 1988.

Real GDP growth in Japan is expected to slow from 3 percent in 1988 and 1989 to 2 percent in 1990. A slow third quarter in 1989 signals the chip recession in Japan. This should be followed by three to four quarters of mild decline, resulting in an annual growth of 9 percent in 1989 and a mild decline of 4 percent in 1990 in the Japanese semiconductor market.

The European semiconductor market declined 1 percent in 1987, measured in local currency, though this translates to 16 percent growth when measured in U.S. dollars. The European market is now projected to recover to 12 percent growth in 1988, measured in local currency. At a constant exchange rate of 117 European Basket Currency Units, compared with the 1987 rate of 125 Units, this translates to 20 percent growth measured in U.S. dollars. Though European electronic equipment production continues to stagnate with only 5 percent growth expected in 1988, semiconductor demand is spurred by growth in selected areas such as PCs, workstations, and telephones. In addition to the production increase of such U.S. computer companies as Digital Equipment, Hewlett-Packard, and IBM, some Japanese electronics manufacturers are opening facilities in Europe to be closer to the markets they serve. The long-term projection is for continued modest growth in the European semiconductor market with the usual summer doldrums. The outlook is for 6 percent growth in 1989, slowing to 2 percent growth in 1990.

The Rest of World (ROW) semiconductor market, including the Asia/Pacific region (Korea, Taiwan, Singapore, Hong Kong, China) boomed in 1987, growing a whopping 67 percent. We expect this growth to "moderate" to 39 percent in 1988 in this fastest-growing region of the world. While the 1987 growth came from relocation of electronic equipment production by U.S. companies, this trend has slowed considerably. However, Japanese electronics manufacturers are now reported to be relocating plants to Asia/Pacific, sustaining growth in the region. As the U.S. economy slows, the growth in the ROW semiconductor market should flatten during the second half of 1989. The long-term outlook is for growth slowing to 22 percent in 1989 and 7 percent in 1990 in the ROW semiconductor market. As we move into the 1990s, semiconductor consumption in the ROW region should be sustained more and more by electronic equipment produced for local consumption in potentially vast markets such as China. Dataquest estimates that the ROW semiconductor market will surpass the European market in size by 1992, accounting for more than 16 percent of worldwide semiconductor consumption (see Figure 4).

The Worldwide semiconductor shipment forecasts are shown in Tables 6 and 7. The relative product trends are similar to the North American market. MOS memory leads the pack with 42.0 percent growth in 1988, followed by MOS logic growing 33.0 percent and MOS microcomponents growing 28.0 percent. Linear (analog) ICs and optoelectronic devices will grow 20.0 percent, faster than the North American pace, with Japanese and ROW markets contributing to the growth. The long-term outlook is for a strong 13.8 percent CAGR for the world semiconductor market from 1987 through 1992. MOS memory leads with 17.7 percent CAGR, followed by MOS logic with 17.3 percent CAGR, MOS microcomponents with 14.3 percent CAGR, and linear with 13.3 percent CAGR. Optoelectronics will grow at 11.7 percent CAGR because of fast-growing segments such as laser devices used in compact discs (CDs), charge-coupled device (CCD) sensors used in imaging, and fiber-optic couplers used in telecommunications.

In summary, Dataquest forecasts the world semiconductor market to grow 26.0 percent in 1988, measured in U.S. dollars. Due to the cyclical downturn caused by slowing demand and capacity buildup, growth should decelerate to 9.0 percent in 1989, followed by a mild 1.5 percent decline in 1990. The industry should then enter the recovery cycle, topping 22.0 percent growth by 1992.

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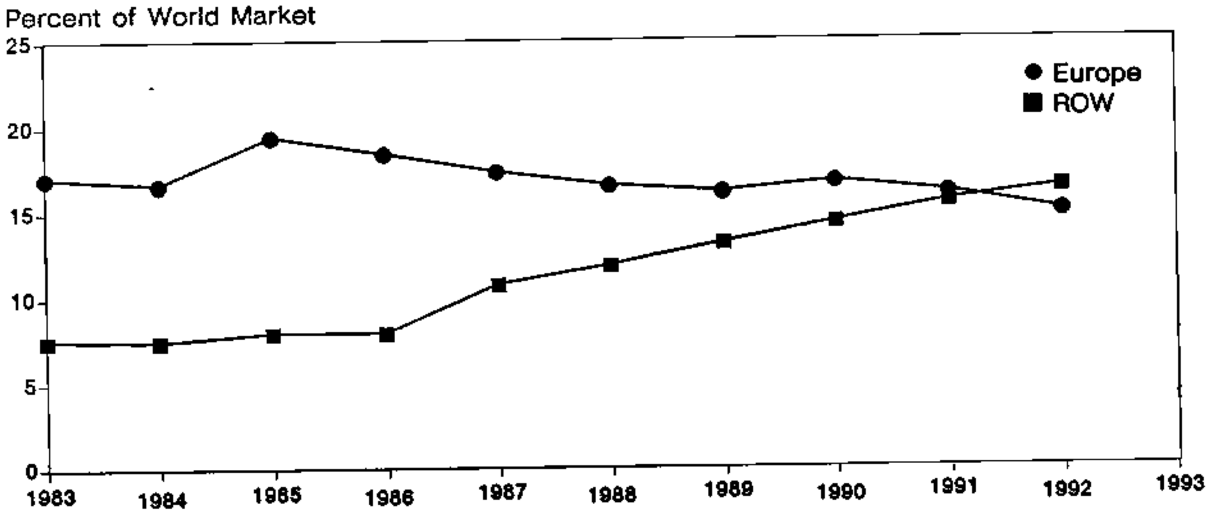
Jennifer Berg
Joseph Borgia

Figure 4

Semiconductor Markets:
The Emergence of Rest of World



Source: Dataquest
June 1988

Table 6

Estimated Worldwide Semiconductor Shipments (Millions of U.S. Dollars)

	1987	Q1/88	Q2/88	Q3/88	Q4/88	1988	Percent Change 1988
Total Semiconductor	$36,498	$10,831	$11,404	$11,736	$12,077	$46,048	26.2%
Total IC	28,668	8,602	9,098	9,399	9,707	36,806	28.4%
Bipolar Digital	4,672	1,263	1,364	1,424	1,480	5,531	18.4%
Memory	565	143	153	158	167	621	9.9%
Logic	4,107	1,120	1,211	1,266	1,313	4,910	19.6%
MOS Digital	16,788	5,285	5,580	5,783	5,973	22,621	34.7%
Memory	6,019	1,999	2,099	2,184	2,246	8,528	41.7%
Micro	4,819	1,435	1,531	1,579	1,609	6,154	27.7%
Logic	5,950	1,851	1,950	2,020	2,118	7,939	33.4%
Linear	7,208	2,054	2,154	2,192	2,254	8,654	20.1%
Discrete	6,112	1,734	1,797	1,814	1,840	7,185	17.6%
Optoelectronic	1,718	495	509	523	530	2,057	19.7%
Exchange Rate Yen/$	144	130	130	130	130	130	(9.7%)
European Basket/$	125	117	117	117	117	117	(6.4%)

	1988	Q1/89	Q2/89	Q3/89	Q4/89	1989	Percent Change 1989
Total Semiconductor	$46,048	$12,368	$12,713	$12,649	$12,464	$50,194	9.0%
Total IC	36,806	9,960	10,241	10,181	10,019	40,401	9.8%
Bipolar Digital	5,531	1,506	1,526	1,469	1,400	5,901	6.7%
Memory	621	165	164	156	151	636	2.4%
Logic	4,910	1,341	1,362	1,313	1,249	5,265	7.2%
MOS Digital	22,621	6,139	6,332	6,339	6,263	25,073	10.8%
Memory	8,528	2,332	2,421	2,425	2,405	9,583	12.4%
Micro	6,154	1,643	1,697	1,704	1,699	6,743	9.6%
Logic	7,939	2,164	2,214	2,210	2,159	8,747	10.2%
Linear	8,654	2,315	2,383	2,373	2,356	9,427	8.9%
Discrete	7,185	1,864	1,911	1,907	1,891	7,573	5.4%
Optoelectronic	2,057	544	561	561	554	2,220	7.9%
Exchange Rate Yen/$	130	130	130	130	130	130	0
European Basket/$	117	117	117	117	117	117	0

Source: Dataquest
June 1988

Table 7

Estimated Worldwide Semiconductor Shipments
(Millions of U.S. Dollars)

	1987	1988	1989	1990	1991	1992	CAGR 1987-1992
Total Semiconductor	$36,498	$46,048	$50,194	$49,446	$57,152	$69,533	13.8%
Total IC	28,668	36,806	40,401	39,572	46,253	57,203	14.8%
Bipolar							
Digital	4,672	5,531	5,901	5,731	6,492	7,572	10.1%
Memory	565	621	636	613	578	534	(1.1%)
Logic	4,107	4,910	5,265	5,118	5,914	7,038	11.4%
MOS Digital	16,788	22,621	25,073	24,291	28,621	36,179	16.6%
Memory	6,019	8,528	9,583	8,967	10,327	13,608	17.7%
Micro	4,819	6,154	6,743	6,603	7,742	9,382	14.3%
Logic	5,950	7,939	8,747	8,721	10,552	13,189	17.3%
Linear	7,208	8,654	9,427	9,550	11,140	13,452	13.3%
Discrete	6,112	7,185	7,573	7,613	8,339	9,341	8.9%
Optoelectronic	1,718	2,057	2,220	2,261	2,560	2,989	11.7%
Exchange Rate Yen/$	144	130	130	130	130	130	
European Basket/$	125	117	117	117	117	117	

Source: Dataquest
June 1988

ESIS Code: Vol. IV Newsletters
1988-10

U.K. SEMICONDUCTOR DISTRIBUTORS' 1987 REVENUE

INTRODUCTION

In 1986 Dataquest's European semiconductor research group produced an analysis of U.K. semiconductor distributors' revenue. Since then, we have conducted a detailed survey of the U.K. network and attempted to break out individual companies in more detail. This research bulletin brings that analysis up to date, with the publication of our 1987 estimates, as shown in Table 1.

SUMMARY

We estimate that U.K. distributor revenue grew by 12.1 percent in local currency, from £262.4 million in 1986 to £294.2 million in 1987. This exceeded the growth of the total U.K. and Ireland semiconductor market, which grew by only 9.4 percent, from £875.8 million in 1986 to £957.7 million in 1987. The semiconductor market in the United Kingdom, Europe, and, indeed, the world entered a recovery phase in 1987; the recovery was reflected strongly by the distribution market.

The top three distribution groups—Diploma, STC and Lex—accounted for £140.2 million, or 47.7 percent of the 1987 marketplace, with the acquisition of Newey & Eyre by STC helping reinforce the STC group's number-two position. The largest single distributor was again Macro Marketing, with an estimated revenue of £30.0 million.

Jim Beveridge
Jim Eastlake

Table 1

Estimated 1987 Semiconductor Revenue of U.K. Distributors (Millions of Pounds Sterling)

Distributor	1985 Sales	1986 Sales	1987 Sales
Diploma	51.0	50.1	55.5
Macro Marketing	32.0	29.0	30.0
Access Group	12.0	16.0	18.0
Anzac Components	6.0	4.0	6.0
DTV Group	1.0	1.1	1.5
*STC Group	51.0	46.4	55.3
STC ESD	25.0	24.0	27.0
Newey & Eyre	14.1	12.8	16.1
HI-TEK	8.0	6.0	6.5
BA Electronics	6.0	5.3	6.6
DC Distribution	0.1	1.5	3.0
Celdis	5.7	4.0	5.0
Unitel	1.2	1.0	1.5
Dialogue Distribution	4.0	3.0	4.0
Swift-Sasco	1.0	1.6	1.7
Lex	33.1	27.8	29.4
Jermyn Distribution	20.7	17.6	16.0
Impulse	7.4	5.7	7.5
Hawke Components	5.0	4.2	5.4
Mogul	0.0	0.3	0.5
Electrocomponents Group	26.6	21.9	25.5
RS Components	18.0	16.0	17.0
RR Electronics	8.0	4.4	6.0
Online Distribution	0.6	1.5	2.5
Memec Group	13.0	20.0	20.5
Ambar Cascom	5.0	9.7	10.0
Thame Components	6.0	7.0	8.0
Kudos	2.0	3.3	2.5
Farnell Electronics	16.0	16.4	17.0
Abacus Group	8.9	11.5	12.5
Abacus Electronics	7.0	8.7	9.0
Quest Electronics	1.9	2.8	3.5
Unitec	7.9	8.0	10.5
Rapid Recall	7.6	7.0	8.5
Rapid Silicon	0.3	1.0	2.0
Polar Electronics	4.0	8.0	8.3
Pronto Electronic Systems	3.0	6.0	8.0
Norbain	6.1	5.0	6.0
Micromark Electronics	7.0	6.8	6.0
VSI Electronics	7.5	4.5	5.5
Gothic Crellon	7.0	6.0	5.5
Quarndon Electronics	4.0	3.7	4.5
Axiom Electronics	3.0	3.2	4.0
Bytech	2.8	3.1	3.5
Manhattan Skyline	4.5	3.0	3.0
Intel	1.8	2.0	2.5
Barlec-Richfield	1.9	2.0	2.5
Semiconductor Specialists	3.0	1.7	2.0
Add-On Devices	0.4	1.1	1.8
Verospeed	0.5	0.8	1.0
United Components	0.5	0.7	1.0
Aztec Components	0.5	0.7	0.9
Others	4.0	2.0	2.0
Total	269.0	262.4	294.2

*STC acquired the Newey & Eyre group during 1987

Source: Dataquest
May 1988

ESIS Code: Vol. IV, Newsletters
1988-9

"INTELLIGENT" ICS POWER THEIR WAY INTO $1.1 BILLION SEMICONDUCTOR APPLICATION MARKET

SUMMARY

A Dataquest survey shows that North American and European vendors, led by SGS-Thomson, garnered more than $476 million in revenue during 1987 from sales of intelligent power products. This newsletter covers major trends in this vibrant marketplace. Table 1 provides product definitions, supplier rankings, and 1987 market size. The following are highlights of this newsletter:

- We believe that a dramatic 47 percent compound annual growth rate (CAGR) in the consumption of newly evolving bipolar/MOS technologies will push the market to $1.1 billion by 1992.
- Vendors must quickly translate newly developed technologies into reliable and cost-effective products, while users must ascertain which vendors, if any, offer viable products for their systems of the 1990s.

A SERIES OF NEWSLETTERS

This newsletter is the first in a series of newsletters being prepared by Dataquest on the issue of intelligent power products. Future newsletters focus on prospective winners and losers and on intelligent power hybrids. A main point of these newsletters is that Dataquest has developed a critical mass of information and insight regarding long-term trends in the intelligent power products marketplace in terms of supplier base, technologies, and semiconductor application markets (SAMs).

Table 1

North American and European Suppliers* Intelligent Power Products

1987 Ranking	Supplier	1987 Revenue ($M)
1	SGS-Thomson	$150.0
2	Motorola**	114.0
3	National Semiconductor#	100.0
4	Texas Instruments	42.0
5	Sprague Electric	10.3
6	GE Solid State	10.0
7	Unitrode	9.0
8	International Rectifier	7.5
9	Seagate Microelectronics	7.0
10	Silicon General	5.6
11	Cherry Semiconductor	5.5
12	Supertex	5.0
13	Linear Technology	4.0
14	Siliconix	3.0
15	Rifa	2.9
16	IXYS	<1.0
17	Micrel	<1.0
17	Silicon Power Cube	<1.0
	Total Revenue	$476.7

*Excludes Harris, Siemens, and Japanese vendors

**Estimated

#Estimated as to bipolar voltage regulator revenue

Definitions: An intelligent power integrated circuit (power IC) is a monolithic IC that incorporates a power element (with current of 1 amp or greater or with 100 volts or more) with a control/logic circuitry elements.

An intelligent power hybrid device contains two or more semiconductors in order to incorporate a power element and control-logic circuitry element, as specified for a power IC.

Source: Dataquest
May 1988

THE SURVEY METHODOLOGY

The information in Table 1 results from a survey conducted during the first quarter of 1988. Seventeen North American and European semiconductor vendors provided detailed information. Three firms (Harris Semiconductor, Motorola, and Siemens) would not reveal complete financial information. As cited in footnotes, Dataquest developed estimates for the total revenue of Motorola and National Semiconductor, respectively. The survey did not extend to Japanese vendors. By definition, the survey excluded all discrete semiconductors.

NORTH AMERICAN AND EUROPEAN VENDORS: SUPPLIER BASE

As shown in Table 1, the North American and European supplier base for intelligent power integrated circuits (ICs) and intelligent power hybrids includes a host of familiar and unfamiliar firms. Suppliers like SGS-Thomson, Motorola, National Semiconductor, Texas Instruments, GE Solid State (which includes the former GE Semiconductor, RCA, and Intersil), and Siemens rank as giants in the global semiconductor industry. Producers such as Harris Semiconductor, International Rectifier, Siliconix, Sprague Electric Company, and Unitrode are well recognized as manufacturers of linear ICs and/or power semiconductors.

The following vendors aim to win a share in the intelligent power marketplace: Seagate Microelectronics (formerly Integrated Power Semiconductor), Silicon General, Cherry Semiconductor, Supertex, Linear Technology, and Rifa. At least three of the newer firms—IXYS, Micrel, and Silicon Power Cube—seek a share of the business. In addition, Dataquest expects other suppliers, such as Powerex, to enter the marketplace.

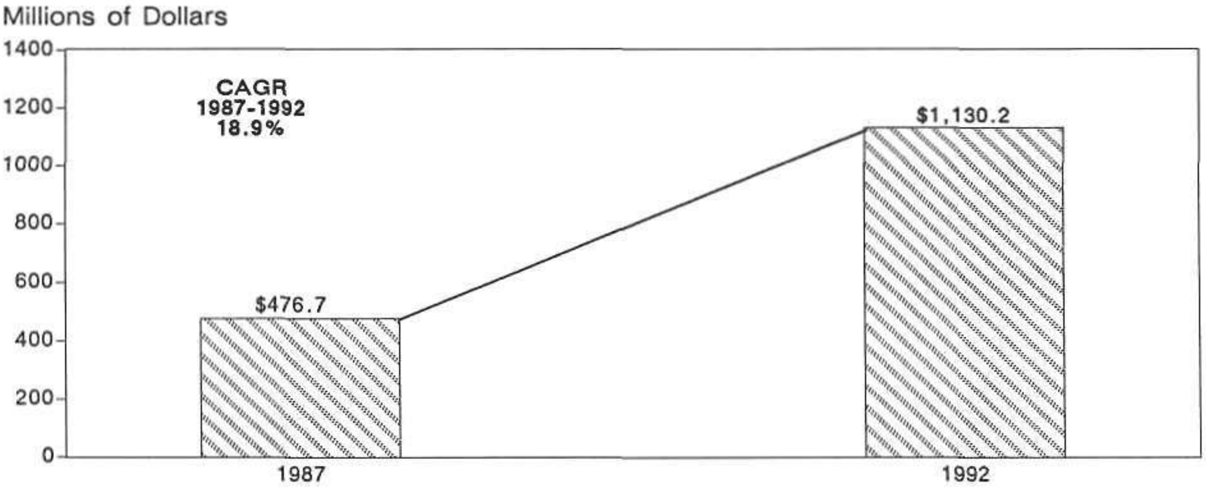
$1.1 Billion Marketplace by 1992

Figure 1 presents Dataquest's forecast for growth in intelligent power product consumption.

As shown in Figure 1, vendors should expect users' consumption of intelligent power products to expand at a healthy 18.9 percent compound CAGR during this period. Demand from users in the data processing, industrial, and transportation application markets drives growth.

Figure 1

1987 and 1992 Intelligent Power Product Revenue



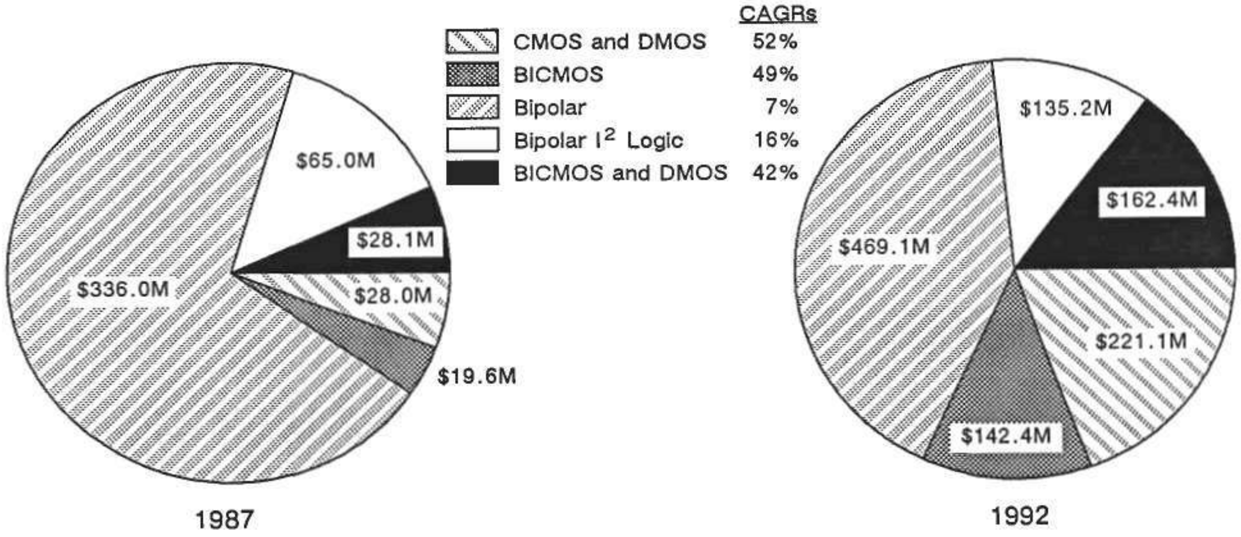
Source: Dataquest
May 1988

The Trends by Technology

Figure 2 presents Dataquest's 1987 through 1992 forecast for growth by technology in this marketplace. The figure clearly reflects the predominant trend in terms of intelligent power technologies: a shift from pure bipolar technology to mixed bipolar–MOS or mixed MOS technologies.

Figure 2

1987 and 1992 Intelligent Power Technologies (Millions of Dollars)



Note: CAGR covers 1987 through 1992.

Source: Dataquest
May 1988

The Mature Bipolar Technology

Table 2 provides information on suppliers of pure bipolar devices. As noted in Figure 2, the bipolar technology segment accounted for $336 million in revenue during 1987, with growth expected at a CAGR of 7 percent from 1987 through 1992.

For users, many of these firms listed in Table 2 are quite familiar, because voltage regulators that draw more than 1 amp of current meet the definition of a power IC. Table 2 shows that several smaller firms—Cherry Semiconductor, Linear Technology, Rifa, Seagate Microelectronics, Silicon General, Harris Semiconductor, and Silicon Power Cube—also have stakes in this segment.

Table 2

North American and European Suppliers Bipolar-Technology Intelligent Power Products

1987 Ranking	Supplier	1987 Revenue
1	SGS-Thomson	N/S
2	Motorola*	N/S
3	National Semiconductor*	N/S
4	Texas Instruments	N/S
5	Unitrode	N/S
6	Seagate Microelectronics	N/S
7	Cherry Semiconductor	N/S
8	Silicon General	N/S
9	Sprague Electric	N/S
10	Linear Technology	N/S
11	Rifa	N/S
12	Silicon Power Cube	N/S
	Total Revenue	$336

N/S = Not Specified
*Estimated ranking
Note: Harris and Siemens also produce these devices.

Source: Dataquest
May 1988

The Newly Evolving Technologies

Table 3 provides information on suppliers whose product portfolios include devices that are based on the newly evolving technologies (BICMOS, CMOS+DMOS, BICMOS+DMOS).

Users should anticipate that one or more of the technological leaders of tomorrow will emerge from the ranks of these suppliers listed in Table 3. By 1992, these technologies should represent a $525 million marketplace (47 percent CAGR).

Table 3

North American and European Suppliers*
Intelligent Power Products
1987 through 1992

	Technology			
Supplier	CMOS +DMOS	BICMOS	Bipolar I^2Logic	BICMOS +DMOS**
SGS-Thomson	F	F	C	C
National Semiconductor	F	O	O	O
Texas Instruments	F	F	O	O
Sprague Electric	F	O	O	C
GE Solid State	F	C	O	F
Unitrode	F	O	O	F
International Rectifier	C	O	O.	O
Seagate Microelectronics	O	F	F	O
Silicon General	O	F	O	O
Cherry Semiconductor	F	O	F	O
Supertex	C	O	O	O
Linear Technology	O	O	O	O
Siliconix	C	O	O	C
Rifa	C	F	O	O
IXYS	C	F	O	O
Micrel	C	O	O	C
Silicon Power Cube	F	O	O	O
Harris	O	O	O	O
Powerex	F	F	O	O

*Excludes Motorola and Siemens

**See Table 2 regarding bipolar products. BICMOS+DMOS includes Bipolar-MOS and Bipolar+DMOS.

C = Current supplier

F = Future entrant

O = Does not plan to supply

Source: Dataquest
May 1988

CMOS+DMOS Technology

International Rectifier, Siliconix, and Supertex are establishing leadership positions in the CMOS+DMOS technology area. As depicted in Figure 2, consumption of intelligent power products based on the newly developed CMOS+DMOS technology is expected to expand into a $221 million marketplace at a 52 percent CAGR from 1987 through 1992.

Users should closely track the performance of Rifa, IXYS, and Micrel, because these firms could emerge as significant players in the CMOS+DMOS arena. The following vendors plan to migrate to this segment: Cherry Semiconductor, GE Solid State, National Semiconductor, Powerex, SGS-Thomson, Sprague Electric, Texas Instruments, and Unitrode.

BICMOS Technology

As depicted in Figure 2, the BICMOS segment is expected to expand at a 49 percent CAGR into a $142 million marketplace by 1992.

Table 3 reveals that GE Solid State supplies intelligent power products that are based on the BICMOS process technology. (Motorola also targets BICMOS as a key technology in its product portfolio.) Users can expect the following vendors to migrate to the BICMOS technology: IXYS, Powerex, Rifa, Seagate Microelectronics, SGS-Thomson, Silicon General, and Texas Instruments. Users can also look to GE Solid State and Powerex (and to a lesser extent, Rifa) as suppliers of BICMOS intelligent power hybrids.

BICMOS+DMOS Technology

As shown in Figure 2, consumption of intelligent power products that utilize the newly developing BICMOS+DMOS technology should grow at a 42 percent CAGR into a $162.4 million segment by 1992.

Table 3 shows that SGS-Thomson, Siliconix, and Sprague Electric Company are advancing to leadership positions in this marketplace. Micrel's ASIC product portfolio includes the BICMOS+DMOS technology. Users can also expect GE Solid State and Unitrode to enter this segment.

THE FUNDAMENTAL FORCE DRIVING GROWTH

The need for systems manufacturers to replace systems' electromechanical assemblies with electronic circuity is <u>the</u> fundamental force driving long-term growth. The incorporation of intelligent power products into users' systems should translate into enhanced reliability, greater functionality, new applications, space savings, efficient energy management, and reduced system-production costs.

Overcoming Barriers to Growth

Nevertheless, formidable barriers threaten to stall progress in this business. Vendors of intelligent power products face an engineering challenge in terms of building bridges between technologies. Similarly, a tremendous challenge remains in terms of packaging technologies. Vendors also confront a stiff challenge in accommodating users. A predominant trend in the global semiconductor industry is toward closer user-vendor relationships. Consequently, users are becoming more dependent on (and demanding of) the streamlined supplier base.

Given two specific forces—namely, vendors' high costs of developing intelligent power ICs and users' aims of streamlining the supplier base—strategic alliances have evolved as a major vehicle in the business.

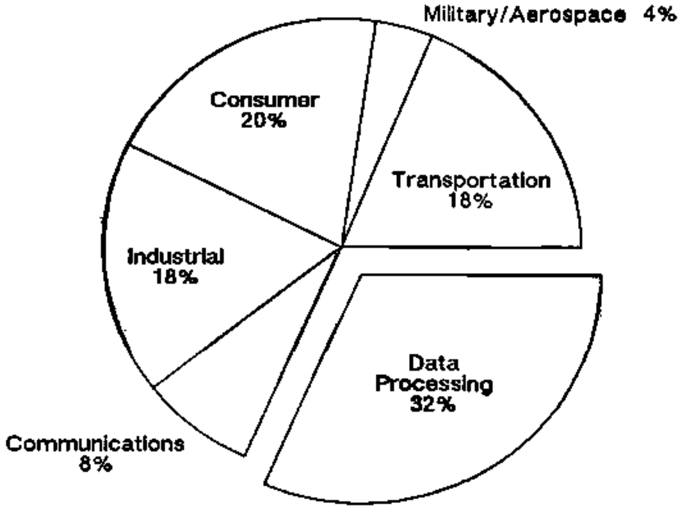
Perhaps the greatest barrier to growth in this marketplace could be a basic failure of vendors and users to communicate. Vendors must communicate to prospective users the potential benefits of intelligent power products. On the user side, system design engineers must work closely with procurement managers and vendors in assessing the relative benefits, costs, and applications of intelligent power products.

THE USER BASE: THE WORLDWIDE SEMICONDUCTOR APPLICATION MARKETS

As shown in Figure 3, data processing ranked as the leading SAM for intelligent power products (32 percent share) during 1987.

Figure 3

Intelligent Power Products by Semiconductor Application Market (Millions of Dollars)



Source: Dataquest
May 1988

Figure 3 shows that other leading application markets during 1987 were consumer (20 percent), transportation (18 percent), and industrial (18 percent). The communications and military/aerospace markets are just starting to use intelligent power products.

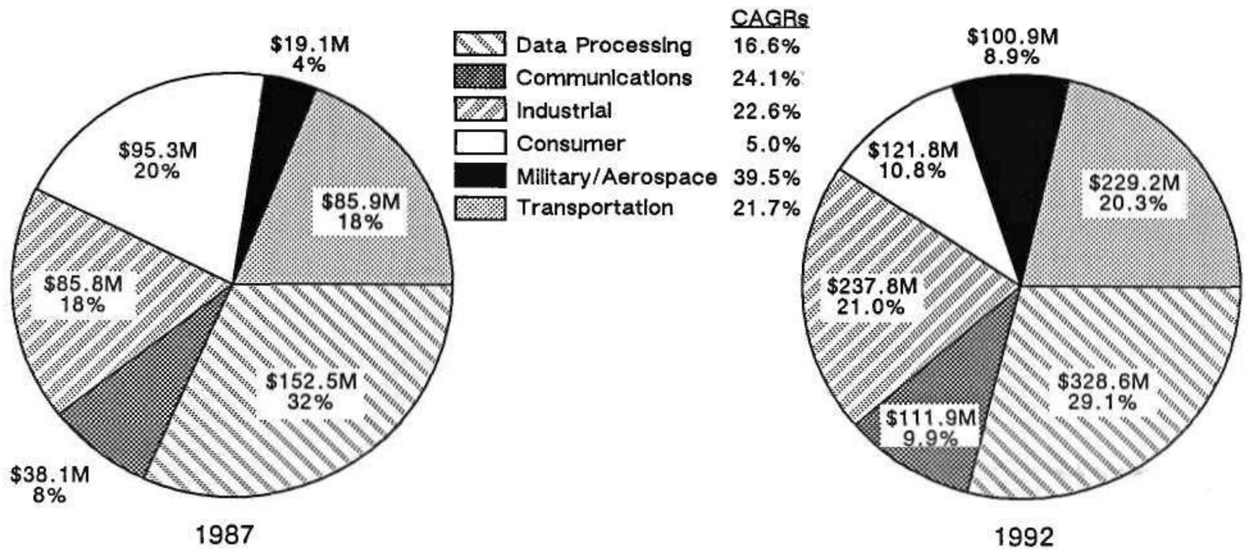
Figure 4 depicts the anticipated rate of growth in consumption of intelligent power products by SAM from 1987 through 1992.

As shown in Figure 4, data processing should remain the largest SAM ($328.6 million by 1992); however, other SAMs are expected to increase consumption of power products at faster rates.

Along with data processing applications (16.6 percent CAGR for an already big segment), the industrial and transportation SAMs should drive the intelligent power marketplace during the 1987 to 1992 time frame, to exploding into $200 million-plus segments by 1992.

Figure 4

1987 and 1992 Growth in Intelligent Power Products by Semiconductor Application Market



Note: CAGR covers 1987 through 1992.

Source: Dataquest
May 1988

The Semiconductor Application Markets by Technology

A critical but unresolved issue concerns which technology or technologies will prove most suitable for which applications. As a "sanity check" on the future flow of intelligent power products by technology into the six SAMs, the Dataquest survey asked responding vendors the following question regarding actual 1987 revenue and anticipated 1992 sales:

> "To which semiconductor application market did your company sell the most CMOS+DMOS–based, BICMOS–based, Bipolar–based, Bipolar I^2 Logic–based, and BICMOS+DMOS–based intelligent power products?"

Table 4 presents the results.

As shown in Table 4, manufacturers of data processing equipment should expect vendors of intelligent power products to use at least five technologies over the long term in an effort to serve users' needs in computer and related applications. Two technologies are expected to flow to the industrial SAM, while three technologies should meet the needs of users in the other SAMs.

Table 4

Vendors' Estimate of Leading Intelligent Power Technology by SAM

	Semiconductor Application Market (SAM)					
1987 (Actual)	DP	Comm.	Indus.	Consumer	MIL/Aero.	Trans.
CMOS+DMOS	3	0	2	0	2.0	0
BICMOS	0	0	2	0	0.5	0.5
Bipolar	3	1	0	1	0	4.0
Bipolar I^2 Logic	1	0	0	0	0	0
BICMOS+DMOS	1	0	0	0	0	0

	Semiconductor Application Market (SAM)					
1992 (Expected)	DP	Comm.	Indus.	Consumer	MIL/Aero.	Trans.
CMOS+DMOS	4	1	3.5	0.5	0.5	4.5
BICMOS	1	1	2.0	0	0.5	2.5
Bipolar	2	1	0	1.0	0.5	4.5
Bipolar I^2 Logic	2	0	0	1.0	0	0
BICMOS+DMOS	4	0	0	0	0	0

Note: Several firms did not respond to this question. Some firms specified two leading SAMs for a few technologies.

Source: Dataquest
May 1988

The Semiconductor Application Markets by Supplier

Table 5 shows prospective users of intelligent power products that vendors are serving or expect to serve in the six semiconductor application markets (as reported to Dataquest by survey respondents).

Table 5 tells users that numerous firms plan to enter or expand their roles in the intelligent power business over the long term. Table 4 signals the shift by suppliers from the pure bipolar technology to the mixed bipolar/MOS technologies, while Table 5 shows the anticipated move by suppliers to the transportation SAM (seven new entrants expected), consumer SAM (six entrants), and other SAMs (five to six entrants) over the long term.

Users should expect suppliers that serve data processing applications to expand their reliance on the CMOS+DMOS technology over the long term. The "dielectrically isolated" bipolar process technology should find use in high-voltage communications applications. Another approach for communications applications will be hybrid circuits based on the CMOS+DMOS technology.

Users in the industrial SAM can anticipate that suppliers will base intelligent power products for this SAM on the CMOS+DMOS or the BICMOS technology. Users should expect the bipolar technology to continue as the technology of choice in consumer electronics applications. As shown in Table 4, users of intelligent power products in the military and aerospace arena can expect devices based on either the CMOS+DMOS technology or the BICMOS process from suppliers specified in Table 5.

Users in the transportation equipment marketplace should expect the newly developed technologies (CMOS+DMOS and BICMOS), along with bipolar products, to flow their way over the long term.

Table 5

Suppliers of Intelligent Power Products by Semiconductor Application Market 1987 through 1992

	Semiconductor Application Market (SAM)					
	DP	Comm.	Indus.	Consumer	MIL/Aero.	Trans.
SGS-Thomson	C	C	C	C	C	C
National Semiconductor	C	O	F	F	O	F
Texas Instruments	C	C	C	C	C	C
Sprague Electric	C	C	C	C	C	C
GE Solid State	F	F	C	F	F	O
Unitrode	C	C	C	C	C	F
International Rectifier	C	C	C	F	F	F
Seagate	C	O	O	O	O	O
Silicon General	O	O	C	O	C	C
Cherry Semiconductor	C	F	C	O	O	C
Supertex	C	C	C	C	C	O
Linear Technology	C	C	C	O	C	C
Siliconix	C	C	C	O	C	C
Rifa	C	O	C	O	O	F
IXYS	F	F	C	F	C	F
Micrel	F	F	F	O	C	F
Silicon Power Cube	O	O	C	F	F	O
Harris	F	C	F	O	F	F
Powerex	F	F	F	F	F	O

Note: Excludes Motorola and Siemens data. National Semiconductor's 1987 presence in these SAMs is per bipolar voltage regulators.
C = Current supplier
F = Future entrant
O = Does not plan to supply

Source: Dataquest
May 1988

DATAQUEST CONCLUSIONS

The intelligent power marketplace is a large business for North American and European vendors—$476 million in revenue during 1987—with several segments poised to push total revenue to $1.13 billion by 1992. The newly evolving technologies (CMOS+DMOS, BICMOS, and BICMOS+DMOS) are expected to generate rapid rates of growth (47 percent CAGR) during the 1987 to 1992 period. By SAM, data processing leads the way and continues as the largest segment over the long term; however, the industrial and transportation SAMs are also expected to boom during the 1987 to 1992 time frame.

As noted at the outset, this newsletter is the first in a series of Dataquest newsletters on the vital topic of intelligent power. This newsletter lays out the critical mass of 1987 historical and 1992 forecast information regarding supplier base, technologies, and SAMs. The next newsletter examines the prospective winners and losers from developments in the intelligent power arena. The newsletter includes specific Dataquest recommendations on the strategic response for prospective and current users and vendors of intelligent power products. The third newsletter looks at the vendors that view intelligent power hybrids as a possible winning strategy.

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Jennifer Berg
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SEMICON EUROPA: A SLOW SHOW FOR A YEAR OF SLOW EUROPEAN EQUIPMENT SALES

INTRODUCTION

The fourteenth SEMICON/Europa Exhibition was held at the Zuspa Convention Centre in Zurich, Switzerland, March 1 through to March 3. This show, organized by the Semiconductor Equipment and Materials Institute (SEMI), is the first of several equipment expositions sponsored by SEMI throughout the world this year.

SEMICON/Europa 1988 came and went amid whispers of a lackluster year in European equipment sales. The late, but intense, snow storm in Germany and Switzerland delayed many visitors to the show, and it appeared to Dataquest analysts that the exhibition was effectively over by noon on Thursday, even though the official closing was at 4:00 p.m. While SEMI logged approximately 6,800 attendees—8 percent more than last year's 6,300—it was a disappointing exposition compared to the frenetic activities of the 1983 and 1984 shows. About 50 percent of the stand space was taken by U.S. companies. Although European companies were well represented, their presence was somewhat down from previous years largely as a result of mergers and acquisitions.

In this newsletter, we will report on various front-end equipment and materials segments and on the mood in Europe in general.

SILICON EPITAXY

Both the epitaxial equipment and silicon epitaxy markets are driven by advances in MOS device processing. The pervasiveness of epitaxy in bipolar processes cannot prevent the decline of epitaxial equipment sales as MOS devices gain in performance and replace bipolar applications. In 1984 and 1985, silicon manufacturers added capacity in anticipation of the movement of epi processes into MOS production, and in particular, 1Mb DRAM manufacturing. This movement did not occur, however, and worldwide epitaxial equipment sales fell from $112 million in 1984 to $49 million in 1986 and have only risen to approximately $50 million in 1987.

The outlook for 1988, however, appears to be sanguine. Orders for epi reactors are up, but more significantly, MOS-epi wafer demand is beginning to outpace supply. SEH, Monsanto, Wacker, OTC, and DNS are pursuing aggressive epi wafer strategies worldwide and in Europe. They are not, however, using the new MOS-epi products introduced recently—namely, Applied's 7010 and LAM/Gemini's Tetron I. The lion's share of MOS-epi wafer production is produced on Applied's 7800 series reactors.

Silicon manufacturers will continue to be cautious, carefully keeping supply in tune with demand. Monsanto, for example, has recently purchased capacity from AT&T rather than adding reactors to its plant in St. Peters, Missouri. High-volume system purchases continue to await the movement of epi into DRAM products. Until now, epi wafers have been going into high-performance, CMOS logic and, in Japan, into CCDs.

ETCH

We saw the same cadre of dry-etch systems at SEMICON/Europa as were introduced within the last few years, but with some absences and some new products. Most significantly, the Japanese manufacturers did not show systems.

Leybold AG

Degussa purchased Leybold-Heraeus last year and provided funds for an aggressive attack on the equipment market. Leybold introduced a single-wafer, multichamber reactive ion etcher (RIE) system this year.

The Series 3000 Etcher, can be configured with 1 to 4 chambers. It can be configured uniquely for high-pressure operation for oxide and nitride or as an RIE for aluminum and aluminum alloys. The multichamber operation makes it suitable for low-pressure, low-etch rate processing and for multistep recipes. It can be configured for wafer sizes up to 200mm. The price is about $600,000 for two chambers. So far, two beta sites have been installed.

CIT/Alcatel

CIT/Alcatel introduced a two-chamber version of its CIT series reactors two years ago. Each chamber and handling system can be operated independently of the others. Approximately 30 of these systems have been installed so far. At this year's show, CIT/Alcatel introduced a microwave version of the CIT 260. The system uses technology licensed from CNET, a french agency (also licensed by Electrotech), that employs a network of alternating magnetic poles and microwave antennas around the periphery of a single wafer electrode. The system price is $750,000. Three systems have been installed to date.

CVD

Several companies have introduced new CVD systems in the last three years. Of these companies, Applied Materials has been very successful, shipping 30 systems into dielectric applications in eight months in 1987. Varian has also been successful with its

Model 5101, shipping systems into R&D and pilot applications for refractory metals. The new systems from Novellus and Focus have been very slow getting started. However, Focus has improved its temperature control and has shipped several systems since November. Novellus has moved slightly faster and had shipped about 10 systems by the SEMICON showing of the system.

Spectrum CVD, which had pulled its system off the market soon after introduction, reintroduced the system at SEMICON. The system is now a single-wafer, single-chamber configuration in lieu of a multichamber configuration. Spectrum claims typical throughputs of 30 wafers per hour (wph) for WSi_2 and 15 wph for selective tungsten. Of course, like all refractory-CVD vendors, Spectrum claims to have a "production-worthy" selective tungsten process. The price of the system is $600,000.

DIFFUSION AND PVD

Several companies introduced new diffusion or PVD systems—or modified their existing systems.

MTI

MTI introduced the SypherLine sputtering system, which it claims provides step coverage, film uniformity, and fine grain size that exceeds results of any other system on the market today. The system is available in two through-the-wall configurations: Class 10 and Class 100. The Class 10 system provides minimal clean room penetration and has a cassette/cassette load/unload capability. Each system includes an RF sputter etch module, a sputter deposition module, a cassette lock, and a transfer chamber.

The SypherLine "sputtering . . . plus" process features sideways deposition onto the wafer and an 8-1/2-inch diameter standard target independent of wafer size. The SypherLine can produce 2,500 wafers per target at a throughput of 45+ wafers per hour.

MTI reports that the SypherLine is now being used to fabricate 4Mb DRAM devices.

Varian

Varian introduced the M2000, an isolated-chamber sputtering system. The M2000 integrates free-standing and interchangeable modules. Each self-contained module has independent systems for vacuum, wafer handling, and process control. Modules are interconnected by a central wafer-handling system that is designed for high reliability and exceptional contamination control.

The M2000 is configured with modules for automated cassette-to-cassette wafer loading, central wafer handling, sputter deposition, and RF sputter etch. Process sequences can be tailored to provide optimum processing conditions for different devices. The M2000 can be used for either R&D or for production, and is designed for easy field upgradability and expansion to meet new process requirements.

Process modules can be easily disconnected and wheeled off-line for maintenance while the other modules continue to process wafers. The system is capable of handling gallium arsenide wafers.

Varian plans to introduce future process modules for CVD, RTP, and etch.

E.T. Electrotech

E.T. Electrotech introduced its Plasmafab ND 6210 PECVD system. The 6210 can be used for the deposition of oxide, nitride, doped oxide, and oxynitride. The 6210 offers increased process stability and features a TEOS (tetra-ethyl-ortho-silicate) liquid source for a more planarized film surface. It has a throughput of 25 wafers per hour and can be purchased in a beltless model.

Tempress

General Signal's Thinfilm Company introduced the Omega 5000 PECVD from Tempress. The new system is the result of a joint effort from Tempress and the University Twenty (Enschede, The Netherlands). The new system was developed for the deposition of silicon nitride layers. The Omega 5000 can be used in combination with other diffusion and/or LPCVD processes in the same four-stack furnace. The system is designed for low contamination. The features that have been incorporated into the Omega to achieve low particulates include a rounded scavenger, an RF coil connector at the back of the tube, and a newly redesigned boat. Additionally, the gas system is laid out vertically and is constructed of electro-polished piping with orbital welds.

MASKMAKING

We believe that one of the most significant events at SEMICON this year was the joint announcement by GCA and Ateq of a strategic alliance. Ateq will market and support GCA's photo-repeaters in the United States to U.S. mask shops. GCA will market Ateq's Core 2000 in Europe. GCA will terminate the laser pattern generator introduced two years ago. In addition, GCA and Ateq will cooperate on product and process development.

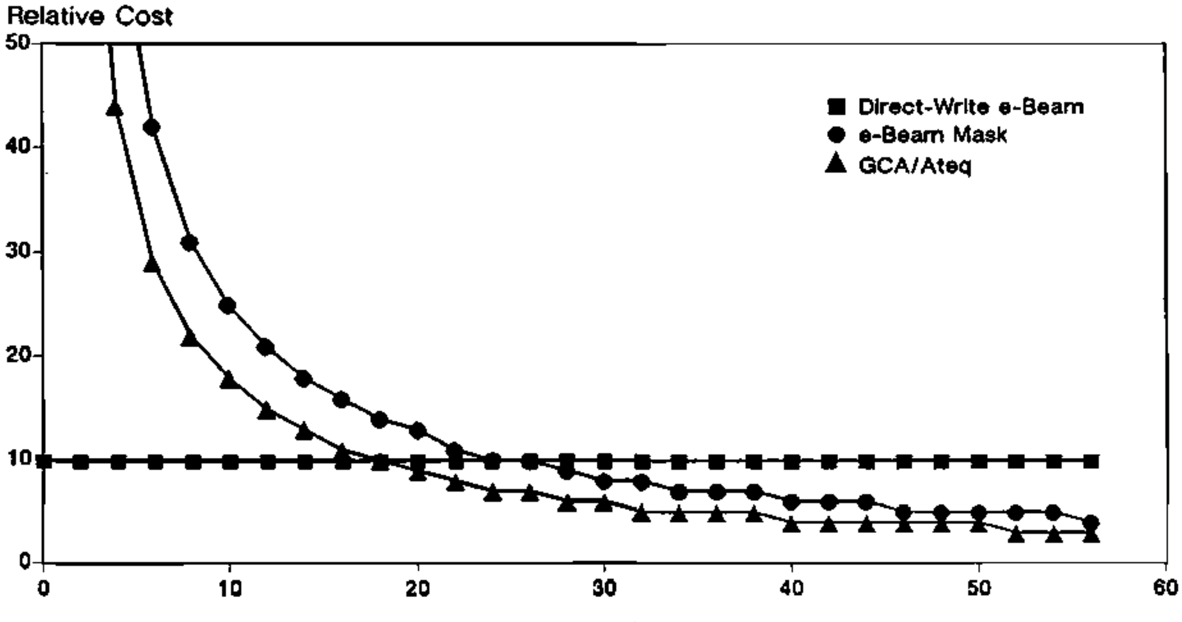
By bundling their products, the companies hope to give semiconductor manufacturers an alternative to direct-write e-beam and to give mask shops a low-cost, quick-turn alternative to e-beam.

Direct Write

Figure 1 represents an analysis of mask versus direct-write cost as a function of the number of devices produced. While the point at which both costs are equal can vary greatly depending on system price, mask cost, and device complexity, the graph shows that lowering the mask cost makes the semiconductor manufacturer much less likely to use direct write. The GCA/Ateq agreement proposes to provide a quick turn alternative to direct-write e-beam.

Figure 1

Pattern Replication Cost
Direct Write Versus Maskmaking



Source: Dataquest
April 1988

The companies claim that designs with geometries of 1.2 micron and greater can be transferred to reticles directly by the Core 2000 and then be produced on a stepper faster than with direct write. For geometries of less than 1.2 micron, reticles can be made by creating a 5x master on the Core 2000, using the GCA repeater to make a 5x or 1x reticle, then stepping the device on silicon, all of which is still faster than using direct-write e-beam.

Maskmaking Shops

If the procedure mentioned in the previous paragraph works, it could provide low-cost capacity in mask shops, be they merchant or captive, for ASICs or for standard products. The issue inevitably will be one of quality. The GCA/Ateq alliance has a long way to go before it demonstrates that this technology can produce masks and (ultimately) devices with the same yields that the e-beam technology has labored so long to enjoy.

The ability of GCA/Ateq to gain experience will be severely limited by the excess mask capacity that currently exists; mask shops do not need more capacity, low cost or otherwise. The development of silicon compilers and simulation software has greatly reduced the amount of prototyping that was necessary in ASIC manufacturing a few years ago. This advance has effectively doubled the mask capacity with little change in the installed base of e-beam systems.

We believe that GCA/Ateq will certainly achieve sales into a niche of quick-turn ASIC products. However, the potential for GCA/ATEQ to penetrate into high-performance applications and into commodity production does exist and is enhanced because of this alliance.

TRACK EQUIPMENT

Convac and MTI introduced new systems at SEMICON/Europa and Eaton announced new enhancements to its system.

Convac

Convac introduced the Module Series 6000 photoresist processing equipment. This system features a Class 1 local environment and is fully compatible with the SMIF concept. The Series 6000 has eliminated belt- and air-driven wafer transfer mechanisms by using four frog-leg pick-and-place wafer handlers. These frog-leg transfer mechanisms give the 6000 the ability to transfer wafers to any station within the module or to an adjoining module. The company claims that the frog-leg pick-and-place transfer mechanism is cleaner than the belt- or air-transfer method.

Another new feature of the 6000 is that the hot plates are stacked one atop the other, five high. Vapor prime stations are also stacked one atop the other. The company chose this configuration in order to reduce space requirements. Each module can be operated as a standalone module or integrated with other modules.

MTI

MTI introduced FlexiFab, a network of independent, single-process modules. Each self-contained module performs a complete process step. Each module has its own electronics, handling system, and facilities connections. Since the modules are linked only by communications and power to a master controller, the modules can be configured in a variety of ways to fit individual process needs. Each module is capable of both wet and dry process. The mean-time-between-failure of each module is estimated to be 900 hours.

Eaton

Eaton added some new features to its existing Spin-on-Glass System, the 6020XL. These new features include a new teflon tub, a full-coverage nozzle rinse, and a tub rinse.

Eaton also showed its complete Point and Go Operator Interface Model 6010XL for the first time. This system has a menu-driven touchscreen with capabilities in all major European languages. The 6010XL is retrofittable to all 6000XL systems.

STEPPERS

Although all of the major stepper companies were present at SEMICON/Europa, only GCA and Perkin-Elmer announced new products.

GCA

GCA introduced the 200mm ALS Waferstep wafer stepper for sub-micron production. The ALS 200 is intended primarily for 4- to 16-Mb production. The system has improved stage precision, registration, and overlay. It offers tightly controlled machine-to-machine matching. The system can be equipped with either i-line or g-line optical systems. Lenses for the ALS Series are available from either GCA Tropel Division or Carl Zeiss Inc. The system can be configured with the GCA Environmental Chamber Model 8860. The system features a dark field alignment system and is usable in a 100 percent die-by-die operation or with flexible die sampling routines. The ALS 200 features a 0.15-micron registration and a 0.25-micron overlay and has an average selling price of $1.2 million to $1.4 million, depending on the type of lens used. GCA claims that the system has a 95 percent uptime.

Perkin-Elmer

Perkin-Elmer introduced the OMS 1 overlay measurement system at SEMICON/Europa. The new system can monitor overlay, suggest correction coefficients, and perform overlay measurement at many sites on production wafers. Software is available for overlay correction for both the Micralign 600 HT and Micrastep stepper.

EUROPEAN MOOD

Dataquest's Malcolm Penn reported at SEMI's Tuesday morning press conference that in 1987, the European semiconductor industry experienced a 14 percent growth rate in U.S. dollars (to $6,355 million), which equates to about 9 percent in local currency. The United Kingdom showed the most dynamic growth in Europe and now accounts for 37 percent of all European wafer fabrication manufacturing capability.

With the fabrication industry entering what might be described as a fairly "mature" phase compared with the volatility of earlier years, growth is expected to settle into the range of 10 to 12 percent CAGR, while the outlook for 1990 considered to be good.

Equipment vendors at the show are experiencing lackluster sales in Europe while Japan and the ROW markets have been heating up. Equipment and materials vendors expect European equipment sales to be flat or, at best, up only slightly in 1988.

In the last two years, Europe has provided equipment vendors with a growing market while the United States and Japan were in severe slumps. European governmental monies have been disseminated into European semiconductor manufacturers—most notably Philips, Siemens, and Thomson—as Europe has attempted to regain its lost position in electronics. It is time for European manufacturers to demonstrate the wisdom of their strategies as they fill this new capacity with new production.

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EUROPE REFRESHES ITS STAGNANT WHITE GOODS MARKET

SUMMARY

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

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

MARKET ESTIMATES

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

Table 1

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

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

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

Source: Dataquest
December 1988

Table 2

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

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

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

Source: Dataquest
December 1988

COMPANY ANALYSIS

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

AB Electrolux

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

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

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

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

AEG Aktiengesellschaft

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

Bosch-Siemens Hausgerate

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

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

GEC

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

Hoover U.K.

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

Merloni

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

Miele

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

NV Philips

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

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

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

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

Thomson SA

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

Others

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

FUTURE OUTLOOK

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

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

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

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

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1992—WHAT'S IN A NUMBER?

SUMMARY

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

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

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

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

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

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

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

(Slide 1)

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

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

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

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

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

(Slide 2)

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

Ladies and Gentlemen, 1992 is a reality. On 31st December 1992, that Act will become law. That law will override local governments. Majority voting, as opposed to the present almost universal procedure of unanimous voting, will ensure that the days of filibustering are finally dead and buried. The four major barriers to trade mentioned above will no longer exist.

The first of my recommendations this morning is that we had all better take this reality seriously—the days of the cozy cartels, monopolies, hidden tariffs, and other protectionist or self-interest motivated practices are numbered—1,653 days to be precise.

Nobody likes change—we're all very much creatures of habit—but this is one change that will be viewed with hindsight as worthwhile. That is my second prognostication of the morning.

What, I hear you ask, gives me the confidence to make such an equivocal statement? To answer that I would like to look back over past decades of the western world's economic performance.

(Slide 3)

The single biggest contributor to the postwar world economic recovery was market liberalization. The 1920s/'30s saw trade barriers dismantled, government-nurtured cartels broken up and controls on direct foreign investment lifted. The western world enjoyed a market-led sustained high GNP growth throughout this period.

The oil shocks of the 1970s triggered a gradual shift away from market-led forces with an increasing tendency for cozy self-interests to prevail. GNP growth has slowed—unemployment has reached an intolerably high level (pan-Europe) and doggedly refuses to nudge down. EEC estimates reveal that the cost of non-European unity currently exceeds $100 billion dollars—$100 billion revenue lost due to internal trade barriers. To put that into perspective, that represents a year's growth in Europe today. SEA (The Single European Act) will change all that—prognosis number three.

(Slide 4)

Listed here are just a few examples of "hidden" trade barriers, and these are just some. Believe me, they are multitudinous in nature. This is today's reality. A reality we've grown up with, and a reality we've organized our activities, built factories, marketing plans, business strategies, and end products around.

(Slide 5)

At the stroke of midnight, 30 December 1992, all of these strategies and plans will be rendered obsolescent. They are all obsolescent now. Companies that are today still acting in a "country" organization structure and defining tactical issues on a local basis are in grave danger of missing the boat. On the 31st December 1992, we will have a have a free domestic market of over 330 million people, very nearly as many people as in the U.S. and Japan combined. Some of today's companies will not make the transition—they will fail to survive in this new competitive environment.

If you would allow me to hypothesize that you accept that this will be the consequence of the SEA—given the drastic consequences it will bring—why then is it so necessary to change in the first place?

(Slide 6)

One of the few things in life that is a given certainty is progress. It is inevitable--I agree that not all progress is necessarily for the best, but nonetheless it happens. In the economic scenario, progress has taken us to a new dawning—one I would like to call "globalization." Joe Duncan, Dun & Bradstreet's corporate economist and chief statistician, points to seven factors that together characterize the new global economy.

- First, trade and the fact that this has become now largely deficit driven. Large regional trade imbalances are no longer politically or commercially an acceptable way of life.
- Second, macroeconomic policy—it ripples around the world. We worry about the size of the U.S. budget deficit, the fact that Germany remains unwilling to stimulate internal demand, and whether or not Japan really will open up its markets.
- Third, currency fluctuations are a real wild card. How do you plan where to build new factories in an environment where an exchange rate variance can render them uncompetitive overnight, even before they have come on stream?
- Fourth, international competition. That situation will continue to intensify.
- Fifth, direct and indirect investment. Do I manufacture or buy the component or service I need? Will this be via an outsourcing agreement or via a joint venture?
- Sixth, foreign capital flows. The excess liquidity at the global level slopping around the world seeking the best interest level or return is 26 times bigger than the total of all world trade put together. It is no longer trade factors that determine exchange rate values today—it is excess liquidity.
- And, finally, information transfer. It is far easier than ever before, since financial transactions etc. are knitted together by instantaneous communications.

I would like now to turn more specifically to your own industry, i.e. semiconductors, and its related fields, and to examine just where this industry is positioned today against the global backdrop I have just painted.

(Slide 7)

The semiconductor industry is currently embarking on a new phase in its evolutionary process. Phase 1 was technology-driven and the U.S. won that round. This was primarily due to the social and political environment at the time, ready access to venture capital, lots of innovation, and a strong military/aerospace industrial driver.

Eventually technological strength alone was not sufficient and the mid-70s saw Phase 2 arrive—manufacturing. That round went to Japan, again due to their social and economic environment at the time, manufacturing science, people discipline, culture, and better economies of scale. That too is no longer sufficient.

The 1980s have brought us to Phase 3—the marketing era. This is opening right now and no clear winners have yet emerged.

(Slide 8)

The implications, though, that it has on our industry have emerged. The winners in the marketing phase will be determined by these companies who today are positioning themselves internationally. And by that I don't just mean selling internationally, I mean sharing internationally: sharing products and technologies; embarking on horizontal and vertical alliances; and restructuring their organizations accordingly. All of this of course must clearly keep the focus on the customer as the priority objective.

Let's now get down to the next level of detail and look first to see how Europe's end equipment industries are faring, and then, the position of Europe's semiconductor industry and its prospects for being among the winners for this next phase of the semiconductor evolution.

(Slide 9)

At the time the SEA becomes law, Dataquest predicts that the European semiconductor market will exceed $10 billion in value, up from our current estimate of the 1987 European market of $6.4 billion. That delta is slightly more the size of the whole of the 1983 European market. I would like to examine now what lies behind this growth rate and at the key industry segments that will impact the growth.

(Slide 10)

The computer segment will continue to have a major impact. With the creation of new emerging standards like UNIX and X OPEN, we expect to see more aggressive postures adopted by equipment vendors for larger market shares. This in turn will impact on price/performance ratios of semiconductors.

It is important to remember when talking about computers nowadays that this industrial segment is no longer dominated by the mainframe computer. That era is fading after 30 years of dominance—the micro is taking command and in this area Europe's manufacturers have an already established strong position.

In 1987, microcomputer revenue surpassed mainframes and there were over 15 million PCs shipped into U.S. offices alone. The balance of power has moved to small systems that didn't even exist 10 years ago. Today's 80386-based machines can be bought for between $5K to $10K and offer the computing potential equivalent to the last generation of mainframes. By 1992, you will have 100 mips of computing power on your desk for the same cost as an 80386-based machine today.

(Slide 11)

Overall, the telecommunications market is not expected to experience rapid growth rates, mostly due to the slowdown in the number of digital lines installed as the system upgrade program reaches maturity, and the fierce PABX competition continues. The picture looks brighter for modems, cellular phones, and local area networks, other areas of European strength. In the wake of the recent consolidation amongst the European industry leaders, the now slimmed-down companies are better equipped to grasp the challenge that these opportunities will provide.

(Slide 12)

The consumer industry is making increasing use of sophisticated semiconductor devices and is responsible for driving some leading-edge products like data conversion and DSP products. Philips and Thomson dominate this market in Europe and together with Amstrad, especially as DSB starts to impact, are well poised to maintain this leadership position.

(Slide 13)

The joint Eurofighter project will have a major impact in Europe as it is not clear which military specification will be used for semiconductor components. This could be either U.S. specifications or the recently adopted CECC specifications. The resounding success that Airbus has had on the civil aircraft market is best measured by the rapid increase in protectionist political lobbying by Boeing in the United States over the past two years.

(Slide 14)

The relative strength of the European currencies over the U.S. dollar has resulted in a slowdown of exports of luxury models to the U.S. market. However the future trends for higher semiconductor contents in the midrange models will make the automotive market one of the most exciting segments for semiconductors.

It is important here to remember that Europe produces more cars (12 million) than either the U.S. or Japan (8 million each), almost comparable with the total production of the U.S. and Japan added together. The problem today is that current "nontariff" trade barriers don't allow this potential economy of scale to be realized—1992 will change all that.

(Slide 15)

Finally, the industrial segment. This remains fragmented, but, for example, the adoption of solid-state electricity-measuring meters will give this area a big boost in semiconductor consumption, as the potential volumes involved are similar to those seen in the video games arena. Last year alone saw 2 million units shipped in field trials.

An even bigger potential market will be that of the smart card, not particularly the financial sector of this market (though I agree that will be significant) but the disposable market, e.g. intelligent (nonforgable) tickets.

What I would like to do now is to examine how Europe's big three semiconductor manufacturers are positioned in these six industrial segments, i.e. Philips, SGS-Thomson, and Siemens.

(Slide 16)

This slide shows the relative market size within the total European market along with the three companies' relative market ranking within the individual sectors. As you can see, apart from data processing and military sector, Europe's big three hold a commanding position. Now let's examine the facts behind these already impressive facts.

First, military. I've already discussed that this is a future high-growth segment, yet apparently Europe's semiconductor manufacturers do not participate strongly? Wrong, the number two supplier is Plessey/Ferranti just slightly behind National/Fairchild and ahead of Texas Instruments at number three. And with SGS-Thomson's total commitment to the European CECC program-I predict this picture will change dramatically over the next five years.

In industrial, ASEA Brown Boveri commands the number five position and in consumer, ITT is number four. Though strictly speaking ITT is in our definition a U.S.-owned company—in reality it is totally European in structure, management, and control. I do not believe I am distorting the facts therefore by including ITT amongst the European manufacturers for the purpose of this analysis.

In the other segment, data processing, we are all well aware that Europe's computer manufacturers conceded defeat to the U.S. in the mainframe market in the 1970s. No wonder, therefore, that the European semiconductor manufacturer's share here is the lowest. As I mentioned before, though, the whole characteristic of the data processing segment has changed—by 1992, therefore, we predict that Europe's semiconductor market share in this segment will increase from its present 24 percent to 35 percent.

(Slide 17)

The overall impact is shown here. Today's reality is that Europe's semiconductor companies control significant market share on a by-segment basis within Europe, from a low of 24 percent in data processing to an impressive high of 65 percent in consumer electronics.

This achievement is the state of play at the entry point of the SEA. It has been achieved from a position of disadvantage brought about by fragmented markets, specification differences, and other operating and marketing inefficiencies. By 1992, those disadvantages will no longer be relevant. The true potential power that these numbers reflect will be capable of being unleashed against Europe's global competitors.

Furthermore, I predict that the market pull will increase dramatically over the same time period, especially as Europe continues to flex its new-found cooperative strength under the banner "united we stand—divided we fall." For example, we are all well aware of the EEC antidumping issues that have affected the electronic printer industry over the last few months. This next slide clearly demonstrates the impact.

(Slide 18)

This year, Japanese production of electronic printers in Europe will reach 1.2 billion units, up from less than 100K units in 1987. Next year, it will rise a further dramatic 40 percent to 1.7 billion units. And with an EEC mandated 40 percent minimum local content, this is a huge shot in the arm; a tremendous marketing opportunity for Europe. There will be many more examples of this kind to follow as Europe starts getting tough in the globalization economic era.

(Slide 19)

Let's now step down one more level to look at the area of semiconductor production in Europe. Approximately 75 percent of the total semiconductor manufacturing base in Europe is European-owned. I predict that this will decrease over the next five years, not in real terms, but as a percent of total, as foreign companies rush to build new factories in Europe. And here I'm not talking about low value-added assembly plants—the semiconductor equivalent of a screwdriver plant. I'm speaking about full-blown wafer manufacturing facilities. Already Japan, led by NEC in Scotland, has gotten this message loud and clear.

I'd like to pause now to reflect on what I've been discussing over the past 30 minutes or so. What I've tried to do is to walk you "top down" through the current economic, political, and social environment, and show you how we see this changing over the next five years; to look at where Europe's end equipment markets are within this context; and the position of Europe's semiconductor industry to support this. I've made several prognostications en route, but so far no conclusions. Before I do that, I'd like to traverse that same route, "bottom up"—the classical analyst's approach to issue solving.

(Slide 20)

Whenever I've shown this slide in the past, it is always the first-level facts that dominate the dialogue. "See how dominant Japan is in its home market—isn't it time we forced them to open their markets?" Another common statement is "Look how small Europe's share of its own market is, compared with that of Japan and the U.S." To me though, the correct analysis is that Europe, far from being the laggard, is actually a perfect representation of the model multinational citizen of the future—build where you sell, buy where you build—emphasis on local value added.

(Slide 21)

In this new model of future excellence, the essence will be focused on a more even balance and sharing internationally. I would remind you of my earlier comments on the factors characterizing the new globalization economic era.

Europe has already achieved this balance. Its downsizing and adjustment process is well down the track. The U.S and Japan are only just beginning on this route and for them, the painful adjustment process that Europe went through in the 1970s and early 1980s lies ahead. I'm sure they will adjust quicker than Europe did, but today Europe has the strategic and tactical advantage.

(Slide 22)

This necessary adjustment to the U.S and Japanese semiconductor domestic supply markets is of course an export opportunity for Europe's semiconductor manufacturers. In past years, poor export performance has been a fundamental characteristic of the so-called European malaise. Not any more I am glad to say.

In 1987, exports accounted for 42 percent of Philips' worldwide revenue, 38 percent of SGS-Thomson's, and even Siemens, with its still essentially parochial marketing approach to semiconductors, achieved a commendable 28 percent figure. With the already strong home base I talked about earlier, the impact 1992 will have will be in making this position even stronger. European companies are positioned with the strongest set of cards than at any time previously in the history of the semiconductor industry.

Let's turn now to the political initiative in the EEC. What chance does the EEC really have of significantly influencing industrial policy after 40 years or so of internal wrangling over such items of global importance as the price of sugar beet, milk quotas, and other agricultural related issues?

(Slide 23)

In the beginning was Esprit, considered at the time as doomed to failure, except perhaps by the more visionary champions.

This slide shows the present status at the end of the first phase of the program. Even the most cynical are now compelled to accept that this initiative has not been a failure. I would agree it is too early to say it has been a resounding success, but I believe it is fair to say that it has exceeded even the most optimistic of expectations at the onset. It also showed that collaborative research could work and it spawned many clones, e.g. Alvey, Eureka, and Jessi as well as specific company collaboratives, e.g. Philips' and Siemens' Megaproject. Moving on from collaborative research and development to manufacturing, I would remind you of a prophecy I made in 1984 that a major restructuring in the world semiconductor industry was imminent.

To succeed in the semiconductor industry you need to have either a sufficiently large market share to be somewhat isolated and protected from the industry's cyclical or tactical issues (that figure is around 4 to 8 percent market share). Or you need to be small enough to exploit a niche market opportunity, either technology or market related, where other factors allow a leadership position to be developed within a narrow field. Only a handful, perhaps 10 or 12 companies, will be in the former position, whereas in the latter position, this is where the bulk of the semiconductor companies will lie. Each will have less than 1 percent market share.

It is in the middle band where the bulk of the industry realignments will occur—companies that are too big to be small and too small to be big. For these companies there is only one of two options. Merge (or be merged) or face extinction.

(Slide 24)

As you are aware, there have been many such examples of mergers in the semiconductor industry over the past 18 months, most noticeable in Europe that of SGS and Thomson, Plessey and Ferranti, and Brown Boveri and ASEA. In all cases, the combined companies are potentially much stronger and better equipped to face the issues of globalization than either part could have done independently.

(Slide 25)

Moving on now to Europe's equipment manufacturers. Here, too, evidence of change is endemic. I'd like to draw your attention to two interesting examples.

First, cellular radio in Scandinavia. As the result of cooperation between the four local manufacturers and their PTTs, Sweden, Norway, Denmark, and Finland have managed to achieve an economy of scale and technological leadership that none could possibly have achieved unilaterally. And that in perhaps the most closeted of all industries—telecommunications.

(Slide 26)

Secondly, the activities of an organization called STACK. In existence now since the early 1970s, STACK is a user group of predominantly European system manufacturers whose role is to exploit the benefits of shared resources. An incredibly visionary decision when first formed and one of Europe's true success stories.

Its early pioneering work has already put in place real programs covering the issues that are today only just beginning to achieve the necessary level of visibility in many other companies.

(Slide 27–29)

These three slides show a sample of some of the programs STACK has already established.

(Slide 30)

If one returns to the changing industry characteristics brought about by the era of global economy, these driving forces at work in the changing supplier/customer relationships show remarkable coincidence to the programs already successfully undertaken by STACK.

(Slide 31)

I mentioned this briefly earlier in my talk, but the implication of the previous slide is that as a result of the changing supplier/manufacturing relationships, foreign companies operating in Europe will progressively move down the so-called "value added" manufacturing chain, from sales, moving rapidly through pure assembly (or screwdriver operations) down to design, development, real local manufacturing, and local procurement, to eventual export of original European conceived and manufactured products. IBM is probably the best established in this regard at the present time, though other foreign companies, notably Digital and Sony, are catching up fast—the trend is inevitable. Given the 1992 deadline, we expect an acceleration of this trend as foreign companies strive to become good Europeans before the internal trade barriers fall.

(Slide 32)

I polled our internal Dataquest statistics recently to review the five hottest areas in the electronics equipment markets. They are shown here listed in this slide. Europe's electronics manufacturers are already strongly positioned in all of these areas of activity. The SEA and the resultant strength that a consolidated single market will provide gives them a unique opportunity to achieve a world-class position as these industrial segments reach maturity.

I would like now to use my closing minutes to draw some conclusions.

(Slide 33)

First, Europe will become a unified market after 1992. Restrictive trade barriers will be illegal, the market size will truly be 330 million people, and new European standards will emerge, especially in the areas of consumer electronics, telecommunications, and data processing. Companies that fail to recognize this prospective reality are destined for the scrap heap. And no matter how intransigent the problems may appear today, ignoring the inevitable will not help.

The resultant economies of scale will drive down operating costs and Europe will be not only more competitive in its own market, but strategically and tactically positioned to exploit the export opportunities from a position of strength and equality with its other world competitors.

(Slide 34)

Europe will have the necessary semiconductor technology in place. Programs such as Esprit, Eureka, Megaproject, and Jessi will ensure that. It has today a production process capability comparable to the best, e.g. 1.2 micron CMOS, 1.5 micron bipolar, BiCMOS, and state-of-the-art sophisticated packaging techniques.

The EEC initiative will also ensure that multinationals do adopt sound "good citizen" operating principles already discussed, including a high value-added local procurement content, and collaborative research and development, to ensure a strong manufacturing base is maintained. Europe's existing industrial strength will increase significantly.

(Slide 35)

As I speak to you here today, 1992 is only 1,653 days away. The question that remains on the table is whether the progress towards it will be evolutionary or revolutionary. Clearly the methods of managing revolution are different from evolution.

I believe it will be revolutionary—and those companies that act the fastest will be the ones to make the substantial gains in the future. Indeed, I would go even further. I believe that if you haven't today already got a clear plan in place to take account of this effect that the SEA will have when it comes to force an 31st December 1992, it may already be too late.

Now for some tactical advice—how to organize a revolution.

(Slide 36)

For this I've called upon the collective wisdom of prior experts to this field: Marx, Lenin, and Mao.

- Get rid of the old guard
- Build a new team
- Explain the new reality
- Develop a new philosophy and culture
- Implement a new strategy
- Declare a general modularization
- Keep the revolution going

(Slide 37)

To conclude, I believe we do have a picture of 1992; we think we know what it will look like, but the trouble is, it is currently a jigsaw and the pieces are distributed throughout the countries in Europe. For the first time in nearly two decades, the 1990s offer the outlook of a new springboard for economic policy management and for major reductions in chronic European unemployment.

I would like to close by postulating the answer to the following question: What will be the critical success milestones looking back to 1992 in, say, 1998?

The first is really a prerequisite, without which the reality of a single European market will be unattainable—monetary unity and a central European bank. The second is qualitative, a perspective, and that is the feeling that the job is not quite finished yet. And third, the quantitative aspect, that the growth in Europe was higher than it would have been had unity not occurred.

The challenge of a single European market by 1992 is first and foremost a challenge for Europeans. If they respond robustly, they will propel Europe onto the world stage in a position of competitive strength and on an upward trajectory of economic growth lasting into the next century.

Jennifer Berg
Malcolm Penn

(Slide 1)

1992: HAS EUROPE GOT IT?

MALCOLM G. PENN

VICE PRESIDENT

DATAQUEST EUROPE

(Slide 2)

1992

In 1992 the EEC countries form a genuine 'Common Market'.

'The 31st December 1992 deadline is now enshrined in a single European Act which defines the international market as an area without frontiers in which the free movement of goods, persons, services and capital is insured'. 'In recent months there has been an upsurge of support from businesses for the grand design implicit in the 1992 deadline'.

'The Commission will develop a policy to promote the services market with an eye to completion of the internal market and the growing globalisation of trade'.

JACQUES DELORS - EEC PRESIDENT - 20 JANUARY 1988

(Slide 3)

POSTWAR WORLD ECONOMIC RECOVERY

- Market liberalization
- 1920s/'30s trade barriers dismantled
- Government-nurtured cartels broken up
- Controls on direct foreign investment lifted

Since the 1970s there has been
a gradual shift away from market-led forces

The Single European Act will turn the tide

(Slide 4)

TRADE BARRIERS -- EUROPE

- Technical
  - -Standards (TV, telecommunications, power supplies)
  - -Safety
  - -Environmental (RF radiation, automobiles)

- Financial
  - -Standard terms and conditions
  - -Local currency trade
  - -Interest rates and capital sources

- Government and legal
  - -Tariffs and tax rates
  - -Duties
  - -Quotas
  - -Subsidies

(Slide 5)

1992 IMPACT

- This will require a substantial re-think of our marketing strategies
- Can manufacturers continue to have 'Country' organisations defining
  - marketing strategies?
  - sell prices?
  - inventory levels?
  - support?

(Slide 6)

NEW ECONOMIC ERA - GLOBALIZATION

Seven factors on global economy

- Trade
- Macroeconomic policy
- Currency fluctuations
- International competition
- Direct and indirect investment
- Foreign capital flows
- Information transfer

(Slide 7)

THREE PHASES OF SEMICONDUCTOR INDUSTRY

- Phase 1 – Technology
- Phase 2 – Manufacturing
- Phase 3 – Marketing

(Slide 8)

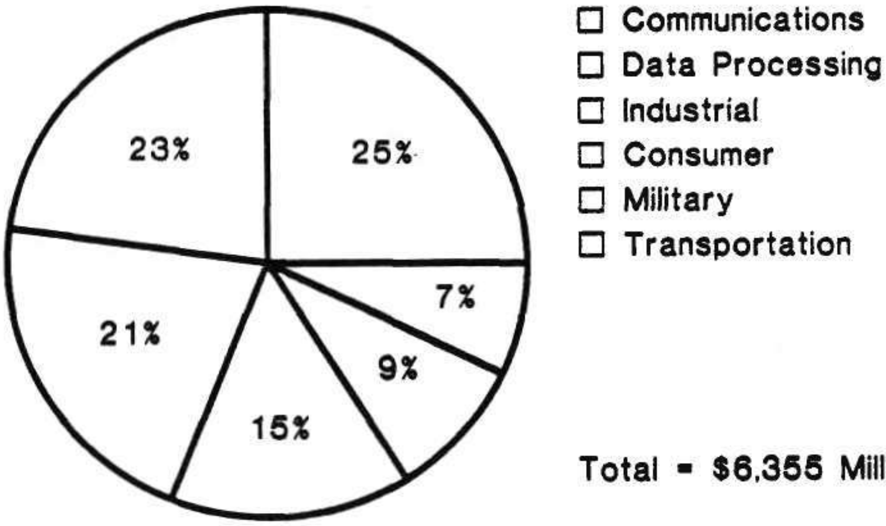
POSITIONING INTERNATIONALLY

Means sharing internationally

- Products and technologies
- Organizational restructuring
- Horizontal and vertical alliances
- Customer–orientated as first objective

(Slide 9)

EUROPEAN SEMICONDUCTOR MARKET BY END-USE SEGEMENT - 1987



Total = $6,355 Million

Source: Dataquest

(Slide 10)

EUROPEAN COMPONENTS GROUP

Telecommunications

- Merger mania
  - GEC-Plessey
  - Ericsson-Matra
  - Bosch-Schneider
  - Alcatel-ITT

- Growth areas - 1987-1988
  - Modems - $540 million to $611 million - 13.1% growth
  - Central switches - $8.7 billion to $8.9 billion - 2.8% growth
  - Cellular phones - $730 million to $951 million - 30.3% growth
  - LANs - $524 million to $786 million - 49.9% growth

Source: Dataquest

(Slide 11)

EUROPEAN COMPONENTS GROUP

Computers

- Northern Europe takes the lead
  - Amadahl, Apple, Compaq, Digital, IBM, ICL, Wang
- Higher-resolution graphics
- Networking
- 3.5" disk drives

(Slide 12)

EUROPEAN COMPONENTS GROUP

Industrial

- Medical
  - GEC/Philips venture abandoned

- Energy management
  - Solid-state meter trials in U.K. and France successful
  - Enertec, Ferranti, GEC, Sangamo, Siemens

(Slide 13)

EUROPEAN COMPONENTS GROUP

Consumer

- "Professional consumers"
  - Nokia, Philips, Siemens, Thomson
- Compact disks (DSPs, video, RAMs)
- High-definition TVs (DACs, DSPs, ECL)
- Digital audio tape

(Slide 14)

EUROPEAN COMPONENTS GROUP

Military

- Eurofighter project
- Procurement flat in U.K. and France
- Potential growth in German market
- Airbus Industrie

(Slide 15)

EUROPEAN COMPONENTS GROUP

Transportation

- Huge impact due to currency revaluation
- Slow growth in luxury models
- Semiconductor content increasing
- Car production higher in Europe than in U.S. and Japan

(Slide 16)

EUROPEAN END-USE VENDOR RANKINES - 1987

(Millions of US Dollars)

Segement	Philips	SGS-Thomson	Siemens	Market Size
Data processing	4	8	6	23%
Communications	1	3	5	25%
Industrial	1	3	2	21%
Consumer	1	2	3	15%
Military	4	8	N/A	9%
Transportation	6	2	1	7%
Total	1	2	5	100%
Revenues	$930	$537	$475	$6,335

Source: Dataquest

(Slide 17)

EUROPEAN END-USE VENDOR MARKET SHARES - 1987

Segement	% Share
Data processing	24
Communications	40
Industrial	49
Consumer	65
Military	36
Transportation	48
Total	43

TOP 5 EUROPEAN COMPANIES CONTROL 38% OF THE MARKET

Source: Dataquest

(Slide 18)

JAPANESE PRINTER MANUFACTURER SURVEY

Expected Offshore Printer Production (Thousands of Units)

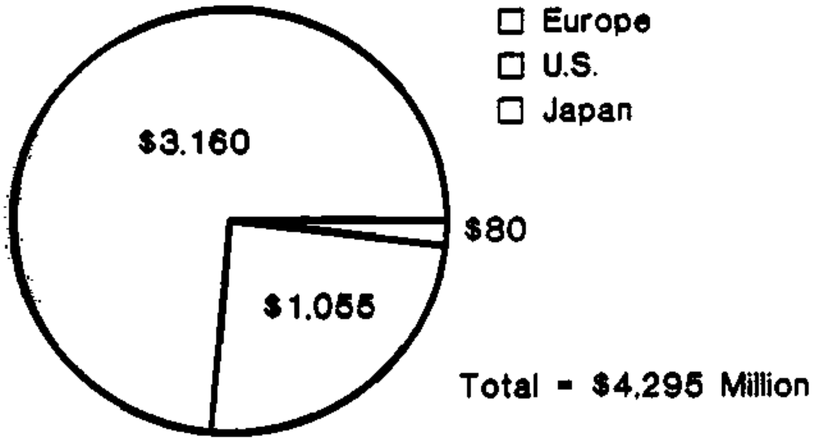
	1987	1988	1990
North America	205	500	850
Western Europe	92	1,245	1,740
Rest of World	3	5	10
Total	300	1,750	2,600

Source: Dataquest

(Slide 19)

ESTIMATED EUROPEAN SEMICONDUCTOR PRODUCTION IN 1987

(Millions of U.S. Dollars)



Source: Dataquest

(Slide 20)

1987 REGIONAL MARKET SHARES

(Billions of US Dollars)

	Europe	US	Japan	ROW	Total
Europe	2.6	0.8	0.1	0.5	4.0
US	2.9	8.7	1.2	1.1	13.9
Japan	0.9	2.0	13.0	1.9	17.8
ROW	0.0	0.2	0.0	0.4	0.6
Total	6.4	11.7	14.3	3.9	36.3

Source: Dataquest

(Slide 21)

1987 EUROPEAN EXPORTS

(Millions of US Dollars)

	Philips	SGS-Thomson	Siemens
Europe	$930	$537	$475
Other	673	322	182
Total	$1,603	$859	$657
% Export	42.0	37.5	27.7

Source: Dataquest

(Slide 22)

IN THE BEGINNING - ESPRIT

Of the 227 projects in first phase

- 143 Industrial significance
- 27 Marketed products
- 44 Products in developments
- 44 Transferred outside esprit
- 28 Contributed to international standards
- 11 Scrapped or merged

(Slide 23)

EUROPEAN SEMICONDUCTOR MERGEOVERS

- Plessey/Ferranti
- Brown Boveri/Asea
- SGS/Thomson

(Slide 24)

CELLULAR RADIO - SCANDINAVIAN EXAMPLE

- Common system throughout Scandinavia
  - Sweden
  - Norway
  - Denmark
  - Finland
- Co-operation between PTT's and local manufacturers

(Slide 25)

stack

STANDARD COMPUTER KOMPONENTEN GmbH

Control Data Corporation
International Computers Limited
The Plessey Company plc
Nixdorf Computer A.G.
Ing. C. Olivetti & C., S.p.A.
British Telecom plc
The General Electric Company plc
Standard Telephones & Cables plc
General Telephone & Electronics Corp.
Honywell Bull Inc.
Italtal S.p.A.
Northern Telecom Limited

(Slide 26)

VENDORS - USERS
CLOSER CO-OPERATION - TO ACHIEVE

- Better Communication
- Improved Quality and Reliability
- Optimum Testing
- Ship to Stock Procedures
- On Time Delivery
- Just in Time Delivery
- Accurate Forecasting
- Shorter Lead Times
- Electronic Data Interchange

(Slide 27)

VENDORS - USERS
CLOSER CO-OPERATION - TO ACHIEVE Cont.

- Standard Packeting for Devices
- Standard Labelling e.g. Bar Codes
- Electronic Data Sheets
- Computerized Device Models
- Realistic ASIC Second Sourcing
- Productive R & D
- Realistic Pricing
- Improved Quality and Realiability
- Lower Cost of Ownership

(Slide 28)

FORMAL MEETINGS

- Technical Policy
- Purchasing - Trend and Techniques
- Test and Correlation
- Purchase Specifications
- Shared Evaluation
- Semi-Custom - USICs
- ASICs
- Failure Analysis Techniques
- Surface Mount Technology
- Surface Mount Dimensions
- Reliability

(Slide 29)

SUPPLIER / CUSTOMER RELATIONSHIP

Closer	Strategy – Technology roadmaps
	Product migration linkage
	Matched quality programmes
	Co-operative programmes
	– Developments
	– Qualifications
	– Tools
	Total data sharing
Longer-fewer	Take time to establish
	Resources to maintain
	Sensitive data transfer
	Win-win requires changes

(Slide 30)

VALUE ADDED MANUFACTURING CHAIN

- Sales
- Assembly
- Manufacturing
- Local procurement
- Design and Development
- Export

(Slide 31)

MULTINATIONAL CITIZEN PROFILE

Buy where we build and sell

- Products
- Services
- Technology
- Jobs
- Export

(Slide 32)

MAJOR MARKET OPPORTUNITIES

Markets	5-Year CAGR*
32-bit PCs	53.0%
Digital TVs	30.0%
Smart Card Electronics	60.0%
Automotive Electronics	10.7%
Personal Communications	26.0%

* Measured in dollars

Source: Dataquest

(Slide 33)

EUROPEAN ELECTRONICS INDUSTRY

Future Trends

- Europe will become a unified market after 1992
- Restrictive trade barriers will disappear
- Size of population will be 330 million
- New European standards will emerge in consumer, telecommunications, computer
- Scale of economy will drive down costs
- Europe will be more competitive in its own market

(Slide 34)

EUROPEAN ELECTRONICS INDUSTRY

Future Trends

- Europe will have state-of-the-art processing capability
  - Esprit, Eureka, Megaproject, Jessi

- European Community will ensure:
  - Multinationals sourcing components locally
  - Collaborative R & D on all fronts
  - Maintaining strong manufacturing base

- Europe
  - Still strong in consumer, automotive
  - Telecommunications will get stronger
  - Stability in military market

(Slide 35)

ARE WE FACING EVOLUTION OR REVOLUTION?

- If we decide the 1992 opportunity will substantially change the "rules" under which we operate – then it must be "revolution".

- The methods of managing revolution are clearly different from evolution!

(Slide 36)

HOW TO ORGANISE A REVOLUTION

1. Get rid of old guard
2. Build a new team
3. Explain the new reality
4. Develop a new philosophy and culture
5. Implement a new strategy
6. Declare a general mobilisation
7. Keep the revolution going!

Source: Marx, Lein, Mao

(Slide 37)

THE 1992 CHALLENGE

HIGH STAKES FOR EUROPE –

THE PRIZE WITHIN THE GRASP

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FAR EAST MARKET OVERVIEW

SUMMARY

The year 1987 was full of major changes for Japanese printer manufacturers. The dollar-to-yen exchange rate reached the highest point in history, antidumping pressures from Western Europe became a reality, and Japan was asked to change its export-oriented economic structure.

This newsletter focuses on several topics relating to the Japanese printer industry, including the following:

- Japanese worldwide printer shipments
- The Japanese domestic market
- Trade friction
- Japanese overseas manufacturing trends

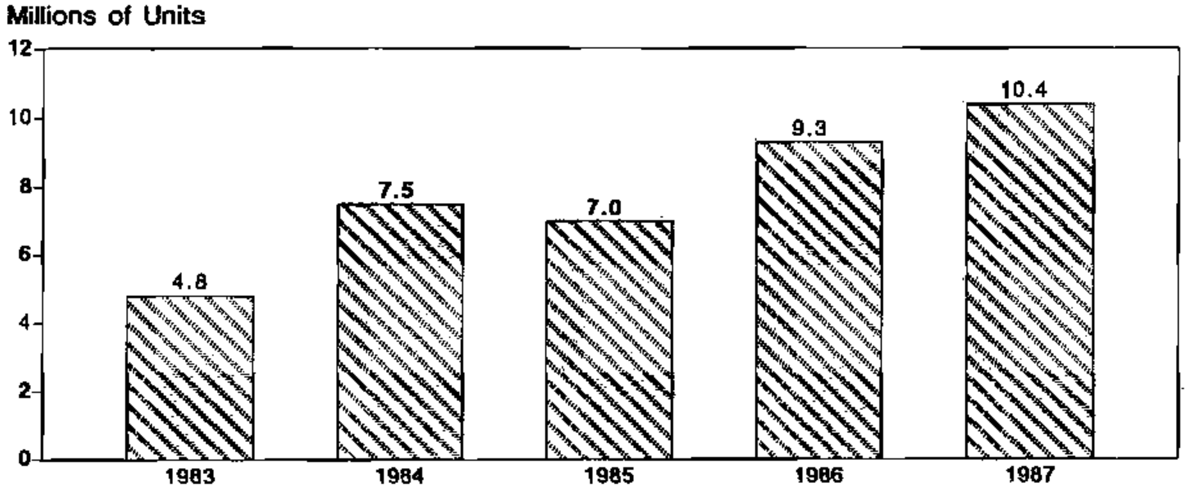
(The material in this newsletter was derived from a presentation given by Kenji Muto, an Industry Analyst at Dataquest Japan. Mr. Muto gave his presentation at Dataquest's thirteenth annual Electronic Printer Industry Conference in April 1988.)

JAPANESE WORLDWIDE PRINTER SHIPMENTS

As shown in Figure 1, Japanese printer shipments for the past five years have grown at a compound annual growth rate (CAGR) of 22 percent. In 1983, 4.8 million units were shipped; in 1987, 10.4 million units were shipped with an export ratio of 90 percent. Dataquest expects that Japanese local printer production will drop below 10 million units in 1988. This expected decline in local Japanese production will result from the production shift to Western Europe due to EEC protectionist actions.

Figure 1

Total Japanese Printer Shipments



Source: Dataquest
June 1988

The 1987 Japanese printer shipments by world region are shown in Figure 2. The 10.4 million units shipped are broken out into the following regions:

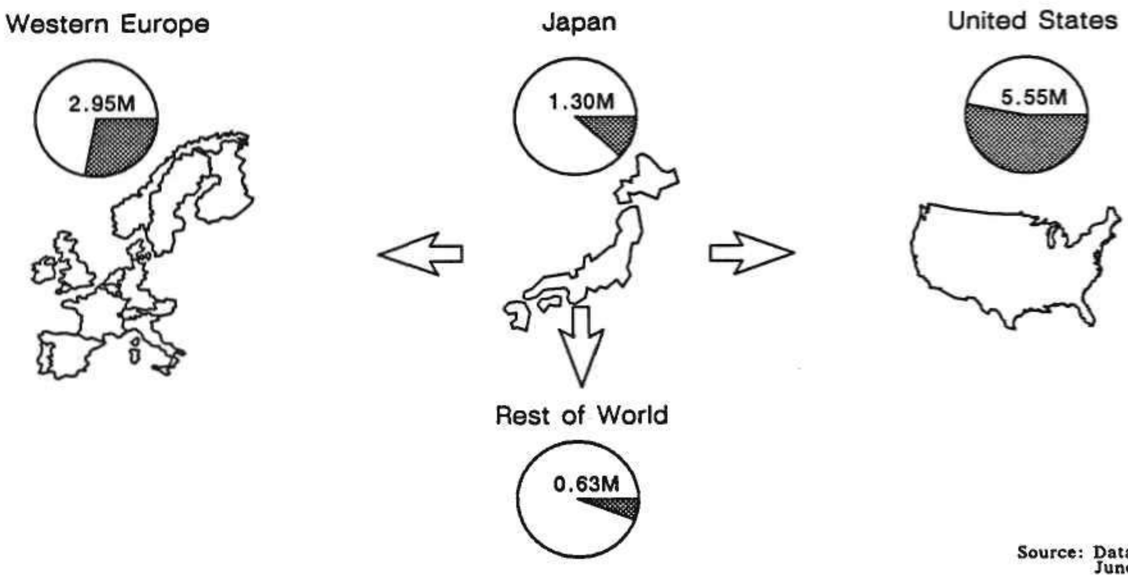
- 5.55 million, 53 percent, shipped to the United States
- 2.95 million, 28 percent, shipped to Western Europe
- 0.63 million, 6 percent, shipped to the Rest of World countries
- 1.30 million, 12.5 percent, remained in the Japanese domestic market

Table 1 illustrates the 1987 Japanese printer shipments for the overseas and domestic markets, by printer technology. For the 1987 overseas market, the combined serial, impact, dot matrix (SIDM) and page, nonimpact, plain paper (PNPP) printers represented more than 90 percent of total units shipped. For the 1987 Japanese domestic market, however, the serial, nonimpact, thermal transfer (SNTT) and serial, impact, dot matrix printers accounted for more than 90 percent of the shipments.

In terms of units, Epson is the world's leading printer shipper with its products under the Epson brand name. The second leading exporter is TEC, which is an OEM-oriented company. Following TEC is Oki. For the Japanese domestic market however, NEC is the leading shipper because of its 40 percent personal computer market share. Total Japanese domestic computer shipments for 1987 were estimated at 1.3 million units, with PCs accounting for 1.2 million units. Following NEC in the domestic printer market are Epson and Oki.

Figure 2

1987 Japanese Printer Shipments by Region



Source: Dataquest
June 1988

Table 1

1987 Japanese Printer Shipments, by Technology

Technology	Overseas		Domestic	
	Units(M)	Percent	Units(M)	Percent
Serial, Impact, Dot Matrix	7.61	83.5%	0.94	72.1%
Page, Nonimpact, Plain Paper	1.14	12.5	0.03	1.9
Serial, Nonimpact, Thermal Transfer/ Direct Thermal	0.08	0.9	0.27	21.0
Serial, Impact, Fully Formed	0.23	2.5	0	0.1
Serial, Nonimpact, Ink Jet	0.04	0.4	0.02	1.6
Line, Impact, Fully Formed/ Dot Matrix	0.01	0.1	0.03	2.6
Line, Nonimpact, Thermal Transfer/ Direct Thermal	0.01	0.1	0.01	0.7
Total	9.12	100.0%	1.30	100.0%

Source: Dataquest
June 1988

Most of the Japanese firms are quite diversified. Consequently, printer sales are a small portion of their total business. For Epson, TEC, and Oki, 40, 25, and 20 percent of their total sales, respectively, are attributed to printers, and only 4 percent of NEC's sales are attributed to printers.

Japanese Domestic Market

The 1987 Japanese domestic printer market represented 1.3 million units (12.5 percent) of the total worldwide Japanese shipments. Dot matrix printers accounted for 940 thousand units (72.1 percent) and thermal transfer printers accounted for 270 thousand units (21 percent). Shipments of other printer technologies represented rather small shares of the market.

Shipments of the 24–wire, dot matrix printers in Japan accounted for 93 percent of all serial, dot matrix printer shipments, whereas the 18–wire printers accounted for only a few thousand units shipped. This imbalance is a result of the high resolution offered by 24–wire printers, which is needed when printing kanji characters. It is interesting to note that Epson recently introduced a $2,500, 48–wire, 300–dpi dot matrix printer, to the domestic market, the VP–4800.

The previously discussed Japanese domestic printers are those that are connected to computers. In the thermal transfer market, there is another market segment, the built–in Japanese word processor market (JWP). In 1987, more than 2 million JWP units were sold, of which at least 1.5 million were lap–top type printers. The JWP lap–top configuration consists of the following:

- A keyboard
- An LCS 4 x 10–inch display
- A 3.5–inch flexible disk drive
- An 80–column serial, nonimpact, thermal transfer (SNTT) printer

If this shipment segment were counted, the total serial, thermal transfer market would consist of 1.8 million units. In terms of resolution, JWP printers are increasing to 36, 42, and even 56 elements per printhead.

Table 2 shows the Japanese domestic printer market rankings segmented by technology. As noted in the table, NEC is strong in the serial, dot matrix technology. The most popular speed range is 120 to 180 cps, accounting for 40 percent, followed by 181 to 250 cps, accounting for 25 percent. Printing kanji takes approximately one–third to one–half the time required for printing the Japanese alphabet—alphanumeric Kana (ANK).

Table 2

Japanese Domestic Market Share
(Based on Units)

SIDM		SNTT		PNPP	
1. NEC	49%	1. NEC	80%	1. Canon	90%
2. Epson		2. Epson		2. TEC	
3. Oki		3. Hitachi		3. NEC	

Source: Dataquest
June 1988

For the serial, thermal transfer technology, NEC is again the top market participant. The personal computer market affects this segment because the printers used are for the low-end PCs. The top three participants hold 80 percent of the market and offer speeds of less than 120 cps.

In 1987, Japanese page printers were in the introductory stage, and only 28 thousand units were shipped to the domestic market. However, we expect the Japanese domestic page printer market to soar in 1988. The desktop publishing market is also expected to grow in the third quarter of 1988.

TRADE ISSUES

Our trade friction analysis is based on our Japanese printer manufacturer survey in the first quarter last year. The survey results are based on 27 of the major Japanese printer manufacturers. Seventeen companies responded to the survey. Our survey covered the following topics:

- The movement of overseas production and its related problems
- The exchange rate issue and its effect on overseas production
- The Japanese printer manufacturers' response to trading difficulties

As previously stated, the major Japanese printer production technology is serial, dot matrix. The survey respondents accounted for over 70 percent of the entire serial, dot matrix production. We believe that this percentage qualifies the validity of the survey results.

Table 3 illustrates the respondents' offshore printer production plans. As shown for 1987, the actual production was 300 thousand units, of which 200 thousand were produced in North America and 92 thousand were produced in Western Europe. We project that in 1988, production units will increase to 500 thousand for North America and 1.25 million for Western Europe.

Table 3

Japanese Printer Manufacturers' Projections for Estimated Offshore Printer Production (Thousands of Units)

	1987	1988	1990
Western Europe	92	1,245	1,740
North America	205	500	850
Rest of World	3	5	10
Total	300	1,750	2,600

Source: Dataquest
June 1988

MOVE TO WESTERN EUROPE

The primary reason for Western Europe's production growth stems from the expected EEC antidumping duty expected to be levied on serial, dot matrix printers. In 1987, Japanese printer exports to Western Europe were 2.9 million units and both serial dot matrix and fully formed printers were produced in Western Europe by Japanese companies. We expect that in 1988, 38 percent of the Western European market shipments will be produced locally by Japanese firms. Page printers will also be manufactured in Western Europe. By 1990, the number of locally produced units is predicted to increase to 1.74 million units.

The situation is different for Japanese production in North America, however. Production growth is moderate in North America compared with Western Europe.

The locations of Japanese printer factories in Western Europe are shown in Figure 3. These factories have commenced operations within the last 15 months and should expand production this year. We believe that the expected monthly run rate will reach 160 thousand units. The average factory size is anticipated to be 8,000 square meters with 1,200 total employees for this factory expansion.

Figure 3

Location of Japanese Printer Manufacturers in Western Europe

1.	Brother	Wrexham
2.	Citizen	Scunthorpe
3.	Epson	Telford
4.	Star	Tredagar
5.	NEC	Tekfird
6.	Oki	Glasgow
7.	Panasonic	Newport
8.	Canon	Littre
9.	Epson	Paris
10.	Canon	Aglie
11.	Fujitsu	Malagre
12.	TEC	Braunschweig

Source: Dataquest
June 1988

Local Content

In June 1987, the EEC passed legislation to control local content of new factories set up by companies with products subject to EEC antidumping duties. Essentially, the law states that products assembled in the EEC to escape antidumping duties must have 40 percent local content. The EEC group investigating local content in European factories has recently completed its investigation of electronic typewriter factories, and it is currently evaluating local content in copier factories. The investigation of SIDM factories will begin in the fall of 1988.

How soon can Japanese printer manufacturers meet with local content requirements? Table 4 focuses on this issue. As shown, within the next two years, a 50 percent local content goal is possible, but it will pose a challenge for manufacturers.

Table 4

Japanese Printer Manufacturers' Projections for Meeting Local Content Requirements (Western Europe)

Number of Years	% Content	Part	
0.5	22	Case Mechanism	Electronic, PWB
1.0	41	Case PCB	Manual Book
1.5	45	Motor PCB	Mechanism, Electronic
2.0	50	PCB	

Source: Dataquest
June 1988

Japanese manufacturers indicated that it would take twice as long to reach a 50 percent goal, compared with 40 percent, which is the requirement mandated by the EEC. Table 5 illustrates the key concerns of Japanese manufacturers regarding overseas production in both North America and Western Europe. The three primary problems for Japanese companies manufacturing overseas are:

- Parts procurement
- Quality control
- Production costs

In the past, these problems were advantageous for Japanese manufacturers, however, but now, production and local content requirements are making overseas production disadvantageous. Production cost is a key element in manufacturing.

Table 5

Japanese Printer Manufacturers' Key Concerns in Overseas Production

Concern	Points*
Parts Procurement	91
Quality Control	82
Production Cost	71
Delivery	40
Worker Education	36
Local Government	35
Domestic Employment	31
Research and Development	23

*Maximum points possible = 100

Source: Dataquest
June 1988

This year, Japanese manufacturers have projected the dollar-to-yen exchange rate as $1 to ¥123.8. The projected range is relatively small: between ¥120 and ¥130. If the yen rises to 100, the expected overseas production ratio increases by nearly 50 percent. Changes in the dollar-to-yen exchange rate will primarily affect overseas production in North America.

Table 6 illustrates the Japanese printer manufacturers' projected actions toward government dumping charges. The top three answers to our survey question were factory set up, joint ventures with local manufacturers, and rationalization of production. In the case of Western Europe, factory set up has already taken place due to the European community movement.

One-half of the survey respondents said they believe that some sort of trade restriction action will be taken by the U.S. government. The reasons they gave dealt with inconclusive trade laws and the U.S. manufacturers' appeal regarding dumping of serial, dot matrix printers.

Regarding the high yen exchange rate, the respondents said they believe that a decrease in sales will occur. To maintain revenue, either price or volume will have to increase, resulting in either a value-added product or low-cost, high-volume production. Japanese manufacturers indicate they will focus on the following value-added areas, by technology:

- PNPP—Higher functionality, dependability, software, controller, and color
- SIDM—Paper handling, increased copies and speed, lower noise level, and special paper capabilities
- SNIJ and SNTT—Regular paper, color, and high resolution

Table 6

Japanese Printer Manufacturers' Projected Actions from Government Dumping Charges

Activity	North America*	Western Europe*
Factory Set Up	90	89
Change Export Item	31	32
Lobby Japanese Government	46	50
Withdraw from Market	17	20
Local Joint Venture	72	83
Lobby Local Government	39	37
Rationalize Production	73	71
Review Marketing Channel	42	55

*Maximum points possible = 100

Source: Dataquest
June 1988

The characteristics of the Japanese manufacturers in the printer business include the following:

- No Japanese company manufactures printers exclusively.
- Diversification of business is the mission for Japanese manufacturers.
- Capturing market share is a prime strategy. Adequate market share, low-cost, and mass-quality production can provide enough investment return.

Even among Japanese manufacturers, these characteristics lead to highly competitive environments. On the other hand, both Western Europe and the U.S. SIDM producers' governments are focused on local production and niche markets.

DATAQUEST ANALYSIS

We expect 15 percent of Japan's 1988 production capacity to move overseas. This trend is likely to continue because Japanese players are not only questioning the world economy, they are also realizing that cooperation and peaceful coexistence is imperative in order to maintain their prior levels of success. Thus many Japanese manufacturers are now seeking new ways of becoming recognized international companies by adding value to their products and contributing to the local economy.

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Research *Newsletter*

ESAM Code: Vol. II Newsletters
1988-4

FAX MARKET SURGES AHEAD; JAPAN LEADS THE PACK

SUMMARY

The year 1987 proved to be another period of major growth for the worldwide facsimile market. In regional terms, the European market grew the fastest, with a compound annual growth rate (CAGR) of 110 percent (1987 versus 1986). The Japanese market, which is more mature, increased at a CAGR of 49 percent, while the U.S. market grew by a significant CAGR of 102 percent.

In terms of unit shipments, the Japanese still led in 1987 with 1.1 million units. The number of European shipments (421,000 units) was slightly higher than U.S. shipments (417,000 units) for the second year running (see Table 1).

Table 1

Estimated Worldwide Facsimile Shipments
(Thousands of Units)

	1986	1987	1991	CAGR 1987-1991
Asia	40	60	329	53.0%
Europe	199	420	1,876	46.0%
France	21	45	256	54.5%
Italy	21	60	211	37.0%
Sweden	11	20	64	34.0%
United Kingdom	50	100	340	35.8%
West Germany	24	60	340	54.3%
Rest of Europe	72	135	665	49.5%
Japan	738	1,100	2,280	22.0%
North America	227	456	1,500	34.5%
United States	206	417	1,380	35.0%
Canada	21	39	120	34.0%
Rest of World	25	45	136	32.0%
Total	1,229	2,081	6,121	31.0%

Source: Dataquest
May 1988

All this activity is of great interest to Japan, where 98 percent of the world fax manufacturing is currently taking place.

In this newsletter, we will review the present fax market and the Japanese manufacturing phenomena. In addition, we will look at some development factors affecting the market into the 1990s.

MARKET OVERVIEW

A facsimile (fax) machine is a telecommunications product that must meet the stringent and often restrictive requirements of local PTTs and operating companies in order to receive approval for connection to the public switched telephone network (PSTN). Given that fact, it is a remarkable phenomenon that, in 1987, more than 98 percent of the approved fax machines were of Japanese origin. Furthermore, as the market continues to grow, Dataquest expects the proportion of Japanese fax machines to exceed 99 percent in 1988. The following factors contribute to this situation:

- Although the fax machine was initially developed in Europe by Muirhead and in the United States by Xerox, these western manufacturers were unable to maintain high volumes of commercially attractive products; they had stopped manufacturing fax machines by 1975.
- The fax machine was then found to fulfill a major user requirement in the Japanese market as a mean of communicating kanji characters. Consequently, the Japanese domestic fax market grew rapidly; local production became firmly established, helped by this strong internal demand.
- The fax machine proved to be a product ideally matching Japan's skills in high-volume electronic production, based on the country's abilities in improved productivity and electronic miniaturization.
- By 1987, Alcatel of France was the only non-Japanese manufacturer producing its own fax equipment (sold under the brand name Thomfax).
    - Alcatel had trouble manufacturing products to the same price margins as the Japanese, however. Consequently, during 1987, Alcatel made an agreement to manufacture equipment in France under license from Toshiba.
    - Alcatel will continue to manufacture the high-end "feature machines" but will only partly manufacture and assemble Toshiba products for the low end of its product portfolio.
- Sagem, another French manufacturer, has reached a similar agreement with Murata of Japan. However, under this agreement, Murata will supply all the products of the Sagem portfolio.
- These two agreements permit continued fax manufacturing in France and an increased dependence on Japan as the low-end fax product market share continues to increase.

- Dataquest believes that as Japanese manufacturers proceed further along the learning curve of high-volume fax production, it will become much more difficult for any other country to successfully compete in the production of facsimile equipment.

Tariffs and Import Restrictions

Having noted the domination of the fax market by Japanese manufacturers, we must also consider the issue of trade barriers. Similar situations of overwhelming Japanese production superiority have developed in both the copier and the electronic printer industries. A review of these industries may help to explain the international reaction.

During the last 12 months, action has been taken by the European Commission and a number of individual countries to impose severe penalties on products that are not at least assembled within relevant trade zones such as Europe or America. In the case of fax products, the issue of PTT approval further complicates free access to a market.

Dataquest believes that the Japanese manufacturers should take note of this international trend to require local manufacturing and should make appropriate plans. In fact, a number of Japanese manufacturers have already positioned themselves to meet such market restrictions. Most notable is Canon, which has reached a marketing and manufacturing agreement with Olivetti in Italy and has established its own fax manufacturing facilities in France.

Ricoh with Kalle Infotec, NEC, and Toshiba also have local manufacturing facilities that could commence fax operations, if required.

The 1987 Fax Market

Table 1 presents the initial Dataquest estimates of worldwide facsimile shipments for 1986, 1987, and 1991.

Table 2 shows the initial Dataquest market share estimates for the top suppliers in the European facsimile market for 1987.

Table 3 provides a breakdown of 1987 shipments into the major European countries.

Table 2

European Facsimile Market Share by Supplier (Actual Units)

Supplier	Units	Percent Share
Panasonic	70,800	16.8%
NEC	45,274	10.7%
Canon	73,900	17.5%
Infotec	38,727	9.2%
Alcatel	39,200	9.3%
Toshiba	31,650	7.5%
Oki	39,995	9.5%
Sharp	20,670	4.9%
Xerox	8,610	2.0%
Murata	17,765	4.2%
Hitachi	13,604	3.2%
Fujitsu	10,013	2.4%
Pitney Bowes	4,750	1.1%
Others	6,905	1.7%
Total	421,863	100.0%

Table 3

Estimated 1987 European Facsimile Placements (Actual Units)

Country	Units	Percent Share
United Kingdom	102,951	24.4%
France	45,032	10.7%
West Germany	59,294	14.1%
Italy	57,391	13.6%
The Netherlands	21,593	5.1%
Norway	17,392	4.1%
Sweden	21,530	5.1%
Switzerland	16,727	4.0%
Belgium	18,393	4.4%
Greece	1,839	0.4%
Finland	7,784	1.8%
Denmark	15,577	3.7%
Spain	18,827	4.5%
Turkey	3,755	0.9%
Ireland	3,030	0.7%
Austria	6,582	1.6%
Portugal	2,725	0.6%
Others	1,449	0.3%
Total	421,871	100.0%

Source: Dataquest
May 1988

Market Analysis and Forecast

From 1984 through 1986, most facsimile shipments in Europe and in the United States were aimed at businesses' communication rooms, in which the fax machine typically stood next to the telex machine. In 1986 and 1987, the low-end facsimile products began to penetrate smaller business organizations and started to find their way into department-level applications.

Dataquest believes that shipments through 1992 will show the greatest growth in the low-end product sectors. The low-end products are becoming increasingly popular in Japan; now they are becoming known by the alternative name, "personal fax." Using innovative production techniques, the Japanese manufacturers are making these products even more compact, progressively decreasing the footprint size, and integrating a telephone handset with the box.

Personal faxes are beginning to penetrate very small businesses now, in addition to being targeted for executive desktops. As the average selling price (ASP) of these machines continues to decline, two questions arise:

- What proportion of desktops and homes of business executives will become populated by faxes? In other words, what is the personal fax total available market (TAM)?

- What channels of distribution should be used for these products as the cost of sales becomes a proportionally more significant factor in the product price?

The Japanese fax market, which is one to two years ahead of the European and U.S. markets in maturity, is already beginning to face these issues. Retail channels are being tried, and Dataquest recently noted personal fax machines on sale in Tokyo stores for as little as ¥79,000 ($640).

Focusing on retail channels, however, ignores the issue that the fax machine remains, in principal, a business tool with the need for effective supplier provisions and maintenance contracts. Thus, the retail channel is less attractive to the business purchaser. Home, door-to-door salespeople are finding resistance for similar reasons.

Dataquest speculates whether improved advertising techniques, combined with toll-free call facilities for more accurate prospective customer identification prior to sales calls, would reduce direct sales costs (i.e., through achieving a higher percentage sales close rate). Other low-cost sales channels may exist, including office-related electronics retail stores and mail order sales.

TECHNOLOGY TRENDS

Personal Fax Machines

Personal fax machines that are compatible with CCITT Group III standards certainly show much growth potential in the short to medium term.

Color Facsimile Machines

The Japanese, however, are also working on new facsimile developments, and one specialized development is color facsimile. NEC recently demonstrated a prototype of such a machine; however, the technology is still very expensive at this time. We believe that color facsimile certainly could become a very successful niche market sector in the future. Two-color-image (red and black on white) faxes are also becoming available, and Ricoh recently demonstrated a prototype of such a product. These machines are likely to be used in editing applications such as highlighting or making corrections to areas of text and graphics.

Group III Facsimile Machines

High-end Group III fax machines with store-and-forward capabilities, although currently representing only 5 percent of all fax units sold, are expected to show strong growth, with a 70 percent CAGR through 1992. This segment is less price sensitive and is aimed at placements within the headquarters of large companies. Consequently, we believe that many extra new functions and technology advancements will be seen in this area. Other capabilities that we expect to become available with machines in this segment are fax networking and switching functions.

A further advancement that is currently receiving a lot of research and development attention is error correction for secure transmission. The CCITT has put together a preliminary specification for such a facility, and a number of manufacturers are working to have this feature available with their products by the end of 1988.

Plain Paper Facsimile Machines

Much effort continues in the area of plain paper facsimile (PPF) machines. At this stage, these machines are at least twice as expensive as thermal paper machines. Such a high price effectively makes PPF products unacceptable in a market where the user usually has a plain paper copier not far from the fax machine, which means that if required, a PPF copy can be produced easily and at minimal extra cost. The Japanese are currently working on technologies that may eventually drop the price of a PPF machine much nearer to that of a thermal machine. If such a price reduction is achieved, Dataquest expects the PPF market to open up quite rapidly.

Group IV Facsimile Machines

Looking forward, the big question is about Group IV facsimile machines. These products will require an ISDN or compatible 64K digital network to operate. We do not believe that they will be widely available before 1995, even in countries with advanced telecommunications infrastructures. Although Group IV faxes will be capable of sending messages at approximately 3 seconds per page, this capability is already being achieved through improved Group III coding techniques such as Modified Modified Read (MMR), which currently has reduced the transmission time from about 20 seconds to 9 seconds. Further transmission improvements are under development. The recent advancements of Group III clearly reduce the advantage of Group IV. Furthermore, the fax machine became attractive as a text-transmission medium only once a solid user base had been established. The same problem will be encountered by Group IV machines until they gain acceptance and establish a worldwide user base.

Although Group IV will certainly establish its market niche, particularly within large internal network applications, we do not expect it to take a dominant position over Group III in terms of shipments until well into the 21st century.

JAPANESE MANUFACTURING

Japan's success in the realm of facsimile is due to the country's formidable record of achieving economy of scale in electronic manufacturing techniques. Although one South Korean manufacturer has recently entered the facsimile market, its product is comparatively much lower in quality. We believe that this product will need considerable improvement before it becomes a serious contender against Japanese products in world markets.

Factory Automation

Meanwhile, Japan continues to improve its electronic production techniques through advances in semiconductor technology as well as increasingly sophisticated production robots, such as pick-and-place semiconductor component assembly systems.

The Oki Honjo (North of Tokyo) is one of the most modern automated facsimile assembly facilities in Japan. Following a recent refurbishment program, it uses 300 assembly and quality-inspection robots linked to a fully computerized stores-and-supplies system in what is known as an FA (factory automation) environment. Nevertheless, the facility still employs 900 direct workers involved in the fax manufacturing area, as well as a number of subcontractor companies that deliver completed and tested subassemblies and other components to the plant at least twice daily.

Oki insists that all the subcontractors are in the area, close to the Honjo plant to ensure secure product delivery. The subcontractors themselves all work in a typically Japanese manner, with timely deliveries of high-quality products. The stores area is thus minimized, and the reject rate is extremely low. Subassembly and other partly finished components are shuttled around the facility on computerized delivery vehicles that beep and flash warning lights whenever humans cross their paths.

In order to address new target markets, Japanese manufacturers also plan to design fax products with an ever-decreasing footprint size. One of the factors contributing to this effort is a new and extremely compact image-scanning system.

To achieve this smaller footprint, Oki, like a number of other Japanese manufacturers, has recently introduced the direct-contact technology for the image-scanning mechanism. Although not particularly less expensive than the older charged couple device (CCD) technology, it is able to achieve a significant reduction in the equipment size. This size reduction results in an implied saving in material cost, as well as a machine with a more attractive user footprint.

A second route to achieving smaller product size is through the ever-increasing miniaturization of electronic components. For example, a number of manufacturers have started using the new Rockwell single-chip modem, replacing the four IC chips used in previous generations of facsimile modems.

Productivity Race

The facsimile output capacity of the Honjo plant is currently 460 units per day. The final assembly is done on two parallel lines, each with an indicator of the daily production target and a second counter to show performance against the target. As each finished machine comes off the assembly lines, the daily tally is incremented and the performance counter adjusted. The two production-line staffs essentially race against each other, as much for the honor of being ahead as for the small bonus that they can win at the end of the month.

Even the computerized delivery vehicles seem to be in an hurry, competing with one another to raise the daily production quota. At 460 fax units per day, the Honjo plant output is running at approximately $1.5 million daily. This output is far from the plant's ultimate capacity. The factory management anticipates easily reaching more than 700 units daily through shift work at the current facilities. Management further claims that even higher output could be reached through additional improvement in production techniques.

Such increased production capacity will be critical to Harris/3M, Oki's largest worldwide OEM customer. Indeed, in 1987, Harris/3M ramped up its production requirement with Oki by more than 168 percent against its 1986 shipments and is now responsible for more than 55 percent of Oki's total worldwide facsimile output.

Clearly, any restrictions applied on facsimile imports into Europe would have a major impact on Oki and its OEM partners alike. Should such restrictions be applied, however, Oki does have a European manufacturing facility in Scotland and would be able to move fax production there within six months.

DATAQUEST ANALYSIS

Dataquest anticipates that the worldwide fax market will remain one of the fastest-growing telecommunications market segments over the next few years. In terms of unit shipments, we estimate that the worldwide fax market will increase by a 30 percent CAGR from 1988 through 1993. In telecommunications, only the cellular radio handset market is expected to grow as rapidly during this period. Here, again, the Japanese have significant presence.

Dataquest believes that Japanese manufacturing skills, combined with a closely affiliated semiconductor technology and the current level of R&D spending to maintain technical innovation, will make Japanese manufacturers a tough team to beat. This will be particularly true in product areas where production volumes are high and the software content is low. A typical product of this kind is the facsimile machine. Central office switching technology, however, is an example of a product requiring specialized software. In the case of central office switching, we do not expect the Japanese to make a significant market impact in Europe.

Dataquest anticipates that with the continuation of worldwide telecommunications market deregulation, governments and PTT authorities in many countries will be assessing the increasing impact of Japanese products on their markets. We believe that Japan does have an excellent chance for success in the U.S. and European markets with its current and future products in areas such as facsimile. However, we also believe that Japanese manufacturers should seriously consider strategies that would give them a local manufacturing presence in the U.S. and European markets. Dataquest considers such a capacity to be an essential requirement for Japanese facsimile manufacturers hoping to avoid the imposition of future punitive trade restrictions.

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Research Newsletter

ESAM Code: Vol. IV, Newsletters
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YEAR-END EUROPEAN PROCUREMENT SURVEY: THE ISSUES ARE AVAILABILITY, PRICING, AND SUPPLY

INTRODUCTION

This newsletter presents the results of our second European Semiconductor Application Markets (ESAM) procurement survey conducted across a wide range of major Europe-based electronic equipment manufacturers in the fourth quarter of 1987. The first European purchasing survey, conducted during the second quarter of 1987, revealed the then global concern of pricing. Since then, the emphasis has moved away from the issue of pricing and toward that of the availability of components.

The object of the survey was to determine the major concerns of semiconductor buyers in Europe. One major concern is the resulting shortage of memory parts that is due to the export license requirements imposed by MITI on Japanese suppliers. Other issues that were important to buyers included possible price increases on selected products in short supply, increasing demand, and longer lead times.

Table 1 shows the primary concerns emphasized by our respondents.

Table 1

Semiconductor Buyer Concerns

Concern	Percent of Respondents
Availability	20.4%
Pricing	16.3
Supply	12.2
Quality	12.2
Lead Times	12.1
Tariffs	10.3
Surface-Mount Technology	6.1
ASICs	4.1
Memory	4.1
Currency Exchange Rates	2.2
Total Respondents	100.0%

Source: Dataquest
March 1988

SURVEY STRUCTURE

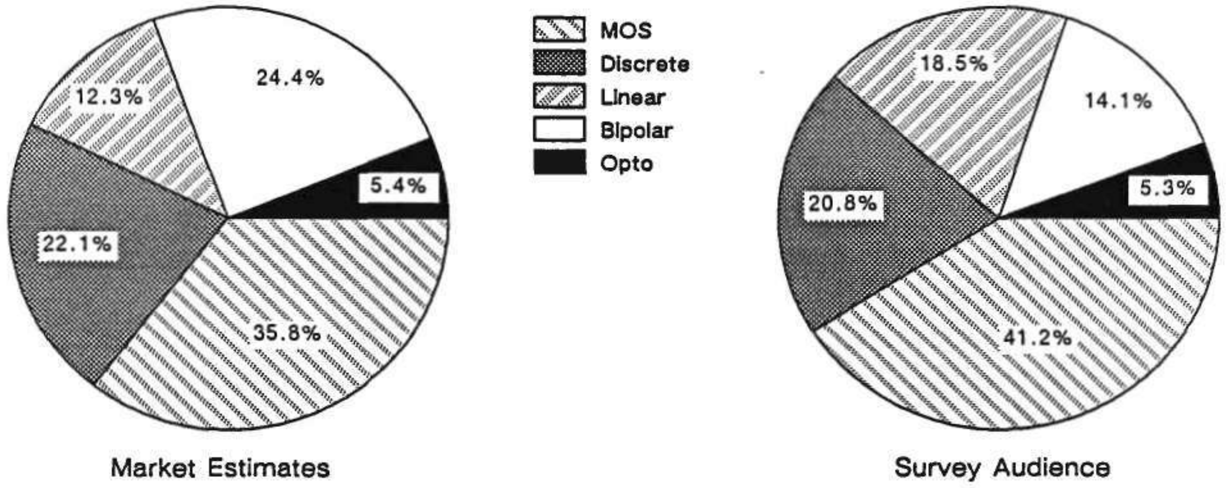
Dataquest selected survey participants from the top electronics manufacturers in Europe, successfully repolling the majority of manufacturers that participated in our first data- and trends-gathering project. We surveyed manufacturers that are actively purchasing semiconductors for electronic systems and subassemblies, interviewing individuals who are purchasing managers and directors, or who are involved in material or corporate contract management.

Subsequently, we compared our survey data on the semiconductor purchase mix with our 1986 European estimates; Figure 1 shows how closely they correspond. The survey results show a higher percentage of bipolar logic purchases than Dataquest's market share estimate of this segment. In the MOS market, however, the situation is reversed, with purchases lower than expected. Overall, the survey results demonstrate that our sample of purchasers closely reflects the total European demand.

Figure 2 shows the geographic distribution of our survey respondents. Although we tried to achieve an even distribution of respondents throughout Europe, the results show that there was a bias toward the United Kingdom. This bias was probably due to the fact that the survey was conducted from the United Kingdom; however, we do not believe that it detracts from the validity of our analysis.

Figure 1

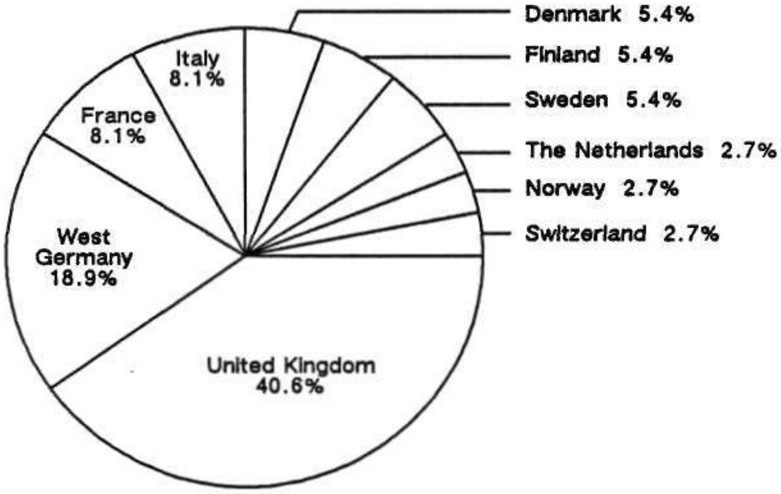
Semiconductor Purchase Mix
Survey Results Compared with 1986 Estimates
(Percent of U.S. Dollars)



Source: Dataquest
March 1988

Figure 2

Geographic Distribution of Survey Respondents
(Percent of Respondents' Regional Base)



Source: Dataquest
March 1988

The survey centered around factors influencing and driving semiconductor purchasers. It focused on the types of products that these purchasers manufacture and the semiconductor quantities/value they bought in 1987. We further asked questions about the sources of their semiconductor purchases on a regional basis. The survey reveals that the majority of manufacturers' purchasing was influenced by price, quality, and availability, in that order. Comparing this survey with the previous one conducted in the second quarter of 1987, a trend emerges showing that buyers are moving away from Europe-based suppliers and toward Japan-based suppliers. The survey results indicate that the purchasing community perceives that a good number of European and U.S. suppliers have difficulty matching Japanese vendors in price and quality on MOS ASIC, microprocessor, and memory product lines.

EUROPEAN MARKET TRENDS

Overall, Dataquest believes that distribution-channel purchases are increasing in Europe as a percent of total semiconductor purchases for two reasons. First, the movement from electromechanical industries to electronic systems implies that more companies are entering the market with relatively modest requirements for semiconductor purchases; these companies are best served by distributors. Second, semiconductor vendors are moving to regulate and minimize sales costs by limiting the number of companies with which they deal directly. By servicing some of these companies through their franchised distributors, the vendors can increase their overall efficiency.

Table 2 shows the currently perceived worldwide shift in supplier base compared with our previous survey's results.

Table 2

Worldwide Shift in Supplier Base

Supplier Base	Q2 1987 Survey Results	Q4 1987 Survey Results
Europe	32.9%	32.0%
United States	50.0	46.0
Japan	14.9	18.9
ROW	2.2	3.1
Total	100.0%	100.0%

Source: Dataquest
March 1988

Figures 1 and 2 indicate a shift in the buying patterns of these equipment manufacturers. Most of the surveyed companies would prefer to buy locally manufactured semiconductor devices. Unfortunately, local suppliers still have to go some way in order to deliver the breadth and depth of the required product range. The increase in Japanese preference for procurement was partially due to a switch to higher-density memories, but it also was moderated by the effects of the U.S.-Japan Semiconductor Trade Arrangement.

The survey also confirmed the penetration of rest of world (ROW) suppliers (such as those based in Korea, Taiwan, and Singapore), with some equipment manufacturers relying on up to 10 percent of their semiconductor requirements from these suppliers.

ASSESSING INVENTORY LEVELS

Dataquest clients have frequently asked us to assess inventory levels. However, it is very difficult to estimate inventory levels because of the varied product mix for discrete, linear, memory, and logic. Table 3 shows our respondents' estimates of their inventories relative to target. Overall, 42.4 percent reported that their inventories were above target. Only 12.1 percent indicated below-target levels. The trend that began two years ago to reduce the excessive levels of 1984 has continued, and we believe that inventories have now reached stable levels. The majority of respondents indicated that their inventories are expected to increase from an average of 6 weeks to 8 to 10 weeks, as the expected demand and growth will create temporary shortages in key areas such as DRAMs and some 32-bit microprocessors.

Table 3

Semiconductor Inventories Relative to Target (Percent of Total Respondents)

Inventory Level	Percent of Respondents
Extremely Low	3.0%
Somewhat Low	9.1
On Target	45.5
Above Target	39.4
In Significant Excess of Target	3.0
Total	100.0%

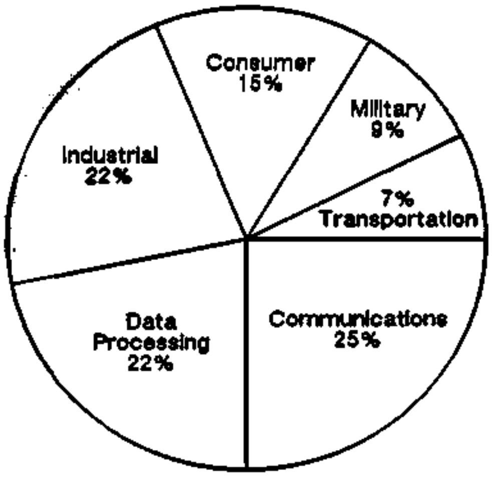
Source: Dataquest
March 1988

PROCUREMENT TRENDS BY SEMICONDUCTOR APPLICATION SEGMENT

Figure 3 shows Dataquest's estimates for 1986 European electronic equipment production by application.

Figure 3

Electronic Equipment Production by Application Segment (Percent of U.S. Dollars) 1986



Source: Dataquest
March 1988

Consumer Application Market

The purchasing pattern in the consumer segment still favors the Europe-based supplier. This segment is a relatively large user of discrete and optoelectronics devices, a market of which Europe-based suppliers have a substantial share.

Most buyers expect these discrete devices to be customized to achieve better price/performance integration, and for this they require close, long-term relationships with local suppliers. They also expect the number of ICs used in consumer products to be substantially reduced in favor of a semicustom/custom approach, which will require a major shift toward surface-mount devices.

Surprisingly, major consumer manufacturers are purchasing up to 30 percent of their requirements from offshore sites rather than from the local sales offices of these offshore suppliers. This situation could be explained by the consumer market requiring close links with the supplier manufacturing site to interface on all levels—design, test, quality, shipping, and logistics.

Major Japanese consumer manufacturers in Europe have started to procure locally, especially with discrete and opto devices. Most of these manufacturers complain that local suppliers do not have the right manufacturing technology to supply their special needs. However, they face increasing pressure from the EEC to source more components locally.

Overall, consumer manufacturers in Europe reported a healthy growth in 1987 compared with 1986, but indicated that they expect to further reduce inventory levels and start engaging more JIT (just-in-time) programs with their suppliers.

Automotive Application Market

Purchasing managers in the automotive segment responded very positively about their inventory levels, as most of them have ongoing JIT programs that have passed the learning-curve period. They reported that suppliers failing to meet their specification and delivery commitments do not win future contracts for supply.

Major concern is still shown over the long-term reliability of semiconductor devices, fault coverage, and incoming test correlation. Very few suppliers are able to meet more than 80 percent of these purchasers' requirements. The suppliers' concern is amplified when dealing with the purchasers' ASIC requirements. Among the major European automotive electronic equipment manufacturers, preference is shown toward Europe-based suppliers or foreign suppliers with a manufacturing base in Europe.

In general, the automotive market anticipates greater IC use in the future as more features are added to standard models.

Military Application Market

Purchasers in the military segment are prepared to hold relatively large inventories for parts that are prohibitively expensive at low volumes. This segment shows heavy reliance on the semiconductor distribution network for standard military-grade parts. Most purchasers indicate above-average inventory levels. North American suppliers are heavily used over their European counterparts, except for ASIC requirements. Major military contractors prefer in-house suppliers for ASICs because of the complex nature of meeting as yet undefined military-standard specifications for these parts.

Major concern was shown about U.S. versus European military specification issues and specifications for surface-mount devices.

Computer Application Market

This segment showed the most volatility, with purchasing managers expressing much concern about the availability of 256K and 1-Mbit DRAMS and the impact of MITI export licensing requirements. This segment is heavily dependent on Japanese suppliers for its memory devices. The supply shortage of these devices, coupled with price rises, is starting to hurt some manufacturers, with the exception of those manufacturers with steady in-house supplies.

Most U.S. multinationals based in Europe procure, on average, 30 percent from European manufacturing sites, including U.S. suppliers manufacturing in Europe.

We believe that 1988 will be a big year for surface-mount devices, as most purchasers reported substantial increases in their purchases of these devices.

Inventory levels of computer manufacturers are, on average, down to 6 weeks, but most manufacturers expect this time to increase to 8 to 10 weeks as a result of shortages of leading-edge products such as 1-Mbit DRAMs and 32-bit processors.

The computer segment also showed a substantial increase in the use of gate arrays and programmable logic. Most purchasers indicated requirements for higher-speed PALs and high-density gate arrays.

Regional preference in this group is still for U.S. suppliers because of the large presence of U.S.-based computer manufacturers in Europe. CMOS now accounts for more than 50 percent of total purchases in the computer segment.

Telecommunications Application Market

Most purchasing managers in the telecommunications segment indicated healthy growth in the amount of semiconductor purchases when expressed in U.S. dollars, but showed a virtually flat pattern when the purchases were expressed in local currency. They expect prices to decrease with the increasing volumes. The use of surface-mount devices is somewhat erratic: Some major manufacturers use surface-mount devices up to 10 percent, while others, at 2 percent, barely use them.

Most purchasers reported inventories on target, but they also expected to further reduce their levels. Some purchasers in this segment have started JIT programs, and many others are moving in this direction.

Purchasers expressed uncertainty about recent mergers in the telecommunications industry, focusing on the issues of plant location, products, and personnel rationalization.

It appears that the telecommunications segment, like the other industry segments, has been unable to reduce the number of its suppliers because of the diverse range of semiconductor devices required. A supplier with a broad product line and the right telecommunications products stands a better chance than one with a narrow product line.

The major concerns shown in this segment are procurement logistics and management of ASIC supplies.

DATAQUEST CONCLUSIONS

The buyers' responses to Dataquest's second European procurement survey primarily indicate concern over availability and cost-related issues. The emphasis on availability, pricing, supply, and quality leads us to believe that this concern is indeed a positive signal for steady growth in the industry. Quality was not at all mentioned in our second quarter 1987 survey; however, this issue ranks high on the list of concerns generated by our latest survey. European semiconductor buyers' mindfulness of ASICs and surface-mount technology reflects the fact that these two product areas are now impacting the marketplace with their cost-competitive and overall system design advantages.

We believe that there is a pressing need for semiconductor vendors to better educate the purchasing community on changing technology and product trends. A large proportion of the respondents indicated that they were swamped with product specifications; however, the information from maunufacturers concerning key areas of interest, such as packaging, quality, and cost benefits, was insufficient.

Bipin Parmar
Mike Williams

Dataquest
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The Dun & Bradstreet Corporation

Research Newsletter

ESAM Code: Vol. II, Newsletters
1988-2

IS THERE A TRANSPUTER IN YOUR FUTURE?

INTRODUCTION

In the last few years, both Intel and Motorola have introduced microprocessors that have changed the face of the PC industry. However, a third company, Inmos Corporation, has introduced the transputer, a microprocessor designed to bring the power of a supercomputer to desktop computing.

This newsletter examines some of the products utilizing transputer technology and discusses the implications of the transputer for the personal computer industry.

BACKGROUND

In November 1986, Inmos Corporation, a subsidiary of United Kingdom-based Thorn EMI, introduced the T800 transputer, a 32-bit microprocessor capable of achieving performance ratings of 10 to 12 mips. Since this announcement, the T800 transputer and its predecessors, the T212 and T414, have been catching the eye of many computer product manufacturers.

The transputer is not a coprocessor. The T800 transputer combines a 32-bit CPU; standard IEEE, 64-bit, floating-point processor; 4KB of fast RAM; and four communications links that are used to connect transputers into networks.

The transputer is designed for high-performance single-microprocessor applications; however, the real power of the transputer is in its capability to be linked with other transputers to provide ultrahigh-performance multiprocessor applications ranging from PC workstation accelerators to supercomputers.

The Inmos T800 competes directly with microprocessors manufactured by Intel and Motorola. The Inmos T800 is the first microprocessor to offer a processor and a floating-point processor on a single VLSI device. This combination is ideal for applications such as high-end graphics and artificial intelligence.

TRANSPUTER APPLICATIONS

The Atari Abaq

At the fall Comdex, Atari Corporation demonstrated a prototype of the Abaq, a 32-bit transputer-based workstation. The Abaq uses the Inmos T800 and is capable of operating at 10 to 12 mips. This level of performance would give the Abaq the ability to operate at speeds 10 times greater than the IBM AT. The Abaq is equipped with 4MB of RAM and 1MB of display RAM. The Abaq supports four graphics modes: 1,280 x 768 pixels in 16 colors or monochrome; 1,024 x 768 pixels in 256 colors; 640 x 480 pixels in 256 colors with two screens; and 512 x 480 pixels in 16 million colors plus overlay.

Perihelion Software is currently developing Helios, a UNIX-like operating system for the Abaq. In addition, an MS-DOS emulator is currently being developed for the Abaq by a third-party developer.

Apple Macintosh Enhancement

Levco has announced an add-on board for the Macintosh II and Macintosh SE, based on the Inmos T800 transputer. The Levco TransLink transputer card will range in price from $2,000 to $12,000, depending on the number of transputers installed on the board and the amount of memory allocated to each transputer. A transputer card with four T800 processors, C compiler and assembler, and 1MB of RAM dedicated to each processor will provide 20 times the performance of the Mac II. Pricing for this configuration will range from $11,000 to $12,000.

Microport V/TT System

Microport Inc., a supplier of UNIX software, recently announced the Microport V/TT System, a UNIX-based implementation of the Inmos T800 transputer.

The system runs on an IBM AT and is equipped with the Inmos B008 transputer module board. The B008 board utilizes four T800 transputers, and it is claimed that this combination can deliver 50 times the power of UNIX running on the IBM PC AT itself.

DATAQUEST ANALYSIS

Prior to the introduction of the PC, users were forced to share the same processor. With the advent of the PC, users now have their own dedicated processors. Transputers linked within a network take the one person/one processor concept a step further by providing a user with access to several processors at a time. Application tasks are distributed among the processors in order to optimize the total application performance.

The problem facing vendors of transputer technology is that very few software applications have been written with the capability of utilizing multiple processors. In order for this technology to gain a foothold in the PC marketplace, we believe that Inmos must persuade software developers to adapt their applications to a multiprocessor environment.

Parallel processing is not a new concept in the computer industry as a whole; however, for the PC industry, it represents the ultimate solution for power-intensive applications. It opens the door to having mainframe computing power on the desktop and is the next logical step for the PC of the future. The embodiment of this capability in IBM's Micro Channel and Apple's Nubus is a reaffirmation of this philosophy.

Although multitasking is the current topic of conversation in the PC industry, we believe that multiprocessing will have a significant impact on the future of the PC industry. How significant an impact the Inmos transputers will have in the area of multiprocessing will ultimately be decided by software developers.

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Jennifer Berg
Bill Lempesis

Dataquest
a company of The Dun & Bradstreet Corporation

Research *Newsletter*

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1988-1

ERICSSON GETS LEANER WHILE NOKIA CONTINUES ACQUISITIONS

SUMMARY

Ericsson's pending sale of its Data System Division to Nokia will put Nokia in a commanding position as the number two European supplier of computer terminals after Olivetti.

This event is of major significance in the European telecommunications market, as it reverses the trend of the early 1980s when telecommunications companies created and/or acquired computer companies due to the pending fusion of communication and information technologies. In the majority of these cases, the ventures have been major drains in financial and management resources.

ERICSSON

The newly acquired Data System Division manufactures terminals, personal computers, minicomputers, and banking and business systems, and has a turnover of SKr 4 billion (US$631 million.) It will be merged with Nokia's existing Information Division, Nokia Data. The merged division will have a turnover of SKr 7 billion (US$1.1 billion).

Ericsson's strategy has been to offload business units that do not form part of its core business, i.e., telecommunications. In October 1987, Ericsson sold off its Office Equipment Division, which manufactures typewriters and office furniture, to Design Funktion of Norway.

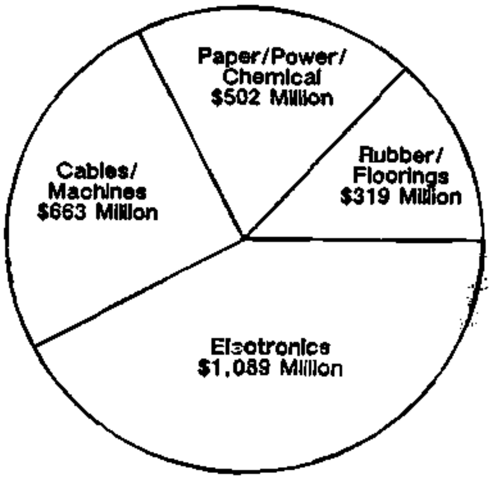
Ericsson's sale of its Data System Division and its Office Equipment Division will stem the flow of red ink that has plagued its Information Division since its inception. This division reported a loss of SKr 284 million (US$45 million) on a turnover of SKr 10 billion (US$1.6 billion) in 1986.

NOKIA

As shown in Figure 1, the Nokia Group of companies' total 1986 sales were Fmk 12 billion (US$2.5 billion), with almost 60 percent coming from the export market. The group's 1986 profit was Fmk 675 million (US$141 million), or 5.6 percent of sales. The Electronics Group represented 43 percent of the Nokia Group's net sales in 1986, before its recent acquisition of Ericsson's Data System Division and the consumer division of Alcatel N.V. (formerly the consumer division of ITT).

Figure 1

Nokia Group Major Activities
Net Sales by Division



1986 Net Sales = $2.5 Billion

Source: Nokia Corp.
Dataquest
February 1988

Electronics Group Activities—1986

The group achieved net sales of Fmk 3.7 billion ($843 million) in the first eight months of 1987, compared with Fmk 2.9 billion ($572 million) in the corresponding period in 1986, and represented a local currency growth of 27 percent (47 percent growth in U.S. dollars).

Information Systems

This division represented Fmk 1.6 billion ($334 million) of the company's 1986 sales. The division consisted of a Data Processing Systems Unit (computer systems and equipment), Data Transmission Unit (modems and multiplexers), Business Communications Unit (digital PABX and key telephone systems), Components Unit (thick film hybrids and PCBs), and a Control and Instrumentation Unit (automation equipment in wood pulping and energy sectors).

Telecommunications

Net sales for this division totaled Fmk 939 million ($196 million) in 1986. The division consisted of a Transmission Systems Unit (PCM equipment and radio relay links), Dedicated Networks Unit (for energy and railway sectors), and Telenokia Ltd. (digital PABXs).

Nokia-Mobira

This division's net sales totaled Fmk 847 million ($177 million) in 1986. The division consisted of an NMT Unit (Nordic Mobile Telephones for the 450- and 900-MHz system) and a USA Unit (mobile telephones for the U.S. Advanced Mobile Phone System (AMPS), and the Tandy Mobira Corp. (TMC) joint venture with sales via Radio Shack). There was also a Euro Unit (mobile telephones for the Total Access Communications System (TACS), R200, and Netz-C networks), an Oulu Unit (base stations for cellular and paging networks), and a PMR (Private Mobile Radio) Unit.

Salora-Luxor

Net sales for this division totaled Fmk 2.1 billion ($439 million) in 1986. The Group consisted of a Consumer Electronics Unit (TV and video recorders), Monitors Unit (color and high resolution), Components Unit (hybrids, TV tuners and power supplies), Satellite Systems Unit (receivers and transmitters, plus cable and pay TV), and an Industrial Electronics Unit (customer-specific components for the automotive, engineering, and plastics industries).

Electronics Group Restructuring—1987

Information Systems

This division is a combination of the former Information Systems Division and the Telecommunications Division. It comprises the Data Processing Systems Unit, the Data Transmission Unit, the Business Communications Unit, the Public Telecommunications Networks Unit, the Dedicated Networks Unit, Nokia Cellular Systems, and Telenokia. Net sales from this division for the first eight months of 1987 amounted to Fmk 1.1 billion ($250 million), a growth in local currency of 19 percent compared with the same period in 1986 (37 percent growth in U.S. dollars). This growth can be attributed to increased sales, particularly in Sweden and West Germany, and deliveries of electronic point-of-sales systems to retailers in Finland.

Consumer Electronics

This division was mainly created from the former Salora-Luxor Division, and comprises the Video/Audio Unit, the Monitors Unit, the Components Unit (formerly the Information Systems Division and the Salora-Luxor Division), and the Industrial Electronics Unit.

Net sales from this division for the first eight months of 1987 amounted to Fmk 1.4 billion ($319 million), a growth in local currency of 17 percent compared with the same period in 1986 (35 percent growth in U.S. dollars). This growth can be attributed to the company's successful penetration of the French consumer electronics market, where it holds a 10 percent market share, and its continuing leadership in Scandinavia as a supplier of color television sets and video recorders. The recent purchase of Oceanic S.A., a French consumer electronics manufacturer (part of the Swedish Electrolux Group), has given Nokia two more recognized brand names, Oceanic and Sonolor. The division has significantly enhanced Nokia's position in the European Economic Community.

Nokia-Mobira

This division is restructured internally, and now comprises the NMT Unit, the AMPS/TACS Unit, the Euro Unit, the Paging Equipment Unit, and the Cordless Unit.

Net sales from this division for the first eight months of 1987 amounted to Fmk 613 million (US$140 million), a growth in local currency of 22 percent compared with the same period in 1986 (41 percent growth in U.S. dollars). Operations overseas accounted for 75 percent of 1987 sales, and included the acquisition of Diversicom in the United States (the only nationwide long-range paging service for the U.S. market). Agreements also were made with McCaw Cellular Equipment (which owns and operates 40 mobile telephone networks in the United States), Mobile Telephone Systems (based in Kuwait), and Shaye Communications (based in the United Kingdom).

DATAQUEST ANALYSIS

Nokia's recent acquisition of the Consumer Electronics Division of Alcatel (formerly ITT) makes Nokia the third-biggest consumer electronics manufacturer in Europe after Philips and Thomson. This will allow Nokia to consolidate and rationalize its European manufacturing and marketing base and allow it to gain further market share while competing effectively against Japanese suppliers. The recent rise in the value of the Japanese yen, together with Nokia's manufacturing synergy with computer monitors and its number two position in the corporate microcomputer market, will allow the company to raise its value-added contribution in these markets. Another significant factor is that Nokia will now be able to make inroads into the European Community through its new acquisitions, as Finland is a nonmember of the EEC.

Dataquest estimates that Nokia-Mobira was number one in the rapidly expanding European cellular radio market in 1987, although the five different standards for cellular radio used in Europe has hindered its growth. Nokia will be able to leverage its number one position when the new GSM (Group Speciale Mobile) European Cellular Network Standard is established, which should be by 1991. Nokia has already taken steps to address the base station market by forming a consortium with Alcatel and AEG, in which Nokia has a 35 percent share.

Together with its strength in cellular subscriber equipment and base station equipment, Nokia will become a commanding force in the European cellular radio market, estimated to reach $3.5 billion by 1995.

Nokia was already the largest manufacturer of microcomputers in Scandinavia prior to its acquisition of Ericsson Data System. These combined forces put Nokia in the number two position in Europe after Olivetti. The relatively successful market penetration in the United Kingdom and the United States of the Ericsson Data System's banking terminals, together with Nokia's microcomputer and digital PABX technologies, will allow Nokia to leverage itself into the lucrative market for fully integrated information systems. Nokia already has an agreement with the Honeywell-Bull-NEC consortium in the midrange computer market.

Although the European market for systems integration already has numerous participants, the biggest potential for growth lies in the North American market. It is not obvious how Nokia will consolidate its position in this important market; but, it already has a head start with its joint venture with the Tandy Corporation and its numerous sales outlets via Radio Shack.

Dataquest believes that because of its leading position in consumer, cellular radio, and business microcomputer markets, which require highly automated volume manufacturing and continuous technological advances, Nokia will become a significant participant in the European market and will join the ranks of Philips, Siemens, and Thomson. This represents a new challenge and potential for the suppliers of semiconductors that previously considered Nokia a small niche player.

Byron Harding
Bipin Parmar
Anne Barbancon

1987

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1987-1

EUROPEAN CD MARKET SYNOPSIS

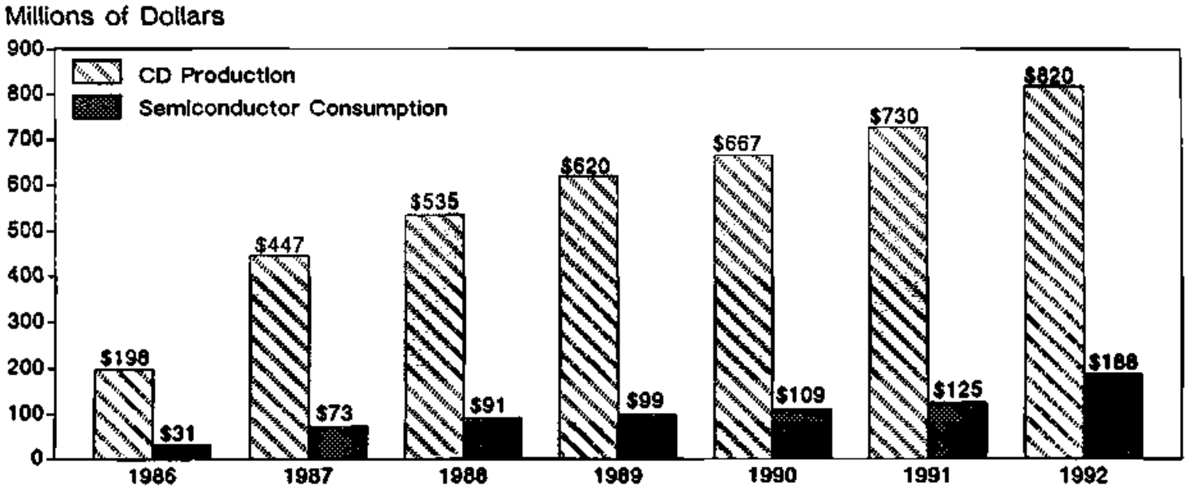
INTRODUCTION

For a number of years, optical storage has been regarded as the mass memory storage technology of the future. One product, the compact disk (CD), has emerged as the technology driver, gaining mass acceptance with devotees of hi-fi sound. Compact disks and players became the darlings of the European audio world in 1986. In this watershed year, CDs gained broad acceptance by music lovers as the medium of choice for the enjoyment of jazz, rock, and classics. Approximately 5 percent of householders in Europe owned CD players in 1986. Half of the current CD players owned were purchased in 1986.

Dataquest's European semiconductor analysts have researched the production and marketing of CD players in Europe between 1984 and 1992, and have estimated the semiconductor content of the players produced in 1987. As indicated in Figure 1, we believe that 1987's European CD market will reach $447 million, a 226 percent increase over 1986. We estimate that this represents a $73 million semiconductor opportunity for 1987 alone.

Figure 1

ESTIMATED EUROPEAN CD PLAYER PRODUCTION



Source: Dataquest
June 1987

BACKGROUND

Developed jointly by Philips of the Netherlands and the Sony Corporation of Japan, compact disk players were the first commercially available digital audio systems to offer far more accurate sound reproduction than conventional analog systems. CD players were introduced to Europe in February 1983 and quickly caught the consumer's attention because of their compact size, easy handling, and superior sound reproduction. However, initial sales were slow because of the CD player's high retail price compared with that of its analog counterpart.

COMPACT DISK PLAYER PRODUCTION IN EUROPE

CD player production is highly competitive in Europe. In order to avoid large import tariffs (19 percent) placed on the goods, many Japanese manufacturers have set up production facilities here. Table 1 lists the major manufacturers, which we believe account for approximately 100 percent of the total CD player production.

Table 1

CD PLAYER MANUFACTURERS IN EUROPE

Country	Company
West Germany	Dual (Thomson subsidiary)* Grundig*
France	Aiwa Akai JVC Pioneer Sony
United Kingdom	Aiwa
Italy	Pioneer Autovox**
Belgium	Philips
Denmark	Bang and Olufsen*
Switzerland	Studer-Revox
Turkey	Crown**

*Assembly only
**Production to start in 1987

Source: Dataquest
June 1987

SEMICONDUCTOR CONTENT

We have examined a medium-scale CD player and its components and have estimated the semiconductor value as shown in Table 2. The component values, based on contract-volume prices, result in an input-output ratio (semiconductor value as a percentage of equipment average selling price) of 16.3 percent.

Table 2

ESTIMATED SEMICONDUCTOR CONTENT OF A COMPACT DISK PLAYER

Components	Quantity	Cost
Integrated Circuits	13	
Standard Logic (SSI/MSI)	1	
Microcontroller (8-bit)	1	
D/A Converter (16-bit)	1	
Digital Filter	1	
Signal Conditioner	1	
Servo Control Unit	1	
Subtotal	19	$24.50
Optoelectronic		
Laser Diode	1	
Optical Sensor	1	
LED Lamp	1	
Subtotal	3	$17.50
Discrete Components	25	$ 3.00
Total	47	$45.00

$$\frac{\text{Semiconductor Value}}{\text{Retail Value}} = \frac{\$\ 45.00}{\$276.00} = 0.163 = 16.3\%$$

Source: Dataquest
June 1987

CD TECHNOLOGY AS A CATALYST

Consumer acceptance of CD players will act as a catalyst in the development of other optoelectronic products. CD-ROM technology is virtually the same as that found in audio CD players, with the exception of more stringent error-correcting demands for data applications. Potential applications for CD technology include the following:

- Computer data storage
- Video disks
- Publishing

- Road map directories in automobile dashboards
- Medical records
- Laser smart cards

The potential applications for CD technology represent numerous attractive markets. They could all gain widespread use by the consumer, in part because of the enthusiastic acceptance of CD players.

DATAQUEST ANALYSIS

Digital audio disks offer better sound than conventional records and tapes and put an end to noise and signal degradation over time. This is because a laser pickup eliminates direct contact with the disk surface; hence, disk wear is avoided. Using error-detection and -correction circuitry together with software, the conventional analog filtering techniques are eliminated. This provides audio that is free of noise and that has concert hall dynamic range. Digital audio tapes (DAT) and DAT players also offer perfect sound reproduction with virtually no deterioration regardless of the number of times the tape is played.

The supply of integrated circuits to CD or DAT player manufacturers is a significant market opportunity for semiconductor manufacturers in the late 1980s and early 1990s. Dataquest believes that as prices for players, CDs, and DATs come down, and as older music systems wear out, owners will replace their combination LP/cassette music libraries with CDs and DATs.

Kathleen Killian
Jennifer Berg

ESAM Code: Vol. II, Newsletters
1987-2

TELECOMMUNICATIONS--SNAPSHOT OF '87

SUMMARY

Dataquest forecasts that the European Communications Equipment marketplace will increase from $17,871 million in 1986 to $19,914 million in 1987, representing an increase of 11.4 percent (see Table 1). The European semiconductor consumption for communications equipment is forecast to increase from $1,411 million in 1986 to $1,700 million in 1987. The purpose of this newsletter is to provide our summary outlook for customer premise equipment in 1987 (see Tables 2 and 3). We estimate that customer premise equipment sales accounted for $7,084 million in revenue and represented 39.6 percent of European communications equipment sales in 1986.

Jim Beveridge
Jennifer Berg

Table 1

EUROPEAN COMMUNICATIONS EQUIPMENT MARKET FORECAST
(Millions of Dollars)

Equipment	1984	1985	1986	1987	1988	1989	1990	1991	1992
Customer Premise	$ 5,391	$ 5,860	$ 7,085	$ 7,850	$ 8,482	$ 9,088	$10,187	$11,562	$12,524
Public Telecommunications	5,125	5,571	5,292	5,960	6,504	6,965	7,649	8,245	8,442
Radio	1,790	1,946	2,594	2,882	3,178	3,425	3,806	4,165	4,205
Broadcast and Studio	1,305	1,418	1,891	2,101	2,319	2,480	2,747	3,150	3,157
Other	693	753	1,009	1,121	1,284	1,411	1,561	1,705	1,776
Total	$14,304	$15,548	$17,871	$19,914	$21,767	$23,369	$25,950	$28,827	$30,104

Source: Dataquest
June 1987
Ref. 0587-05

Table 2

1987 EUROPEAN CUSTOMER PREMISES EQUIPMENT FORECAST
(Millions of Dollars)

Equipment Type	1987
Terminal Equipment	$3,680
Single-Line Telephones	2,019
Integrated Voice/Data Wkstn.	7
Facsimile Machines	470
Telex Machines	477
Teletex Terminals	139
Videotex Terminals	314
Other	254
Data Communications Equipment	$ 992
Modems	580
Statistical Multiplexers	72
TDM Multiplexers	196
Data Network Control Systems	43
Data PBX	4
Packet Switching Networks	55
Local Area Networks	42
Business Communication Systems	$3,156
Key Telephone Systems	1,073
PBX	1,948
Centrex	1
Automatic Call Distributors	134
Attached Network Functions	$ 22
Voice Messaging	11
Call Accounting	3
Video Teleconferencing	8
Total	$7,850

Source: Dataquest
June 1987
Ref. 0587-05

Table 3

EUROPEAN CUSTOMER PREMISE APPLICATION SUMMARY

Application	End Equipment Percentage Growth Rate 1976-1987	1987 Market Estimate ($M)	European Market Outlook
Telex	(6.3%)	$ 477	The market up to present has been characterized by its stability. A modest decline will be experienced during 1987 as the reduction in standalone terminals is not quite compensated for by the increased production of PC telex adapter cards produced by Hasler, (Germany), DCE, (U.K.)
Teletex	57.9%	$ 139	Growth will be mainly confined to Germany. Production is by Siemens and Triumph-Adler.
Videotex	9.0%	$ 314	The product has not gained acceptance in the mass market. Except for France, it is confined to use by the business user groups such as the financial markets and travel agents. Within France, it is enjoying success in the form of Minitel terminals supplied free to PTT subscribers in some regions. Minitel production is running at 1.5 million sets per year. Production is by Alcatel and Matra.
Facsimile	63.7%	$ 470	This is a fast-growing market where supply is dominated by Japanese vendors, NEC and Canon. European production is confined to France where Alcatel Thomson produced 20,000 sets during 1986.

(Continued)

Table 3 (Continued)

EUROPEAN CUSTOMER PREMISE APPLICATION SUMMARY

Application	End Equipment Percentage Growth Rate 1976-1987	1987 Market Estimate ($M)	European Market Outlook
Single-Line Telephones	15.2%	$2,019	Despite the increasing number of Far Eastern imports, European manufacturers continue to dominate production and supply of the standard device. Major manufacturers include Autophon, Comdial, Ericsson, HPF, ITT, Matra, Siemens, and Televerket.
PBX	2.6%	$1,948	Low-end PBX L100 lines are becoming commodity items. Dataquest estimates that 85 percent of the 1986 market in Europe is supplied by local industry: <100 lines = 5.1 million >100 lines = 1.8 million
Modems/ Multiplexers	16.9%	$ 580	The major proportion of growth during 1987 will be accounted for by PC modems. These are manufactured by companies such as Racal, Doughty, and Dacom. The growth area in the multiplexer marketplace is in the installation of private and megabit multiplexers for large companies. Timeplex, (Ireland) and CASE, (England) manufacture for this marketplace.
Local Area Networks	55.6%	$ 42	The market is still in an early growth phase. At present, it is dominated by U.S. manufacturers supplying Europe through distribution. Producers in Europe include Siemens, (Germany), and Philips, (Holland).

Source: Dataquest
June 1987
Ref. 0587-05

ESAM Code: Vol. II, Newsletters
1987-3

EUROPEAN CONSUMER EQUIPMENT--SEMICONDUCTOR MARKET ANALYSIS

INTRODUCTION

As the range of semiconductor applications continues to become increasingly complex, so too has the task of examining and forecasting semiconductor consumption from an electronic equipment perspective.

Dataquest European Semiconductor Division (ESD) has developed a new module called European Semiconductor Application Markets (ESAM) that provides a complete analysis of semiconductor consumption by application market segment. This product is intended to assist decision makers who must take a tactical or strategic approach in their analysis of the semiconductor market, from either an application, demand-side, or end-use perspective.

This newsletter provides ESAM clients with a brief look at the methodology and offers an example of the research and analyses that can be found in this new module.

METHODOLOGY

Market Segmentation

Dataquest's European Semiconductor Industry Service has traditionally broken its end-use analysis into six market segments:

- Automotive
- Computer
- Consumer

- Industrial
- Government and military
- Telecommunications

The ESAM module uses a slightly different market segmentation, splitting the electronic equipment into the following markets:

- Data processing
- Communications
- Industrial
- Consumer
- Military
- Transportation

Data processing comprises all equipment whose main function is flexible information processing. Included in this segment are all personal computers, regardless of price, distribution, or use in the office, education, or home environments.

Within the communications market, Dataquest classifies telecommunications as a subsegment that consists of customer premises and public telecommunications equipment. The other communications categories include radio, studio, and broadcast equipment.

The industrial segment comprises all manufacturing-related equipment, including scientific, medical, and dedicated systems.

The consumer segment comprises equipment that is designed primarily for home or personal use and whose primary function is not flexible information processing. Audio and video equipment and appliances are typical examples of equipment that is classified in the consumer application market.

Military equipment is primarily defense-oriented electronic equipment and is classified by major budget area. It does not include all electronic equipment procured by the government because such a breakout would double-count equipment that logically belongs in other market segments.

Finally, transportation consists mainly of automotive and light truck electronics. This designation leaves room to analyze other markets, such as off-highway equipment, that are potentially large users of semiconductors.

Full definitions of these segments are included in the ESAM binder.

Research

Depth of research includes:

- Information on electronic equipment manufacturers in Europe, including revenue and semiconductor consumption
- European electronic equipment forecasts by application market, including equipment type and year
- European semiconductor consumption forecasts by application market: by product, technology, and region
- Detailed service sections covering market trends and semiconductor analyses within each of the major application markets

ANALYSIS

The following section is an example of the type of information that is available as part of the ESAM module.

Table 1 shows Dataquest's forecast for the European consumer equipment market. The appliance market is the largest portion of the European consumer segment. Dataquest estimates that the European market for appliance equipment will reach $13,546 million by 1991, declining slightly at a compound annual growth rate (CAGR) of negative 0.6 percent for 1987 through 1991.

Table 2 shows Dataquest's forecast for European semiconductor consumption for consumer equipment. The consumer semiconductor market is estimated to grow at a CAGR of approximately 2.1 percent between 1987 and 1991. This is lower than the overall semiconductor market, which Dataquest estimates to be growing at a CAGR of 12.3 percent between 1987 and 1991.

Table 3 shows Dataquest's forecast for European input/output (I/O) ratios for consumer equipment. The I/O ratio represents the value of the semiconductors divided by the value of the electronic equipment and expressed as a percentage.

Table 4 shows Dataquest's estimates for the European appliance market. The European home appliance industry (manufacturing such items as refrigerators, washers, dryers, dishwashers, and microwave ovens) is currently severely depressed and has been so for several years. The saturation point has been reached for several products. Notable exceptions to this are microwave ovens, ranges, ovens, dishwashers, and disposals.

Table 1

EUROPEAN CONSUMER EQUIPMENT PRODUCTION
(Millions of Dollars)

	1985	1986	1987	1988	1989	1990	1991
Audio	$ 791	$ 897	$ 1,166	$ 1,101	$ 1,295	$ 1,338	$ 1,485
Video	3,746	3,910	4,280	4,047	5,069	5,256	5,540
Personal Electronics	1,190	1,220	1,284	1,213	1,581	1,742	1,828
Appliances	10,648	11,803	13,880	13,115	12,770	13,011	13,546
Other	227	222	232	219	260	257	285
Total	$16,602	$18,052	$20,842	$19,695	$20,975	$21,604	$22,684

Source: Dataquest
June 1987
Ref. 0587

Table 2

EUROPEAN SEMICONDUCTOR CONSUMPTION
CONSUMER
(Millions of Dollars)

	1985	1986	1987	1988	1989	1990	1991
Audio	$ 68	$ 87	$133	$ 133	$ 134	$ 142	$ 157
Video	426	448	529	584	588	592	641
Personal Electronics	33	34	39	46	49	49	54
Appliances	201	238	230	274	271	270	303
Other	5	6	7	7	7	7	8
Total	$733	$812	$938	$1,044	$1,049	$1,059	$1,163

Source: Dataquest
June 1987
Ref. 0587

Table 3

EUROPEAN INPUT/OUTPUT RATIOS
CONSUMER
(Percent Based on Dollar Values)

	1985	1986	1987	1988	1989	1990	1991
Audio	8.6%	9.7%	11.4%	12.1%	10.3%	10.6%	10.6%
Video	11.4%	11.5%	12.4%	14.4%	11.6%	11.3%	11.6%
Personal Electronics	2.8%	2.8%	3.0%	3.8%	3.1%	2.8%	3.0%
Appliances	1.9%	2.0%	1.7%	2.1%	2.1%	2.1%	2.2%
Other	2.4%	2.5%	3.0%	3.2%	2.6%	2.7%	2.8%
Average I/O Ratio	4.4%	4.5%	4.5%	5.3%	5.0%	4.9%	5.1%

Source: Dataquest
June 1987
Ref. 0587

Table 4

ESTIMATED EUROPEAN APPLIANCE MARKET
(Millions of Dollars)

	1985	1986	1987	1988	1989	1990	1991
Air Conditioners	$ 192	$ 196	$ 219	$ 207	$ 181	$ 184	$ 192
Microwave Ovens	8	60	138	130	162	165	171
Washers and Dryers	2,793	3,044	3,556	3,360	3,100	3,158	3,288
Refrigerators	1,737	1,862	2,139	2,021	1,774	1,808	1,882
Dishwashers and Disposals	599	702	845	798	1,052	1,072	1,116
Ranges & Ovens	1,933	2,175	2,581	2,439	2,461	2,509	2,613
Vacuum Cleaners	1,029	1,134	1,325	1,252	1,099	1,120	1,165
Food Processors	1,162	1,278	1,492	1,410	1,239	1,262	1,314
Heaters	870	963	1,117	1,056	927	943	822
Total	$10,648	$11,803	$13,880	$13,115	$12,770	$13,011	$13,546

Source: Dataquest
June 1987
Ref. 0587

The full advantage of the methodology detailed above is realized by applying I/O ratios to these appliance estimates. This demonstrates that the estimated semiconductor consumption of European appliances will grow from $230 million in 1987 to $303 million in 1991, a CAGR of 7.1 percent. In the appliance market, Europe's leading producers are now stepping up their development of electronic controls and timers, although only for more sophisticated machines. However, Dataquest believes that it will be necessary for them to display a faster rate of innovation in order to avoid being overtaken by the new Japanese products that should be available on the market in the next five years.

Jennifer Berg

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Research *Newsletter*

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A WORLDWIDE SMART CARD OUTLOOK: EUROPE PIONEERS PRODUCTION

The most dramatic change in the smart card market over the last year is that the market appears more application-driven and likely to grow from a demand-pull. For years the smart card has been a great concept in search of a market--a technology push. Today, smart card technology is able to provide solutions to many problems. This newsletter highlights recent worldwide smart card market activities, Dataquest's current unit production projections, and key developments occurring across the globe.

EUROPE--THE BACKDROP FOR MARKET ACTIVITY

The IC credit card or smart card was pioneered in 1976 by French citizen, Ronald Moreno. Three years later, in 1977, the concept became a reality as a result of collaborative work between Cii Honeywell Bull and Motorola Semiconductors (Europe). Initial production started in 1981 using a single-chip 8-bit microcontroller with 1,026 bytes of EPROM. Today, 10 years on from the first development work, IC cards are running in volume production in Europe in addition to undergoing numerous field trials in a variety of applications.

Table 1 lists Dataquest's world unit production estimates for 1987: nearly 50 million units. Of this 50 million, we expect 45 million or 90 percent of the production to take place in Europe. We estimate that this 45 million will comprise 22 million units of the financial card CP8 and 23 million units of the telephone E^2PROM card being marketed by the French PTT.

Production of the telephone card is exclusively by Thomson Semiconductors and takes place in its Rousset Plant, Southern France. Thomson recently moved a number of MOS processes from the Grenoble Plant to Rousset in order to focus key MOS process development in one center. The development of E^2, EPROM, and HCMOS processes at this site allows the company to rationalize the production and development resources associated with the telephone and

CP8 cards. Dataquest estimates that Thomson will supply approximately 20 percent of worldwide demand on CP8 (8.8 million units) during 1987. The other participants during 1987 are Motorola (Scotland) and Philips (RTC France) with 40 percent and 20 percent of the worldwide production, respectively.

Dataquest expects that the present E^2PROM telephone credit card will be phased out during 1987/1988 to be replaced by a variant of CP8. By 1992, Dataquest estimates that worldwide IC card production will be 525 million units, Europe accounting for 35 percent of the TAM.

Table 1

ESTIMATED WORLDWIDE SMART CARD PRODUCTION*
(Millions of Units)

	1985	1986	1987	1988	1990	1991	1992
Financial	1	7	25	45	70	135	155
Telephone	3	10	22	50	95	185	260
Other	N/A	N/A	3	7	30	55	110
Total	4	17	50	102	195	375	525

*Assumes financial cards have a life cycle of approximately two years. Other cards have a life cycle of six years. Telephone card life cycle is three months.

N/A = Not Available

Source: Dataquest
May 1987

U.S. SMART CARD MARKET ACTIVITY

In the United States the smart card market has centered around entrepreneurial activity and alternative technologies such as that of Datakey, Inc., a Minnesota company focusing on nonfinancial smart card applications. The much-touted financial arena (the most traditionally thought of application for smart cards) had too many barriers to entry--namely ISO packaging requirements and smart card cost. (Other ISO standards activities for the smart card, for example, communications protocols, are still emerging.) Some confuse the unclear standards as a major market barrier. While smart card standards are more complex than for the mag stripe, it is encouraging to note that it took seven years before standards for mag stripe technology were adopted; today nearly a decade later, over 1 billion mag stripe cards are in circulation--for financial transactions alone.

In the past, Dataquest has noted that nonfinancial applications would be the driving force behind smart card development, particularly in the United States because nonfinancial applications:

- Would not be restricted by ISO packaging and communication standards for plastic cards
- Would not be limited by the current infrastructure and manner in which business is currently performed (i.e., working around the already heavy investment in automatic teller machines)

MasterCard International and Visa International, both with very different philosophies, strategies, and approaches to the market, have begun to change this. The nonfinancial market legitimized the technology to a certain extent and acted as a proving ground for smart card technology. Just as Dataquest originally expected, these applications appear to have inspired the financial community to analyze smart card technology with a view toward applications within the financial arena.

MasterCard--Leading the Way

Things changed in 1985 when MasterCard International formally announced its market test, setting off a flurry of interest including a smart card approach announced shortly thereafter by Visa International. Both MasterCard and Visa are outspoken about their approaches to smart card solutions.

We believe that MasterCard has been actively qualifying and discussing vendor participation and we expect an announcement in the first half of 1987 as to who will be the program's major participants and how the program will expand. We believe that MasterCard has been working with as many as six IC manufacturers including NEC and Motorola whose chips are in the cards currently being tested. We believe Motorola is the only U.S. IC manufacturer among the six or so companies. Requirements for multiple sourcing and MasterCard's requirement for state-of-the-art technology are fostering numerous discussions. Another potential boon to semiconductor manufacturers is that MasterCard is considering the testing of biometric identification as a less cumbersome solution than PIN codes. Proposed methods include digitized signatures or finger characteristics.

We believe that MasterCard will begin testing and using a production IC card by the second or third quarter of 1987. MasterCard views the semiconductor industry as a vital support link, necessary to effectively implement the technology. Unconfirmed estimates place MasterCard IC card use at the low hundreds of thousands by mid-1987, the low millions by 1988, and high volume in the late 1989 to early 1990 time frame.

The Visa Approach

Visa International's strategy for smart cards is quite different from that of its counterpart. Visa believes that the current need for the technology comes from improving current bankcard services and providing new services that can produce incremental income. They believe that the current system works and that operating costs and losses through fraud can be reduced. Visa believes that current services are highly profitable and it disagrees with MasterCard that today's bankcard business can justify smart card technology. MasterCard justifies implementation based on reducing losses and authorization costs.

Visa believes that in order to take advantage of new technologies and new services and improve existing services there must be an increase in terminal penetration because different terminals accept different cards. Therefore, by putting the terminal on the card, the industry has a readable card that also becomes the delivery system--no need for a variety of terminals, especially with a single vendor that accepts more than one card.

For the financial community this is truly forward thinking, because the history of banking holds that authority lies in more than one place--to use the analogy of the safety deposit box, the customer brings a key, the banker brings a key, and together they unlock the box. Visa believes that the key and the lock do not have to be in two different places. MasterCard, on the other hand, is approaching the system from a traditional banking operation perspective. In short, Visa views the concept as pocket banking as compared to controlled banking.

Visa's different perspective, namely its cost justification, view toward providing new services, and pocket banking concept has thrust it toward development of the next generation of smart card technology--a card utilizing E^2 technology, which Visa refers to as a super card and which falls at the high end of the card evolution spectrum.

Visa is currently testing a small number of cards developed by Smart Card International and manufactured by General Instrument's Microelectronics Division. The main purpose is to evaluate users' needs and attitudes toward the technology. Meanwhile, Visa has commissioned Toshiba to make a production version of the card with the charter of putting the technology on a card that meets ISO standards of 30 mils in thickness. The time frame for completion is the fall of 1987 to spring of 1988.

We applaud Visa's strategy to seek "a gradual transition to the smarter cards of the future while supporting the coexistence of several technologies," and we believe that E^2 technology is the long-term answer to most future smart card applications. MasterCard, however, is taking a more realistic approach in its attempt to use current technology within the current financial infrastructure.

E^2 technology for financial applications is still not as technically feasible. MasterCard's testing of the technology in a large-scale pilot is a manageable approach to making the technology realistically meet the needs of today's bankcard environment. We believe that smart cards can work in the financial community today, without having to wait for E^2 technology in the late 1980s time frame. Testing the system as it exists appears most feasible from a smart card market perspective. MasterCard is chartering U.S. market development in financial applications.

JAPAN'S FOCUS ON SMART CARDS

There has been a surge in Japanese smart card activity over the last year. Dataquest's semiconductor market analysts in Japan have kept abreast of smart card market trends and we believe that there is no question that this market is being assessed and targeted very seriously by many sectors of the Japanese economy--much of this activity appears coordinated and orchestrated at a government level. The development of the smart card market is a lesson in Japanese industrial policy at work; competition is said to be fierce. There are as many as 50 to 75 small tests actively being observed. Applications are numerous and a myriad of technologies are being used. Consensus holds that a large number of small tests will provide the best window on market opportunities.

The most striking aspect of Japan's involvement has been the pace with which the Japanese have taken an active interest in the market. In terms of manufacturing technology, smart cards are similar to calculators and digital watches. Smart cards lend themselves to assembly and production by Japan's large electronic watch and calculator manufacturers.

In Japan, partnerships and alliances appear integral to the market's early development. Manufacturers are aligning with users to secure volume sales of products that conform to a worldwide or manufacturer's standard. This is all part of the coordination and cooperation that is being brought to bear on the Japanese focus on this market.

CONCLUSIONS

We are encouraged by smart card activity overall, and in particular the surge of activity seen in 1986. We believe 1987 will bring continued market opportunities and growth as the market begins its early shift into high gear. Market participants should be positioning themselves now; waiting much longer may mean that the market will be closed just as it begins to ramp up. There are opportunities for many types of IC manufacturers because the market has needs in large scale, high-volume applications as well as within the niches. The smart card market will not be only for those who are capable of withstanding the tremendous competition of commodity markets.

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Jim Beverige
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EUROPEAN MANUFACTURING AUTOMATION STATUS--SUMMER 1987

OVERVIEW

Development and installation of manufacturing automation in Europe is continuing on an aggressive scale relative to the rest of the world. Key factors that are sustaining investments in industrial plant modernization include:

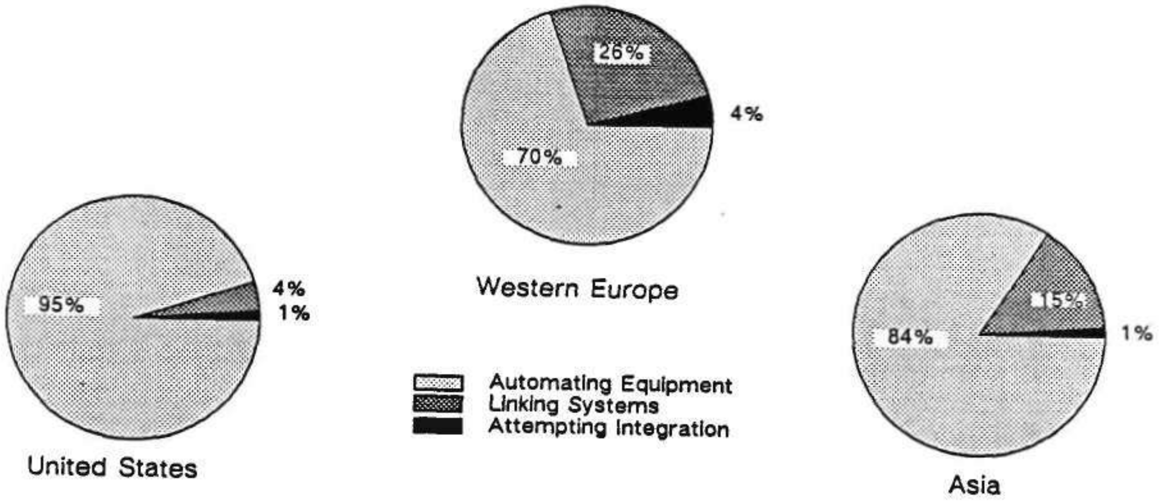
- Pressure to reduce manufacturing costs as local currencies rise in comparison with the U.S. dollar
- Rising confidence in the value of automation based upon results of pioneering efforts of innovative industry leaders
- Cooperative programs between governments, universities, and individual companies for investments in technology development
- Focus of management upon strategic manufacturing as a vital element for European economic strength in a global economy

Dataquest believes that Europe is currently leading the rest of the world in implementation of automated work cells. Figure 1 shows the relative positions of Western Europe, Asia, and the United States as of early 1987. The growth of strategic partnerships between European companies both within and across national borders is enabling this technology to spread rapidly.

The 1987 world market for manufacturing automation, excluding design automation and automation services, is estimated to be US$35.0 billion. Europe is expected to purchase US$7.2 billion, or 22.5 percent of the world total. Figure 2 shows the relative shares of the European total that Dataquest estimates will be consumed by individual European countries in 1987.

Figure 1

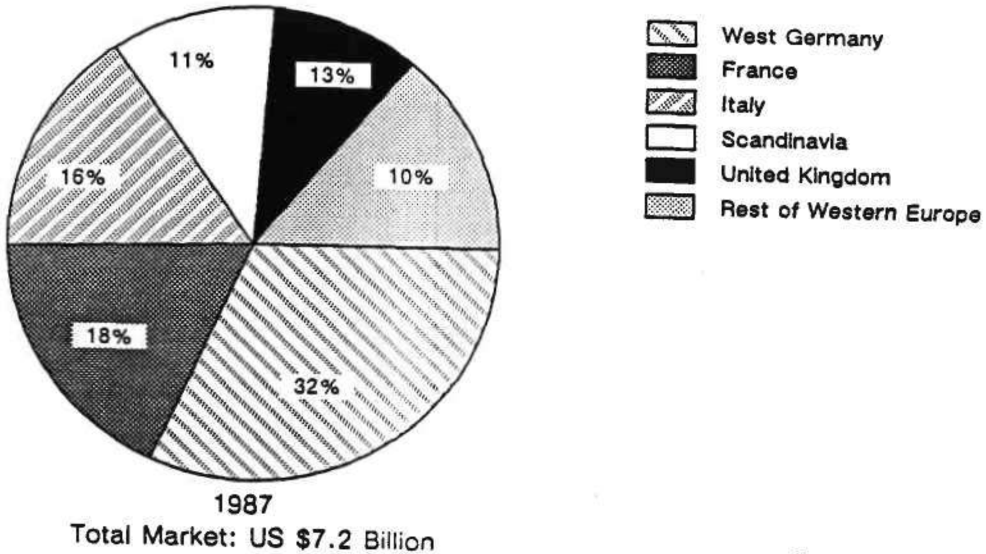
MANUFACTURING AUTOMATION IMPLEMENTATION
Early 1987



Source: Dataquest
August 1987

Figure 2

ESTIMATED WESTERN EUROPEAN MANUFACTURING AUTOMATION MARKET SEGMENTS BY COUNTRY
1987



Source: Dataquest
August 1987

WESTERN EUROPEAN MANUFACTURING DEVELOPMENT TRENDS

During the spring of 1987, Dataquest toured four of the major industrial countries in Western Europe and attended the Hannover Industrial Fair in West Germany and the SICOB and Convention Automatique Productique exhibits in Paris. Dataquest visited factories of both automation users and vendors, and held press conferences with members of the technical press in London and Hannover regarding the status of manufacturing automation developments and trends for the immediate future.

The Hannover Industrial Fair is a massive display. Taking place in buildings encompassing a total of 380,000-square-meters with more than 6,000 companies, universities, and research institutes from 50 countries exhibiting, it attracted nearly half a million attendees.

Although the Fair had a strong West German vendor flavor, the signs of European unity were clearly discernible from the opening address by the vice-president of the European Economic Communities (EEC) commission. Examples of this unity were programs such as ESPRIT (European Strategic Program for Research and Development in Information Technology) and joint exhibits such as the "Initiatives for the Factory of the Future." The latter consisted of 194 individual stands, encompassing 10,000 square meters, that presented production-related automation technology in an overall, integrated context.

Dataquest believes that a major industrial trend in Western Europe is the emergence of a European community that is replacing the old internecine wars and conflicts that characterize much of European history. According to the Treaty of Rome, signed in 1957, a large common European market and technological community is expected to emerge by 1992. The primary objective is to create a market size for European industry that is comparable to what exists for North American and Japanese firms. The market area is expected to result from the planned dismantling of all trade, monetary, and technology barriers between members of the EEC.

The concept of a united Europe has a high acceptance level, according to surveys that have been taken by members of the community. There is a broad awareness of changing international circumstances and a consequent change in priorities for responding to the new international environment. Manufacturing automation development and implementation is high on the list of priorities.

Governments already are pooling funds in technology development and research via such projects as ESPRIT. The EEC has spent $120 million since 1982 developing ideas for the factory of the future. It is now proposed that $1.2 billion be spent on computer-integrated manufacturing (CIM) research over the next 5 years. In addition, the EEC expects to invest over $900 million in communications research with the Race program and $140 million for the Brite program on industrial technologies.

Manufacturing automation protocol (MAP) is well on the way towards development with a distinctly European flavor. Standards are viewed as a means for widening market opportunities for European automation systems vendors. For example, instead of producing machine tools with Italian standards to serve the Italian market, machine tool builders can address world markets if their machines conform to international standards. European users are involved in the MAP development through the ESPRIT program and through membership in EMUG, the European MAP Users Group.

Another trend is toward joint ventures, strategic alliances, and mergers across borders. An example is the agreement between France's Thomson Semiconducteurs and Italy's SGS Semiconductors. This merger will involve the creation of a Netherlands-based company, owned 50 percent by Thomson-CSF and 50 percent by STET, the Italian group. Other examples of noteworthy cooperative efforts include a joint R&D effort for digital switches by France's CIT-Alcatel, Italy's Italtel, Plessey of Britain, and West Germany's Siemens AG; ICL, Siemens, and Bull cooperating on technology for the next generation of computers; and Philips and Siemens working together to develop megabit chips.

The mood of the European manufacturing automation vendors at the Hannover Fair was one of optimism. The same attitude was expressed by both vendors and end users of automation systems during Dataquest visits to factory sites in Europe. Manufacturing competitiveness on a global scale is viewed as a major factor in the economic well-being of European society. Automation is seen as a key element in the ability of manufacturers to sell products on a worldwide basis.

Installation of automated systems and processes in Europe has progressed to a greater extent than might be realized. Experience with successful automation projects has tended to make both systems vendors and end users highly receptive to further investments in manufacturing systems. Dataquest further believes that the Western European region is taking a back seat to no one in such areas as work cell integration, use of expert systems in manufacturing, robotics, automated material handling systems, and factory floor simulation software.

WEST GERMANY

West Germany leads the world in per capita exports, with 60 percent of its gross national manufactured products exported. This level is twice as high as Japan's and four times that of the United States. German manufacturing managers tend to be technically trained with factory operations experience. These executives view manufacturing operation efficiency as one of the key elements to maintaining worldwide competitiveness. Thus, investments in manufacturing technology are strong.

The recent rise in the value of the deutsche mark relative to the dollar has added additional incentive toward investments in manufacturing automation. Since the United States often represents 30 percent or more of the West German market, every attempt to hold product prices down in the United States is being made. Because the price must be lowered to counter the rising mark value, profit margins can be retained only if product costs are reduced. How is this being accomplished? Through increased automation, say German representatives.

Interviews with West German manufacturing executives reveal that the annual rate of automation systems investments will grow between 15 and 20 percent per year for at least the next two years. This rate is the highest in Europe. Particularly strong are purchases of robotics, material handling automation, and industrial sensors. West Germany has more flexible manufacturing systems (FMS) installations than any other country in the world, with approximately 100 such installations as of the end of 1986.

West German industry has close cooperation with universities. Dataquest saw at least 12 universities that exhibited their state-of-the-art technology developments at the Hannover Fair. In contrast to the U.S. students, the highly motivated West German students were looking forward to careers in manufacturing operations or research in manufacturing technology development.

FRANCE

France is the second-largest market for manufacturing automation systems in Europe, with an estimated total of nearly $1.3 billion to be spent in 1987, as shown in Figure 2. Applications of automation are concentrated in the largest companies. The market has been slow in developing for the following reasons:

- Necessity of retrofitting old factories
- Lack of experience and need for extensive training
- Insufficient resources in the majority of small companies
- Wide product and process diversities
- Disappointments with overly ambitious projects that have not met expectations

Emphasis has been on elimination of unprofitable operations and the discontinuance of poorly performing product lines, such as consumer electronics.

The current strategy of many French companies is to consolidate in order to gain benefits from greater pools of resources and also to eliminate duplications. An example of this strategy is the merger of the Peugeot and Citroen automotive firms.

The automotive, aerospace, and appliance industries lead in French manufacturing automation implementation and developments. Some large firms such as Renault have taken advantage of their internal manufacturing expertise to develop products and services for new business developments. Renault Automation has successfully participated on a worldwide basis as a turnkey supplier of systems integration services and as a supplier of robotic and material handling systems.

In an alliance with EMUG, 30 French companies have been working since June 1986 on development of a factory network standard called Factory Information Protocol (FIP). This network is intended to be implemented at the equipment and workstation level below the factory MAP network. The objective of this standard is to provide analog, nondedicated, low-cost communications at the lowest levels in the factory. FIP would be connected to the MAP network via bridges.

Dataquest attended both the Convention Automatique Productique and the SICOB computer fair in Paris. In conjunction with SICOB, Bull held a separate show where it exhibited its capabilities in both design and process automation. All of these events, while not on the scale of the Hannover Fair, were well attended. The French are determined not to be left behind in the European surge toward manufacturing automation developments. They place particular emphasis on software development, modeling of automated structures and organizations, design automation, and workstation scheduling and control innovations.

Concerted efforts are being made to ensure that workers and executives alike are well trained in the developments that are occurring in manufacturing. For example, Peugeot/Citroen advertises that 3.5 percent of the annual turnover of the combined companies is spent on employee training.

ITALY

Italy is currently experiencing the best economic environment that it has seen in a decade. Always strong in engineering capabilities, Italy is at the forefront of European manufacturing automation technology development. There is a new emphasis on worldwide business alliances and product development. An important example of this trend is Olivetti, which has formed alliances with AT&T in the United States, and with European and Asian firms. In addition, Olivetti is actively pursuing its role as a leading vendor of manufacturing information systems development on a worldwide basis. Comau's acquisition of three French machine tool companies is another example of Italian expansion into European markets.

The automotive, apparel, and appliance industries have gained significant penetration into global markets. According to the Italian Economic Study Office, the export-import balance of trade for machine tools has climbed steadily upward since 1975 to an estimated positive level of nearly 1,000 million liras in 1986. Exports of machine tools exceed domestic consumption by nearly 400 million liras. Nineteen eighty-six machine tool revenue increased by 17 percent over 1985. Italy is the world's fifth largest producer of this class of automation systems.

Turnkey plant installations by Italian firms lead the rest of Europe, with 80 percent of their turnover coming from installations outside Italy, according to the chairman of Italimpianti. Evidence of Italian manufacturing technology prowess can be seen from recent contract awards to Italian firms. For example, Mitsubishi has signed an agreement to market rolling mill technology developed by Pomini Farrel throughout Asia. For the Soviet government's ZAZ towncar, Geico of Milan will provide design and construction of the entire painting structure, including pretreatment, catphoresis, and robotized lines for primer and final coats for vehicle interior and exterior bodywork. This car will be produced and marketed throughout the USSR beginning in 1990.

There are 70 robot manufacturers in Italy. The majority of these are simple pick-and-place devices that do not qualify as robots under the Dataquest or Robotics Industry Association (RIA) definition. For example, in 1985, Italy had an installed base of 5,000 industrial and 15,000 additional pick-and-place machines. Dataquest estimates that robot use in Italy is growing at 25 to 30 percent per year. Major suppliers include Comau, DEA, and Olivetti. Major users include Fiat and its newly acquired subsidiary, Alpha Romeo, and Olivetti--which supplies 90 percent of its robots itself.

UNITED KINGDOM

The weakest link in an otherwise upbeat European manufacturing automation market appears to be the United Kingdom. The London Financial Times has reported that in 1987, Italy's GNP is expected to surpass that of the United Kingdom for the first time in modern history. The United Kingdom will be last in terms of GNP size of the major EEC countries.

Even so, Dataquest believes that there are some signs of encouragement for the future of U.K. manufacturing developments. For example, some 50 Japanese companies have set up factories in Britain, putting it neck-and-neck with West Germany as the European nation of choice for Japanese enterprises. Currently, Japanese firms such as Nissan, Sony, NEC, Hitachi, Komatsu, Sumitomo, and Ricoh employ about 13,000 workers.

At the $650 million Nissan plant in Sunderland, evidence of changes to England's class-ridden industrial past are reported to have resulted in a steady increase in output levels, with quality reportedly equal to that of cars produced in Japan. Further, there have been no union grievances to date. A just-in-time system of scheduling the arrival of parts, the utilization of groups of spot-welding robots, and the emphasis of employee teamwork are fundamental changes in British industrial style.

Other areas of British leadership in European manufacturing automation development are that the chairman of EMUG, Colin Hoptroff, is an executive at Jaguar, and that British Aerospace is the prime contractor for CNMA (Communications Network for Manufacturing Applications). CNMA, a parallel to MAP, is a European initiative funded by EEC as one of the ESPRIT developments. MAP and CNMA have the same objective, which is to get suppliers and users of automation systems to use the open network communications standards as defined by the ISO (International Standards Organization).

In spite of these bright spots, Dataquest believes that the United Kingdom lacks the intensity of development that is occurring elsewhere in Europe. Too many developments appear to be academic, with low levels of acceptance in the mainstream of manufacturing industries. The recent reelection of the Thatcher government is more likely to produce a continuation of the present level of development than it is to produce any revolutionary changes in British industry.

DATAQUEST ANALYSIS

In summary, Dataquest finds the status of European manufacturing automation to be as follows:

- European business is generally good and growing for most manufacturers. Exports to the United States continue in spite of the falling U.S. dollar.
- Technology development is being emphasized throughout Europe, especially in applications software and the integration of programmable equipment into automated work cells.
- Dataquest estimates that Europe is spending 25 percent of its total investment in manufacturing automation for integration of equipment into work cells, 4 percent for integrating entire factory systems, and 71 percent for automating individual pieces of equipment. The level of work cell integration is the highest as a percent of the total automation investment in the entire world.
- Generally, European governmental support for manufacturing automation development is clearly evident. Although governments may not be as enthusiastic about the formation of a single European economic community as is industry, Dataquest believes that developments to this end may well occur at a faster pace than is currently anticipated, both within and outside Europe; this will be particularly true if the United States appears to begin to reduce its Western European military support after 1988.
- Worldwide alliances, as well as intra-European alliances, joint ventures, the pruning of unprofitable products and factories, and the implementation of automation in manufacturing, are well under way in Europe.
- Manufacturing competitiveness is a high-priority item in Europe. There is no debate about becoming a service economy or a post-industrial society. Europe intends to continue to be very much a world industrial power.
- Since exports represent a high percentage of the GNP of European manufacturers, the increase in their currency values relative to the U.S. dollar provides additional impetus to reduce the cost of goods sold. Automation is seen as a major element in meeting this objective.

- Europe enjoys good academic support for technical developments in manufacturing automation. Universities are providing a source of highly qualified and motivated human resources for long-term growth in European manufacturing technologies.
- Dataquest's contacts with European manufacturers confirm that most companies throughout Europe intend to focus on specific market niches rather than expand across broad market areas. They are in the process of strategic consolidation and streamlining of their internal organizations in order to become experts in particular areas with products focused upon global market needs.
- The European industrial leaders are solidly behind the development of world standards, such as MAP. However, Europeans are also intent upon improving standards that are developed in the United States. Dataquest estimates that implementation of the MAP standard in Europe will parallel U.S. efforts.

(This newsletter is reprinted with the permission of Dataquest's Manufacturing Automation Service.)

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NIXDORF COMPUTER AG--REACHING FOR THE WORLD

INTRODUCTION

Nixdorf Computer AG has long been one of the most successful computer companies in Europe, particularly in its native Germany. However, the company's success in other important markets in the world, particularly in the United States, has been less than spectacular. In 1987 we may see a positive change in the company's worldwide sales picture as management rededicates itself to the original company goal: to provide standard and tailored vertical programs for small- and medium-size companies in a variety of markets.

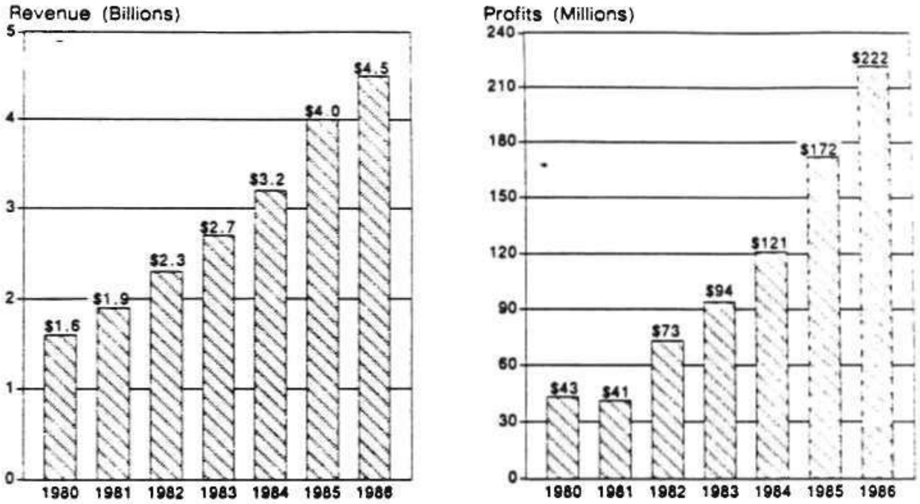
This newsletter discusses Nixdorf's growth, examines its overall product line and its position as a vendor of integrated office systems, and evaluates its marketing strategy in the light of changing end-user requirements.

COMPANY HISTORY

The rise of Nixdorf Computer AG can be considered a success story by any standard. The company was founded in Germany in 1952 by Heinz Nixdorf, and today is represented in more than 44 countries with over 600 branches and service organizations. As shown in Figure 1, revenue has increased steadily by approximately 20 percent per year to DM 4.51 billion (or $2.1 billion) in 1986. More than 89 percent of this revenue is from Europe, the rest from international markets (the United States and Asia). Profits climbed 29 percent in 1986.

Figure 1

Revenue and Profit--1980 to 1986



Source: Nixdorf Computer AG

But Nixdorf measures its success based upon more than just the bottom line. The company takes its social responsibility seriously and regards people and innovative technology as important as an increase in profits. At press and stockholder meetings, Nixdorf always emphasizes two points:

- The size of its research and development budget, which has consistently remained at approximately 10 percent of revenue
- The number of additional people that the company employs each year. In 1986, for example, Nixdorf added 2,300 positions. This increased worldwide personnel to 25,600 people, with approximately 17,000 of them working in Germany.

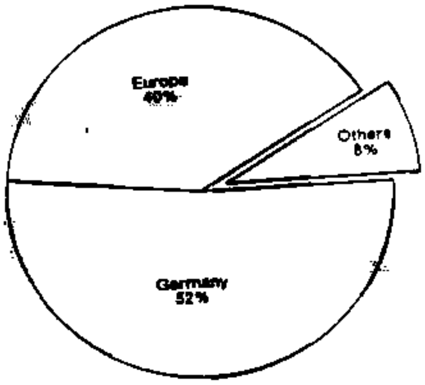
Mr. Nixdorf died prematurely in 1986 at the age of 60. Mr. Klaus Luft, the Vice Chairman of the Board, assumed the position of Chairman of the Board, and Mr. Arno Bohn took the position of Vice Chairman. No other management changes were made. The company continues to be run by the seven board members, five of whom have been with Nixdorf since 1970.

Foreign Markets

As represented in Figure 2, approximately 52 percent of total revenue comes from sales within West Germany, 40 percent from the rest of Europe, and 8 percent from other countries. Excluding Germany, Nixdorf is represented in 325 cities in 17 countries in Europe. Outside of its native Germany, Nixdorf has been most successful in England, France, and Spain. In England, for example, Nixdorf has an 8 percent market share in the retail industry and an 11 percent market share in the banking industry. In addition to Europe and the United States, Nixdorf is represented in 54 cities in 24 countries in South America and Asia.

Figure 2

Revenue by Region



Source: Nixdorf Computer AG

In the United States, Nixdorf has established subsidiaries and service organizations in 110 cities. However, penetrating the U.S. market has proved to be a formidable task. Although Nixdorf is the largest non-American computer business in the United States, its market share after 19 years is 1 percent of midrange computer sales. But several large orders in 1986 (Montgomery Ward, for example) indicate that the trend may be reversing now that Nixdorf has switched from a product-oriented to a solution-oriented approach, the strategy to which it owes its success in Europe.

In its continuing push into international markets, Nixdorf has established software centers in Holland, Ireland, Japan, the United States, and Singapore to develop application programs appropriate to local market requirements. Production facilities have been established in the United States, Ireland, Spain, and Singapore.

Corporate Objectives

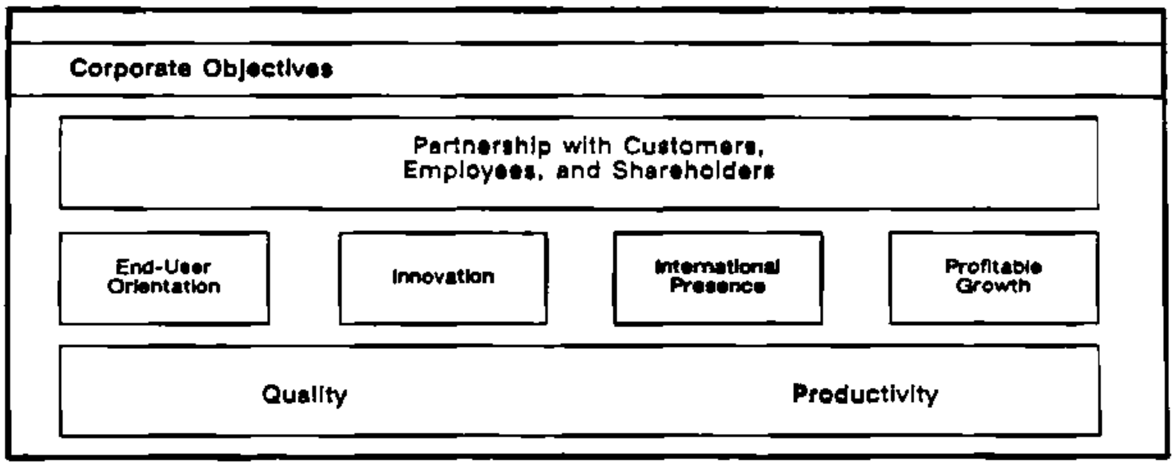
Until his death in 1986, Heinz Nixdorf "was" Nixdorf Computer AG to the public and one of the most prominent personalities in the European computer industry. Yet, when he died unexpectedly in Hannover, the transition to new leadership was untroubled and smooth, largely due to Mr. Nixdorf's vision and long-range planning. Corporate policies had always been set by Mr. Nixdorf in conjunction with the board of directors, and so no changes in corporate strategy were considered necessary.

This includes Nixdorf's determination to remain independent rather than merge with another company. Equity capital is now more than 60 percent, and all voting shares remain in the hands of the Nixdorf family.

Nixdorf's approach to domestic and international business is perhaps best exemplified by the company's traditional corporate objectives as outlined in Figure 3. Nixdorf has always emphasized (and has built its success on) its role as a partner to its customers, its employees, and its shareholders. In its role as partner, Nixdorf has paid primary attention to end-user needs and to the necessary innovation in developing programs for its domestic and international customers.

Figure 3

Corporate Objectives

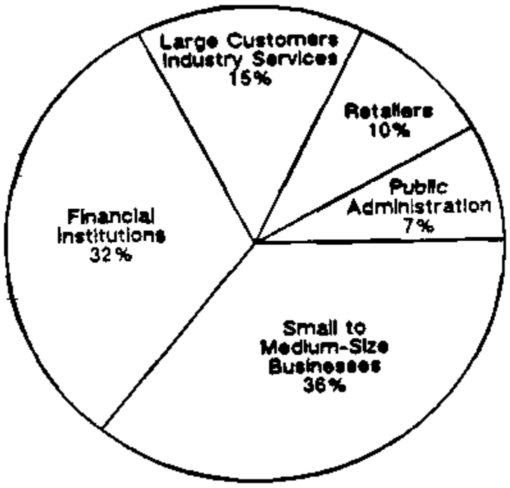


Source: Nixdorf Computer AG

To achieve these objectives, Nixdorf's main strategy has been to penetrate small- and medium-size companies by providing them with tailor-made vertical application programs for solving specific problems. Nixdorf was one of the first to address the needs of vertical markets. In order to produce the numerous tailored, solution-oriented applications, the company established its own 3,500-person software development staff and formed strong alliances with numerous software and system houses. As a result, approximately 36 percent of Nixdorf's revenue comes from sales to small- and medium-size companies as outlined in Figure 4.

Figure 4

Worldwide Revenue by Customer Group



Source: Nixdorf Computer AG

Strategic Changes

Although Nixdorf's basic tenets have not changed over the years, there have been several shifts in the company's strategy that should improve its appeal to multinational companies and international markets. The first shift is in its attitude toward IBM; the second is its attitude toward office automation, reflecting the recent shift from standalone business application solutions to an emphasis on integrated solutions, which include office applications.

Nixdorf initially believed that it could continue to provide its own proprietary hardware and tailored software solutions. Over time, Nixdorf realized that it could be more successful if its products were compatible with IBM and other vendors from large hosts to personal computers. After initial hesitation, Nixdorf added IBM-compatible PCs to its product line. The company's strong support of DISOSS on its primary products (the 8860, the 8890 and the TARGON Series) is additional proof of this change in strategy.

Initially, Nixdorf also viewed office systems as closed solutions appropriate for specific departments of an organization. With its support of the 88BK system, the company paid a high price to recognize that this approach did not work. Nixdorf now believes that office applications are needed throughout an organization and that these products can be cohesive elements tying together the entire organization. If implemented, this approach should make Nixdorf more competitive with other integrated office system vendors such as Digital Equipment, Data General, and Wang.

The shift from standalone, tailored business applications solutions to a more integrated approach has resulted in what Nixdorf calls the Computer Integrated Office (CIO) and Computer Integrated Manufacturing (CIM). CIO consists of three areas: telecommunication, text processing, and data processing/business applications. The three components can be found in each Nixdorf product line, and they are developed to maximize the capabilities of each product family. CIO will be described more fully later on in this newsletter.

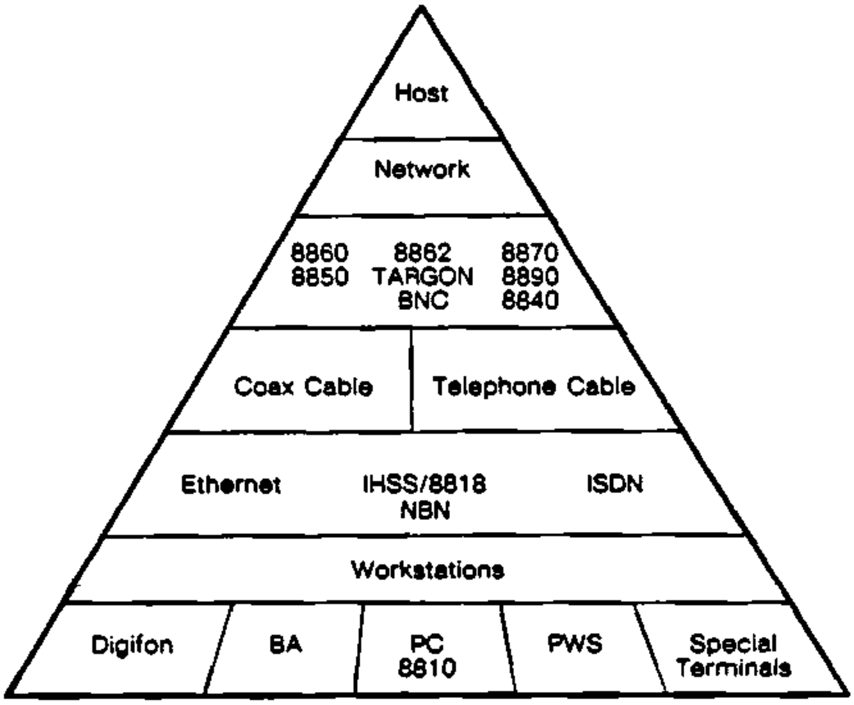
Nixdorf is also a proponent of international standards and continues to work with organizations such as the X/Open Group (UNIX standards); CCITT to promote the X.400 electronic mail standards; X.21 and X.25, with ISO/OSI, ANSI, ECMA, IEEE (Ethernet and Nixdorf Broadband Network) and others.

THE NIXDORF PRODUCT LINE

A brief overview of the product line may be helpful in providing perspective to Nixdorf's offerings. With the exception of large hosts, Nixdorf Computer AG offers an array of hardware and software products for every type of user and application: small- and mid-range computers, personal computers, local area networks, videoconferencing systems, digital PBX systems, image scanners, laser printers, videotex systems, point-of-sales systems, and automatic cash dispensers. Figure 5 outlines Nixdorf's products for the office automation environment.

Figure 5

Pyramid of Products



Source: Nixdorf Computer AG

Terminals

Nixdorf supports character-oriented data processing (DAP) terminals, the personal computer, and the Professional Workstation (PWS). Both PCs and PWS systems function either as standalone workstations or as intelligent workstations to most Nixdorf systems. Through a set of soft keys, the unintelligent DAP 4 terminals offer a user interface similar to the PWS systems.

The Nixdorf 8810 Personal Computer Product Family

Nixdorf models 8810 M 25 and 8810 M 35 IBM compatibles can function as standalone personal computers or they can be attached to other Nixdorf products as workstations. All personal computer models support standard industry software, including the Window Manager from Microsoft and GSX graphics. The 8810/55 is an AT compatible with specific Nixdorf enhancements that is likely to function as Nixdorf's primary desktop publishing system using Page software from Island Graphics.

Professional Workstation (PWS)

The PWS is Nixdorf's primary strategic office workstation. It is a high-resolution (820 x 615 pixels), multifunction workstation with programmable soft keys for use as a videotex terminal, PC, data processing terminal, teletext system, or intelligent workstation to the Series 8840, 8850, 8860, 8862, 8864 BNC (Banking Network Computer), 8870, and 8870 Quattro. Nixdorf markets several models of the PWS: the PWS WP, a low-cost, intelligent, but diskless word processing system terminal; the PWS-D, with diskette; and the PWS-E, the expandable Tower version. The PWS is modular and supports external and internal communications, as well as emulation of the 8840, 8850, 8860, 8870, TARGON, and a variety of host systems from other vendors. It is deeply integrated into each Nixdorf server system for file transfer and remote file access. It supports a wide range of peripherals. Its eight windows permit several applications to run simultaneously, for example MS-DOS (2.11 and 3.2) as well as AT or UNIX software. The PWS can be connected directly, or through the PABX 8818, Ethernet, or the Nixdorf Broadband Network (NBN).

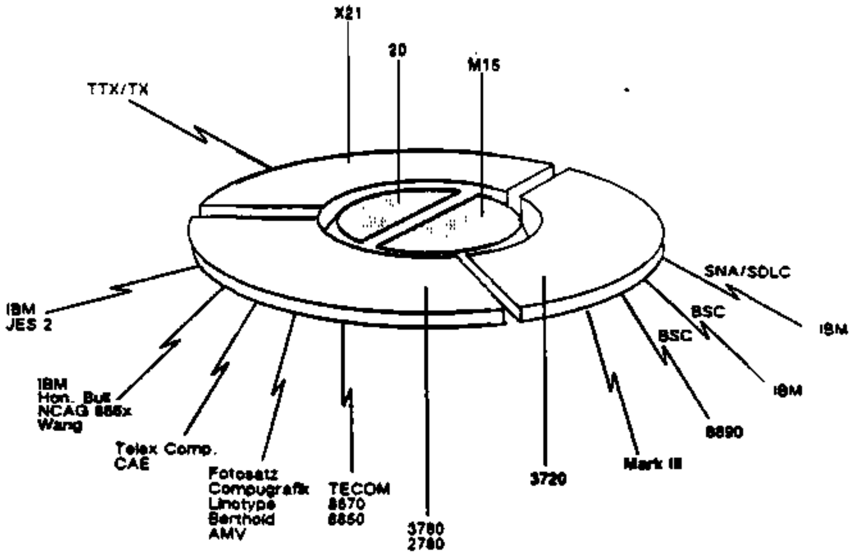
The Nixdorf 8840

Nixdorf's traditional standalone (8840/3) or shared logic (8840/5 to 8840/45) word processing system is expandable to 512K of main memory and 264Mb storage capacity) and supports up to 14 workstations (including personal computers and PWS systems) and 8 printers. The 8840 is designed to handle the integration of text (unstructured) and data (structured) as well as paragraph assembly. The 8840 text software includes mathematical capabilities, teletext capabilities, and communication to a variety of hosts.

Nixdorf has expanded the capabilities of the traditional 8840 text system by providing numerous communication capabilities as outlined in Figure 6. This includes access to the vertical business application capabilities of the larger 8860, 8870, and 8870 Quattro systems. It is also possible for 8840 users to integrate information from the 8870 proprietary data base into the 8840 text program. Editable document exchange is already available between the 8840 and the 8860 text program. Document conversion with the 8870 and the 8870 Quattro text software is planned for 1987.

Figure 6

Communication Capabilities of the Nixdorf 8840



Source: Nixdorf Computer AG

The Nixdorf 8850

The 8850 is a 16-bit decentralized data acquisition and distributed data processing system that is sold primarily to commercial markets. It supports the operating system DIDOS (Distributed Data Processing Operating System), up to 32 workstations including PCs, and a workstation for the blind. The 8850 supports teletext and DETAS (Decentralized Textverarbeitung am Sachplatz), a simple text processing program that merges structured data with addresses and text for mass mailings. The 8850 is able to transfer data and files to the traditional 8840 text system for integration into the more complex text editing programs.

The Nixdorf 8860

The 8860 with Models 60 (industry and public administration), 62 (hotels and wholesale organizations), and 64 BNC (banking systems) is one of Nixdorf's most important and successful products. In the past it was used primarily for distributed data processing applications such as order processing, inventory control, time recording, and recording of production data, and competed with the old IBM 8100. In contrast to the 8870 with its many standard applications, the 8860 fits into environments where tailored systems are needed or where the user develops vertical software.

With the addition of NIOS-TOP at the end of 1986, the 8860 has moved into the office environment and competes against IBM's low-end S/370 line. More than 40,000 processors have been installed: 30,000 in main offices and branches of financial institutions (8864 BNC) and 10,000 (Models 60 and 62) in factories or large organizations as a centralized and distributed information processing system, and more recently, also with terminals for business and office applications. In West Germany, the 8864 is the market share leader in financial institutions.

The 16-bit 8860 with a Nixdorf proprietary operating system consists of modular hardware that provides a user with upgradable systems from standalone micros to MCS, the Multi-Computer System 886X with up to 100 terminals.

The 8860 Multi-Computer System

The MCS was introduced in January 1987 as the most powerful version of the 8860 family. An MCS consists of up to eight autonomous processors coupled with an extremely fast MCS-Bus. Each processor has its own operating system and a copy of the application programs, and each MCS can function as either application or file server. Several Multi-Computer Systems 8860 can be clustered using Ethernet as a local area network. All 8860 software is compatible with the new family.

The application and file server concept of the MCS system provides 8860 users with unlimited growth, and positions Nixdorf to compete directly in the market for major accounts, particularly in the office environment.

The most versatile workstation for the 8860 in an office environment is the Professional Workstation (PWS). Because of its multifunction and windowing capabilities, the PWS can support 8860 emulation in one window, MS-DOS or UNIX software in another, and the NIOS text program (loaded from the 8860) in yet another.

In the office environment, the 8860 supports NIOS-TOP, the Nixdorf Integrated Office Software. NIOS-TOP Word is similar to Quadratron's Q-Office software, and consists of text processing software (including the integration of data processing information), communication (electronic mail, teletext, videotex, and telex), information (calendar, directory, calculator), and document management (filing, retrieval). NIOS-TOP also supports SNA, NCN (Nixdorf Communication Network, and Ethernet, as well as DISOSS DCA/DIA.

The Nixdorf 8870

The 8870 product family is more than 10 years old and has an installed base of more than 50,000 units worldwide. It and the 8860 family are considered by Nixdorf as its "bread and butter" products. The system is primarily sold with standard application programs into small and medium-size organizations as well as into branch offices of large companies.

The Nixdorf 8870 Quattro

The 8870 Quattro family was introduced in early 1987 and offers twice the performance of the 8870 while retaining software compatibility with all 8870 programs. The increased power of the 8870 Quattro is due to the new operating system NIROS 7.0 and its parallel processor architecture with a maximum of four processors. Approximately 50 programs can be run at the same time.

The Micro 7 is the smallest model with two workstations; the high-end Quattro/75 supports up to 30 workstations and 15 printers.

Both the 8870 and the 8870 Quattro support hundreds of standard software programs (bookkeeping, accounting, and so forth) for specific markets under the generic name COMET. As part of Nixdorf's Computer Integrated Office (CIO) approach, the company developed COMET TOP Word, which consists of word processing, filing, archiving, and document creation, as well as COMET data base, telebox, teletext and videotex. COMET TOP Word and COMET Calc can be accessed from all other COMET vertical applications such as bookkeeping, inventory, and so on.

The 8870 and the 8870 Quattro can be networked through the 8818, Nixdorf's digital PABX. Personal computers can be attached through COMET PC-LINK and can support file transfer of business applications information into personal computer programs such as Open Access or Symphony.

The Nixdorf 8890 Product Family

This Nixdorf product competes directly with the IBM 9370 announced in 1986. The Series 8890 (models 32, 13, 18, 23, and 28) is Nixdorf's largest system and ranges from 0.25 mips to 2.8 mips. Together with the 8870 and the 8870 Quattro, it offers a complete modular range, from standalone systems up to the 64-workstation model of the 8890 under VM-Basic. Nixdorf's own PCs, as well as other IBM-compatible PCs, can be attached as intelligent workstations through Ethernet and either in-house or telecommunication lines.

In addition to business application software specific to the 8890, the system supports 8870 and 8870 Quattro compatible COMET TOP commercial software. For the office environment, the 8890 supports COMET TOP Word text processing, electronic mail, resource scheduling (meeting rooms, meeting times, etc.), and meeting facility (videoconferencing). Nixdorf also provides its own relational data base, Reflex.

Reflex is compatible with IBM's Structured Query Language (SQL), a standard set by IBM for its data base products. SQL is portable, independent of application environments, and exchangable. For Nixdorf customers, this means that programs developed under SQL are supported by Reflex. At present, Reflex is available on the 8860, the 8890, and the TARGON systems under Nixdorf's own operating system DIPOS, as well as DOS, VM, and UNIX. Nixdorf is developing Reflex versions for IBM (MVS) and Digital (VMS).

The 8890 systems support IBM's S/370 Office as well as a DISOSS gateway for final-form and revisable-form document exchange.

The Nixdorf TARGON Product Family

Nixdorf has long been a supporter of UNIX V as the standard UNIX implementation. TARGON supports UNIX V, and Nixdorf regards this system as a strategic product, particularly in the public sector. Nixdorf recently received the largest order in its history for more than DM 300 million ($150 million) in TARGON systems from the Bundesanstalt fuer Arbeit (Federal Unemployment Agency). This organization uses Reflex as a distributed data base for its unemployment records and TARGON-Office with teletext and word processing.

The TARGON systems consist of a standalone, the PWS-X (Figure 7) with graphics capabilities, the TARGON/31 M 10 30/50 based on the 86020 processor (8 to 32 users), the TARGON/35 RISC system Models 30 and 50 with 12 mips (32 to 200 users), and the fault-tolerant TARGON/32 (16 to 250 users). PCs and the versatile PWS systems function as workstations to the TARGON system.

Figure 7

PHOTO OF PWS-X

Source: Nixdorf Computer AG

In addition to numerous business applications, TARGON supports TARGON Office software. TARGON Office is the Q-Office program from Quadratron, but it has been enhanced by Nixdorf with soft keys and includes integration of graphics and image. TARGON Office consists of text processing (word processing, text/business applications), notebook, calendar, telephone directory, electronic mail, data base, and calculator. TARGON Calc will be released in 1987. In addition, Nixdorf's TARGON Office supports X.400-Mail, the relational data base Oracle, SQL, and Nixdorf's own data base Reflex in a UNIX coprocessor. TARGON Office also permits access to hosts and networks.

The Nixdorf 8818 PBX

In 1982, Nixdorf launched Germany's first digital PABX, the 8818, a vitally important module in the company's integrated office strategy. According to Nixdorf, the PABX is already being marketed in eleven countries and more than 3000 systems (30 to 3000 users) have been shipped. The 8818 can be integrated into data processing systems to support applications relating to factory data capture (building security, energy management, time recording), charge recording, and wholesale applications. The 8818 also transmits data, text, voice, and graphics within office applications, and will be connected to all Nixdorf products.

All Nixdorf terminals can be attached to the 8818, including the BT01 videotex terminals and the Digifon, a digital telephone used for data switching and telephony. The 8818 permits switching of data from the PC/PWS to personal computers and to midrange computers, as well as from terminals with teletext capabilities to midrange computers.

Voice Box

Nixdorf's Voice Box is a voice store-and-forward system based on 80186 and 80286 Intel microprocessors with the RMX operating system. Voice messages are integrated into electronic mail and appear in the electronic mail directory. Table 1 shows the worldwide installed processor units of the major Nixdorf systems as of the end of 1986:

Table 1

WORLDWIDE INSTALLATIONS OF NIXDORF SYSTEMS

Nixdorf 8840	4,500
Nixdorf 8850	14,500
Nixdorf 8860	40,000
Nixdorf 8870	50,000
Nixdorf 8870 Quattro	released 1987
Nixdorf 8890	700
Nixdorf TARGON	500
Nixdorf 8818 PABX	3,000

Source: Nixdorf Computer AG

CIO, THE COMPUTER-INTEGRATED OFFICE

The CIO concept was developed almost two years ago. To Nixdorf, CIO represents the "informative infrastructure" of an organization, while CIM represents the "productive infrastructure." The CIO concept encompasses all of Nixdorf's hardware products and all data, text, and communication software capabilities, including the digital PBX 8818, Ethernet, and the Nixdorf Broadband Network (NBN).

With CIO, Nixdorf pledges to combine both hardware and software in a number of ways to support managers, secretaries, and knowledge workers in a variety of environments. Through the CIO concept, Nixdorf hopes to show its existing customers that they are already participating in office automation. At the same time, Nixdorf wants to assure them that the investments they have made in Nixdorf products will always be upgradable to state-of-the-art technology without loss of hardware or stored information, and without having to perform duplicate work.

Under the CIO concept, Nixdorf intends to integrate its products according to specific in-house and international standards, perhaps similar to IBM's System Application Architecture that was announced in 1987. In a statement of direction, Nixdorf has formulated rules for each of six main areas:

- Communication with the host
  Rules: RJE (remote job entry), 3270, 8160, SNA, DISOSS/DIA

- Communication between Nixdorf products
  Rules: IHSS in-house communication; remote connection/public networks; Ethernet for server connections; ISDN for workstation connections
  Rules: Ethernet and ISDN

- External postal services:
  Data services: dedicated lines and switched networks; Datex L; Datex P
  Information services: telex, videotex, teletext, telefax, telebox, all according to ISDN standards

- Internal postal services:
  electronic mail according to X.400 and the CCITT standards
  Rules: ISDN standards

- Information management: business applications, word processing, integrated word and business applications, filing and archiving, personal computing, including voice, image and graphics
  Rules: Uniform Information Management (internal Nixdorf standards for uniform integration and user interface)

- Application integration: file transfer, dialog access, multifunctionality (dp + wp + pc + host access and postal services)
  Rules: Multifunctional solutions using standardized interfaces

Dataquest's View of an Integrated System

Dataquest defines an integrated office system as a composite of computer hardware and integrated software that supports and enhances the productivity of work groups. The core functions that have evolved over the years are document management, administrative support, decision support, end-user computing tools, and gateways to other systems.

Vendors must provide for integration, particularly in the area of text, data, image, and voice, and must form them into one compound document. The following capabilities should be available in a tightly integrated system.

- Move data from one application to another without exiting the program or using a conversion utility.

- Move data between applications and files without losing the character of the information (e.g., spreadsheet data inserted into a word processing document retains its spreadsheet identity); when data are changed in one application, the same change is automatically reflected in the second application.

- Store different types of data (such as in compound documents) in one filing system.

- Present a consistent user interface across all applications.
- Run the same software on all proprietary hardware products.

The Nixdorf View of an Integrated System

Nixdorf holds two views of an integrated system. The first one is called CIO, the Computer Integrated Office. CIO champions global integration of data processing, office, and communication applications. This view includes the addition of office and communication capabilities (electronic mail, teletex) to application programs in specific vertical markets, for example, or the addition of those capabilities to already existing installations. Nixdorf has committed to provide this level of integration for all of its products, and is able to deliver many of these capabilities today. For example, many vertical programs access text processing or electronic mail capabilities, or are able to integrate structured data from business applications.

The second view of integration is that of information media: text, voice, graphics, and data. This level of integration provides for the close integration of individual programs in the classical Dataquest definition. Since Nixdorf has never committed to develop a pure integrated office system in the classical sense of Digital's All-in-1 or Wang Office, it must now work to bring its NIOS and COMET office software to the level of these systems. For example, in most Nixdorf systems, spreadsheet information can be integrated into the text program in print mode, but graphic and image data are still stored separately and indicated through a pointer.

However, at the same time, Digital, Data General, and Wang have recognized the need for vertical programs and are working to integrate their office systems software with vertical applications. But even here Nixdorf is more application-oriented and provides this level of integration where its is indicated by customer need and where it provides an enhancement to the existing system.

DATAQUEST ANALYSIS

Nixdorf in the Office Environment

In order to evaluate its office system approach, Nixdorf insists that one must always remember that the company is foremost one that sells into business environments with specifically tailored business applications. This approach has been the primary reason for Nixdorf's success: the ability to give small- and medium-size companies the numerous hardware and software products that solve specific industry-related problems.

The business orientation continues today. Neither in Europe nor internationally does Nixdorf market its systems primarily as office systems. However, in order to compete with companies offering both business and office applications, Nixdorf has added office systems software to most of its systems. In addition, Nixdorf continues to provide its traditional 8840 word processing system in Europe:

- The Series 8860 with NIOS TOP office software
- The Series 8870, 8870 Quattro, and 8890 with COMET TOP office software
- The TARGON Series with TARGON Office

When viewed simply in an office context (a market in which Nixdorf traditionally has not competed), several drawbacks are apparent:

- For Nixdorf, office applications have always been an add-on to business applications. As a result, neither NIOS TOP nor the COMET TOP components are comparable in their depth of integration to the integrated solutions offered by Digital, Data General, Wang, and other competitors.

  However, Nixdorf's strength lies in the numerous specific vertical software programs that the company offers for particular industries. For example, the 8860 is sold primarily into the operating areas of financial and insurance industries, and the office system companies compete primarily in the administrative departments of these organizations. Although NIOS TOP office applications are not as feature-rich or as integrated among themselves as those of its competitors, they can be accessed from NIOS TOP business applications. European customers often prefer this level of integration to office software that is richer in functionality but that lacks integration into business applications.

- The office software programs vary in their ease of use and degree of integration, and some product families consist of incompatible hardware and business applications. This may force users to choose between a strong business application or a strong office application.

- Editable document exchange is possible only from the 8840 to the 8860 and from the 8860 to TARGON. COMET TOP Word is available on the 8870, 8870 Quattro, and 8890, but there is no bridge to the other systems. The document exchange between other products is possible only through teletext.

- The older DAP 4 terminals support only DETAS, an older text processing program well integrated into numerous vertical applications. The newer DAP 4X terminals support COMET TOP Word, but there is no document conversion from DETAS to Word. All new installations are sold only with DAP 4X, leaving DETAS as island applications in specific vertical markets.

However, end-user requirements everywhere have been changing from specific feature/function orientation to an overall systems approach, and from general office solutions to specific vertical applications. In a solution-oriented market, Nixdorf's drawbacks are balanced by an equal number of advantages:

- By positioning itself as the present and future provider of integrated information, Nixdorf has its special emphasis on the integration of business applications, office technology, and communication of all of its products. This means that Nixdorf users can expect continued development of integration capabilities between its major commercial and office software products.

- Nixdorf provides both a digital PABX and computer systems, and intends to integrate them with future ISDN orientation.

- Nixdorf already has strong internal and external communication capabilities and is a strong supporter of international communication standards. These international communication standards are outlined in Nixdorf's statement of direction.

- The company's emphasis on solution-oriented software provides users with a large number of business programs not easily matched by other companies.

- Nixdorf's commitment to software compatibility should assure customers of the longevity of its software programs and company data.

- The TARGON systems now provide Nixdorf with a product that will support truly integrated programs. Nixdorf intends to build on existing programs and to develop an office system that will compete in the office systems market, for example in organizations that already use the 8860 for business applications.

- Nixdorf has announced DISOSS, MAP, and TOP support for the TARGON systems, as well as SNA host functionality and a new 24-mips TARGON system. This expands the TARGON line even farther and positions it as one of Nixdorf's major products.

- Nixdorf intends to exploit the strengths of its PWS systems for all product families and to position it as the workstation of choice. Nixdorf expects to provide the PWS with the more powerful 80386 Intel processor to increase speed and performance.

International Markets

Europe is Nixdorf's primary market. In Germany and in the rest of Europe, Nixdorf's products are well established and will continue to be readily accepted. However, much remains to be done to assure their international competitiveness, primarily in the office systems market. A prime factor aiding Nixdorf in its renewed push into international markets is an increasing emphasis worldwide on vertical applications and solution-oriented software, rather than on the traditional generalized office systems approach.

In order to compete in emerging Asian markets, Nixdorf is busy adapting and translating its COMET TOP vertical software into Japanese, Chinese, and Korean.

One of the largest international markets for Nixdorf could be the United States. However, the office world there is dominated by IBM, Digital, Data General, and Wang; NCR will be a formidable opponent in the vertical application and cash register market.

Several years ago, Nixdorf attempted to compete in the office market with its Nixdorf 8840, designed for predominantly German-oriented integrated text and data applications (for example, merging client addresses resident in a data base with an offer letter originated in word processing, and automatically calculating unit prices). The 8840 was not successful in the United States, and the system was discontinued.

Nixdorf is making another assault on the U.S. marketplace with its 8870, and in particular with its TARGON systems. However, as a pure office systems vendor, Nixdorf at present cannot compete with available integrated office systems from Wang, Digital, and others. Although Nixdorf has rededicated itself to doing what it does best--provide vertical programs for specific U.S. markets--the company is aware that it must continue to deepen the integration level of its office software. In addition, Nixdorf must provide gateways to other vendors and integrate competitors' office software into Nixdorf's vertical business applications.

This is no small task, but Nixdorf is in this business for the duration and realizes that revenue cannot be improved in the short term. Now that the company has moved from a product to a solution approach in the United States, first successes are becoming apparent in the banking, insurance, and retail markets. Nixdorf expects major orders from large companies in 1987, similar to the $100 million order it received from Montgomery Ward & Co.

One of Nixdorf's long-range plans is to bring its ISDN-based products, the 8818 PBX and its Digifone, into the United States. This will put the company not only in direct competition with U.S. vendors of PBX systems, but also with European companies like Philips and Ericsson who intend to garner a share of that market. The 8818 PBX is already sold in Germany, Austria, Belgium, Ireland, Switzerland, Italy, Greece, Portugal, Japan, China, Hong Kong, and Turkey; telephone systems now account for 10 percent of all new orders. In this market, Nixdorf also offers particular vertical applications for hospitals (patient status) and hotels (automatic wake-up calls). Just recently, Nixdorf supplied the renovated Queen Elizabeth II with 1500 digital telephones, to be followed shortly by cash registers connected to the hotel computer 8862 Rio and the 8818 PBX. Again, Nixdorf competed successfully because of its vertical hotel application.

Mr. Luft expects revenue to reach DM 9 billion in five years. As long as Nixdorf retains its market-driven focus (expressed in vertical applications for specific market niches and excellent customer care) Dataquest believes that the company will continue to perform as one of the consistently successful computer companies in Europe and to gain market share in the United States.

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CONVERGENCE AND CONNECTIVITY IN EUROPE: THE RACE HEATS UP

Now that many desktop computing devices in Europe have achieved significant market penetration, the focus is changing to making these devices communicate. It is widely accepted that desktop devices are more useful when connected than when used as standalone units.

Dataquest has combined the resources of several of its European industry programs to focus on the issues of work group computing. This research provides our clients with a context in which to consider how all these pieces of the information processing puzzle interrelate. (Appendices A and B define the terminal types and connection technologies referred to in this analysis.)

Tables 1 through 6 show the estimated installed base of terminals in Europe for 1986, 1987, and 1991, and their connection methods. Tables 1 through 3 show the actual numbers for each connection method, and Tables 4 through 6 show the percentage of use of each connection method.

This newsletter has the following objectives:

- To define the installed base of desktop terminals
- To identify the important connection technologies employed and analyze the trends in types of connection from 1986 to 1991
- To outline the implications for suppliers

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Table 1

Dataquest Connection Matrix—1986 Estimated Units
(Thousands of Units)

Type of Desktop Device	Installed Base at Year End	Units Connected Via: LAN	PBX	Data PBX	Hard-Wired	Remote	Not Connected	Total
Display Terminal	6,630.5	379.3	33.2	186.8	4,918.6	1,112.6	0.0	6,630.5
Word Processor	295.3	29.2	0.3	7.1	77.1	17.4	164.2	295.3
IVDT	15.7	0.0	11.8	0.0	0.0	3.9	0.0	15.7
Electronic Typewriter	140.1	0.0	0.0	0.0	0.7	2.1	137.3	140.1
Personal Computer	4,325.7	298.5	1.7	110.4	558.0	372.0	2,985.0	4,325.7
CAD/CAM	100.4	10.0	0.0	0.0	40.2	5.0	45.2	100.4
Telex	772.4	0.0	0.0	0.0	0.0	772.4	0.0	772.4
Teletex	41.8	0.0	0.0	0.0	0.0	41.8	0.0	41.8
Facsimile	344.1	0.0	0.0	0.0	0.0	344.1	0.0	344.1
Videotex	2,986.2	0.0	0.0	0.0	149.3	2,836.9	0.0	2,986.2
Total	15,652.2	717.0	47.0	304.3	5,743.9	5,508.3	3,331.8	15,652.2

Source: Dataquest
October 1987

Table 2

Dataquest Connection Matrix—1987 Estimated Units
(Thousands of Units)

Type of Desktop Device	Installed Base at Year End	Units Connected Via: LAN	PBX	Data PBX	Hard-Wired	Remote	Not Connected	Total
Display Terminal	7,268.6	567.0	94.5	225.3	4,753.7	1,628.1	0.0	7,268.6
Word Processor	306.8	36.8	2.8	8.0	83.1	18.1	157.9	306.8
IVDT	25.4	0.0	19.1	0.0	0.0	6.4	0.0	25.4
Electronic Typewriter	203.4	0.0	0.0	0.0	1.0	3.1	199.3	203.4
Personal Computer	6,000.2	534.0	36.0	155.5	978.0	606.0	3,690.6	6,000.2
CAD/CAM	179.8	18.0	0.0	0.0	71.9	9.0	80.9	179.8
Telex	811.1	0.0	0.0	0.0	0.0	811.1	0.0	811.1
Teletex	73.9	0.0	0.0	0.0	0.0	73.9	0.0	73.9
Facsimile	658.4	0.0	0.0	0.0	0.0	658.4	0.0	658.4
Videotex	4,571.1	0.0	0.0	0.0	228.6	4,342.5	0.0	4,571.1
Total	20,098.7	1,155.8	152.3	388.8	6,116.4	8,156.6	4,128.9	20,098.7

Source: Dataquest
October 1987

Table 3

Dataquest Connection Matrix—1991 Estimated Units

Type of Desktop Device	Installed Base at Year End	Units Connected Via:						
		LAN	PBX	Data PBX	Hard-Wired	Remote	Not Connected	Total
Display Terminal	9,667.9	2,030.3	290.0	290.0	5,259.4	1,798.2	0.0	9,667.9
Word Processor	251.7	42.7	3.8	6.2	167.9	20.7	10.4	251.7
IVDT	107.6	0.0	80.7	0.0	0.0	26.9	0.0	107.6
Electronic Typewriter	655.1	0.0	0.0	0.0	3.3	9.8	642.0	655.1
Personal Computer	12,814.6	1,922.2	76.9	291.8	2,703.9	1,671.0	6,148.8	12,814.6
CAD/CAM	776.1	77.6	0.0	0.0	310.4	38.8	349.2	776.1
Telex	946.8	0.0	0.0	0.0	0.0	946.8	0.0	946.8
Teletex	376.2	0.0	0.0	0.0	0.0	376.2	0.0	376.2
Facsimile	3,073.5	0.0	0.0	0.0	0.0	3,073.5	0.0	3,073.5
Videotex	10,752.5	0.0	0.0	0.0	537.6	10,214.9	0.0	10,752.5
Total	39,422.0	4,062.8	451.4	588.0	8,885.3	18,284.0	7,150.5	39,422.0

Source: Dataquest
October 1987

Table 4

Dataquest Connection Matrix—1986 Estimated Percentages

Type of Desktop Device	Installed Base at Year End	Percentage Connected Via						
		LAN	PBX	Data PBX	Hard-Wired	Remote	Not Connected	Total
Display Terminal	6,630.5	5.7%	0.5%	2.8%	74.2%	16.8%	0.0%	100.0%
Word Processor	295.3	9.9%	0.1%	2.4%	26.1%	5.9%	55.6%	100.0%
IVDT	15.7	0.0%	75.0%	0.0%	0.0%	25.0%	0.0%	100.0%
Electronic Typewriter	140.1	0.0%	0.0%	0.0%	0.5%	1.5%	98.0%	100.0%
Personal Computer	4,325.7	6.9%	0.0%	2.6%	12.9%	8.6%	69.0%	100.0%
CAD/CAM	100.4	10.0%	0.0%	0.0%	40.0%	5.0%	45.0%	100.0%
Telex	772.4	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
Teletex	41.8	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
Facsimile	344.1	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
Videotex	2,986.2	0.0%	0.0%	0.0%	5.0%	95.0%	0.0%	100.0%
Total	15,652.2	4.6%	0.3%	1.9%	36.7%	35.2%	21.3%	100.0%

Source: Dataquest
October 1987

Table 5

Dataquest Connection Matrix—1987 Estimated Percentages

Type of Desktop Device	Installed Base at Year End	Percentage Connected Via						
		LAN	PBX	Data PBX	Hard-Wired	Remote	Not Connected	Total
Display Terminal	7,268.7	7.8%	1.3%	3.1%	65.4%	22.4%	0.0%	100.0%
Word Processor	306.8	12.0%	0.9%	2.6%	27.1%	5.9%	51.5%	100.0%
IVDT	25.4	0.0%	75.0%	0.0%	0.0%	25.0%	0.0%	100.0%
Electronic Typewriter	203.4	0.0%	0.0%	0.0%	0.5%	1.5%	98.0%	100.0%
Personal Computer	6,000.2	8.9%	0.6%	2.6%	16.3%	10.1%	61.5%	100.0%
CAD/CAM	179.8	10.0%	0.0%	0.0%	40.0%	5.0%	45.0%	100.0%
Telex	811.1	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
Teletex	73.9	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
Facsimile	658.4	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
Videotex	4,571.1	0.0%	0.0%	0.0%	5.0%	95.0%	0.0%	100.0%
Total	20,098.8	5.8%	0.8%	1.9%	30.4%	40.6%	20.5%	100.0%

Source: Dataquest
October 1987

Table 6

Dataquest Connection Matrix—1991 Estimated Percentages

Type of Desktop Device	Installed Base at Year End	Percentage Connected Via						
		LAN	PBX	Data PBX	Hard-Wired	Remote	Not Connected	Total
Display Terminal	9,668.0	21.0%	3.0%	3.0%	54.4%	18.6%	0.0%	100.0%
Word Processor	251.7	17.0%	1.5%	2.5%	66.7%	8.2%	4.1%	100.0%
IVDT	107.6	0.0%	75.0%	0.0%	0.0%	25.0%	0.0%	100.0%
Electronic Typewriter	655.1	0.0%	0.0%	0.0%	0.5%	1.5%	98.0%	100.0%
Personal Computer	12,814.6	15.0%	0.6%	2.3%	21.1%	13.0%	48.0%	100.0%
CAD/CAM	776.1	10.0%	0.0%	0.0%	40.0%	5.0%	45.0%	100.0%
Telex	946.8	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
Teletex	376.2	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
Facsimile	3,073.5	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
Videotex	10,752.5	0.0%	0.0%	0.0%	5.0%	95.0%	0.0%	100.0%
Total	39,422.1	10.3%	1.1%	1.5%	22.5%	46.4%	18.1%	100.0%

Source: Dataquest
October 1987

INSTALLED BASE OF DESKTOP TERMINALS

Figures 1 and 2 show the estimated installed base of terminals for 1986 and 1991 in Europe. The trends are reviewed below:

- While the number of terminals is growing at a 26.1 percent compound annual growth rate (CAGR), the number of potential desks is estimated to grow at only a 3 percent CAGR. Suppliers will have to fight hard for greater penetration into the existing installed base of desktops.
- The replacement market is expected to be low because many users do not discard desktop devices. They simply pass them on to someone else.
- Many suppliers are expected to move toward offering desktop systems (for example, 3Com, which offers LAN connections as well as terminals). Digital Equipment and IBM have been doing this for some years already.

Personal Computers and Display Terminals

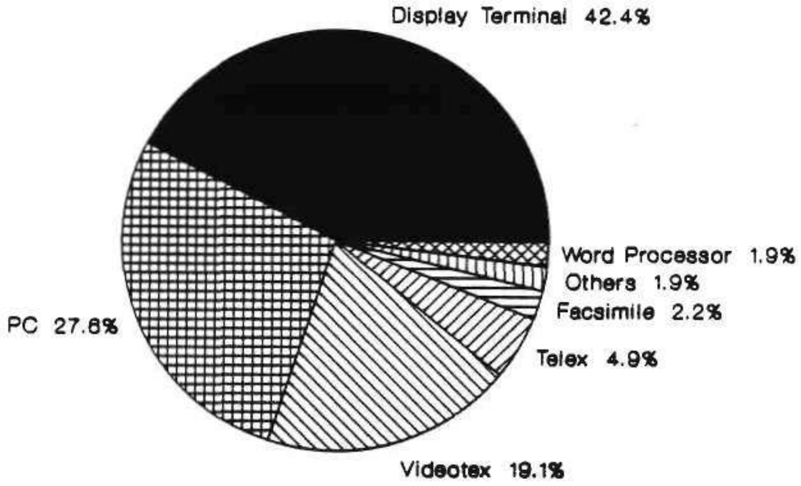
- The wide availability of personal computers (PCs) at prices similar to display terminals will obviously have an impact on the sale of display terminals. The installed base of PCs will have overtaken that of display terminals by the end of 1988.
- The launch of IBM's PS/2 range of PCs will lead to a further decline in the price of PCs. Also, the differences between applications supported by PCs and display terminals is fast eroding. The success of PC plug-in terminal emulation boards such as the IRMA board from DCA is leading this trend.

Integrated Voice/Data Terminals

- Dataquest expects the integrated voice/data terminal (IVDT) to have a limited penetration in the European market. These products are often not standards sold as compatible and sold as part of PBX. The Siemens Hicom PBX with its proprietary IVDT is a typical example.
- IVDTs are generally relatively expensive and, being proprietary, are a less flexible solution. Since IVDTs are rarely compatible with PCs, they consequently are limited in the number of application programs they can run.

Figure 1

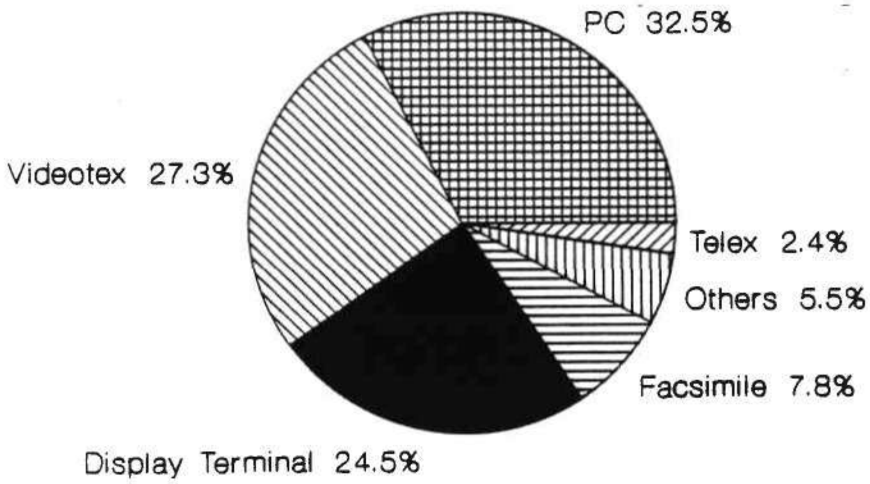
European Desktop Terminal Population—1986 Estimate



Source: Dataquest
October 1987

Figure 2

European Desktop Terminal Population—1991 Estimate



Source: Dataquest
October 1987

Word Processors

Shipments of standalone word processors will quickly decline. Dedicated minicomputer-based word processor systems are experiencing little growth. Dataquest expects these products to be overtaken by "office systems" that, in addition to text processing, will encompass various levels of voice, data, and graphics integration.

The differences between applications supported by PCs and traditional word processors, like those between word processors and display terminals, are also eroding.

CONNECTION TECHNOLOGIES

This section describes how the installed base of terminals connects. Figure 3 shows the spread of connection technologies for all terminals. The trend is clearly toward greater connectivity, using more than one of the connection methods in Table 1.

A standalone PC today may be connected to a local area network (LAN) soon, which will extend to a remote gateway (e.g., a modem) through a wide area network, an international link, and then to another LAN across the world. In consequence, the percentage of standalone terminals will drop to 18.1 percent of terminals in use by 1991. The main beneficiaries will be LANs and remote connection technologies. Data PBX, voice/data PBX, and hard-wired connections will not make significant gains. Figures 4, 5, and 6 show the spread of connection technologies for PCs, dumb terminals, and word processors in 1986, 1987, and 1991.

LAN

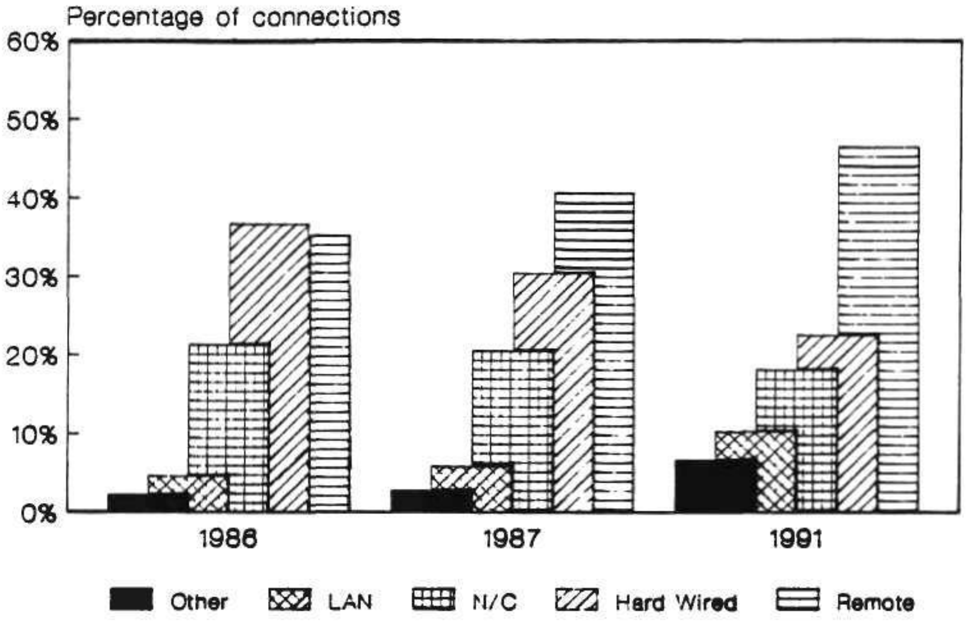
We believe that connections via LANs will show a tremendous growth rate, from 4.6 percent of all connections in 1986 to 10.3 percent by 1991.

Apart from the resource sharing offered by LANs (e.g., storage or printer sharing), one of their key benefits to large organizations is that they provide a flexible cabling solution. When users move around on a LAN, it is simple to unplug a terminal from the network and insert it elsewhere. With a hard-wired connection, such moves require recabling, which is both disruptive and expensive.

LAN connections to PCs and dumb terminals are expected to show significant growth. This will limit the growth of hard-wired and data PBX connections.

Figure 3

European Terminal Connection Trends
(All Terminals)

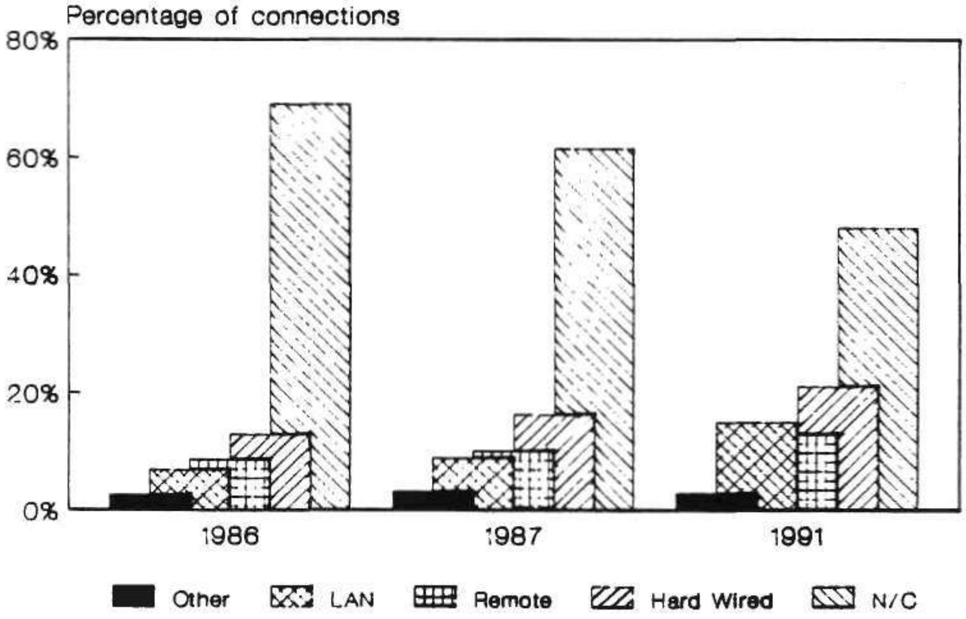


N/C not connected

Source: Dataquest
October 1987

Figure 4

Euroepan Terminal Connection Trends
(Personal Computers)

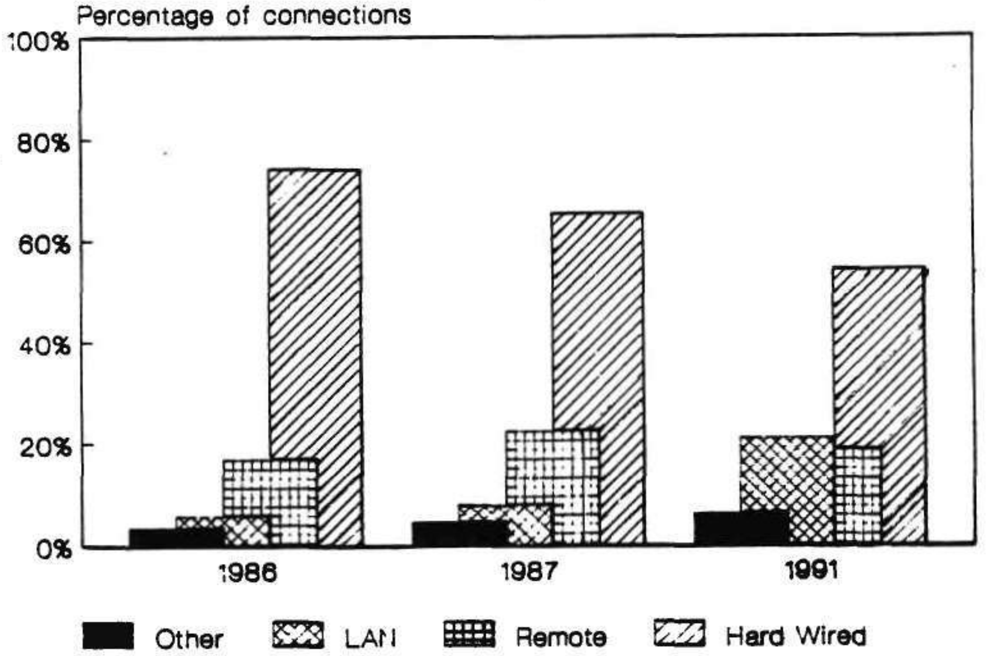


N/C = not connected

Source: Dataquest
October 1987

Figure 5

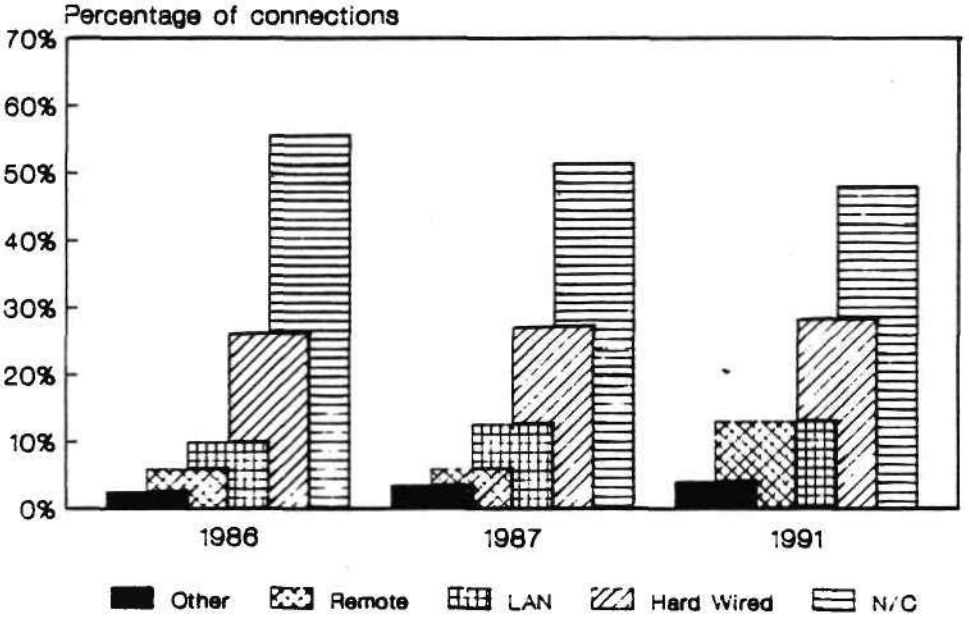
European Terminal Connection Trends
(Display Terminals)



Source: Dataquest
October 1987

Figure 6

European Terminal Connection Trends
(Word Processors)



N/C = not connected

Source: Dataquest
October 1987

PBX

PBXs will continue to be the main connection means for FAX, teletex, and videotex in 1991. Dataquest expects, though, that PBX or voice/data PBX solutions in Europe will show limited growth in data connections for the following reasons:

- The relatively high cost of connecting a terminal to a digital PBX compared to a data PBX
- The low data throughput (up to 64 Kbits per second for local connections on current products) compared to 1 Mbit per second for even a low-speed LAN
- Their low functionality (file handling and printer sharing facilities like PC LANs) for resource sharing compared to that of LANs
- The slow acceptance by data processing managers of traditional communications solutions to data communications connectivity

However, wide area gateways from LANs through a PBX represents a potential growth area.

Data PBX

Data PBX connections are expected to decline in importance for the following reasons:

- Users are migrating to LANs to achieve higher throughput speeds.
- The size and cost of low-end data PBXs precludes their use in new small networks, where LANs provide a cheap entry solution for as few as three users. These systems then grow into large LAN-based networks.
- Although data PBXs are very economic solutions for asynchronous connections when compared to LANs, users are more inclined toward LANs, which are seen to be the vogue in networking. (A typical cost per connection for a data PBX is $185, as opposed to $640 for a LAN.)
- The data PBX market has never gained any large momentum in Europe.

Hard-Wired

The hard-wired connections segment represents direct connections from data terminal equipment to multiuser minicomputers or mainframes. The high cost of reconfiguring a hard-wired network is leading customers to opt for more flexible solutions such as LANs, especially in new installations. The need to switch between resources (mainframes, etc.) in the hard-wired environment requires costly equipment compared to LANs.

Dataquest expects that by 1991, the large installed base of hard-wired connections will decline overall, from 36.7 percent to 22.5 percent of connections. The percentage of PC hard-wired connections will grow, however, from 12.9 percent to 21.1 percent. This represents the rapid growth of PC-to-mainframe connectivity by users who are not ready to use LANs.

Remote

A key growth trend will be in PC remote links; the PC is quickly becoming the focus for office systems technology. A significant growth area in remote lines will be X.25, while X.21 and modem links will also increase in percentage terms. The penetration of the X.400 standard for electronic mail will add to the growth in remote connections over the next three to five years.

ISDN

The connection technologies discussed so far raise important issues about the role of ISDN in local communications. The IEEE 802.9 standard for LANs could provide for 2-Mbit per second connections to the desktop on unshielded, twisted-pair cables. This could support voice/text and image on a distributed system. If IEEE 802.9 becomes a significant standard, the relative merits of ISDN connectivity will be reduced. While the merits of ISDN are being debated, LAN technology is making significant advances.

IMPLICATIONS FOR SUPPLIERS

Dataquest expects to see the following trends in supplier strategies:

- A conscious effort to understand previously unfamiliar markets, for example, communications suppliers moving into the computing area and vice versa. Digital Equipment in the United States recently made public its plans for wide area networking. This surprising move foreshadows the rapid changes to come in the connectivity race.
- An increase in joint ventures, mergers, and takeovers. Suppliers are finding this to be an attractive way of entering new markets and catching up with technology.
- More suppliers offering integrated communications hardware and office applications software as systems solutions. Although this is currently achieved by dealers, we expect to see suppliers use it as a product differentiation strategy.
- A prominence of vertical market offerings. More and more suppliers are beginning to identify specific segments like retailing rather than simply selling into general markets.

- Higher functionality and new features being offered on existing products in an effort to achieve product differentiation. What was once a plain old telephone can now be bought with IVDT functions (the Qwerty phone from British Telecom is an example).

- A plethora of new products, especially in the PC plug-in board market, like plug-in fax, telex, or voice store-and-forward cards. The recent launch of the Orator (voice/data card) from Lion Systems in the United Kingdom is an example of this rapid evolution.

- A significant price erosion across markets. Suppliers will fight to penetrate an installed base of desktops that is showing little growth.

DATAQUEST CONCLUSIONS

Dataquest expects the trends described in this newsletter to result in suppliers fighting for market share in Europe, not only with their traditional competitors, but also with organizations from previously separate areas. Hence computer, telecom, data communications, and LAN suppliers will be in competition with each other for the same business. The market will be characterized by numerous offerings from suppliers of incompatible desktop solutions. In these conditions, suppliers with standards-compatible, user-friendly, systems-based products will have an advantage.

Rapid changes in technology and sharp price competition will mean that market share will be more expensive to achieve and brand loyalty will be difficult to maintain. Dataquest believes that, despite the steady growth in the European data communications market, many suppliers will find themselves working very hard to maintain profitability in an increasingly fierce environment.

This newsletter shows that, after many years of talk about the convergence of computing and communications, and the integration of voice and data, these areas are finally beginning to merge, albeit at the transmission level at the moment. Integrated voice/data products or applications on the desktop have yet to succeed.

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Jennifer Berg
Michael D'Souza

Appendix A

DEFINITIONS OF KEYBOARD INFORMATION DEVICES

Display terminals are desktop electronic devices that are dependent upon a data communications link to a computer system. They have the following characteristics:

- They provide an interface between a human operator and a computer system or a communications network.
- They deliver a visual presentation of incoming data to the operator.
- They allow the operator to enter or modify information in the computer system via a keyboard, media reader, or other local device.

Personal computers (PCs) are computer systems that have the following characteristics:

- They are human-orientated, meaning they are intended to meet individual business, professional, educational, and personal data processing needs, and they do not generally act as instrument controllers or automation devices.
- They are single-user-orientated, meaning that, although communications may be involved, the systems are intended for the data processing needs of individuals and involve only one interactive device. PCs can generally be purchased, operated, and used by an individual rather than by an organization.
- They have full alphanumeric keyboards, which distinguishes them from programmable calculators, video games, and dedicated special-function computers.
- They have local programming capabilities using high-level programming languages, with most personal computers supporting BASIC, or a derivative of it. Other languages such as Pascal, FORTAN, and COBOL are also available on personal computers.
- They have a resident operating system in ROM or magnetic media. This distinguishes PCs from terminals.
- They are able to run general-purpose applications. This distinguishes PCs from systems that are dedicated through permanent hardware or firmware adaptation to functions such as word processing and financial analysis.
- For this study, PCs used in hobby or educational environments are not included. PCs that have integrated voice capability are also not included.

Integrated voice/data workstation (IVDT) products are desktop or board-level devices that integrate the functionality of a telephone and a terminal. This integrated functionality includes, at a minimum, simultaneous voice and data transmission. These devices are not double-counted in the display terminal or personal computer categories.

Word processors are workstations that are designed for entering, manipulation, filing, and printing text documents only. Workstations are defined as computer-based products that perform specifically defined functions as an aid to a user in completing a specifically defined task or series of tasks.

Full-size electronic typewriters are letter-quality printing devices that can be activated by depressing the keys of an electronically driven keyboard (flat or movable keys). This action causes type characters to be selected for printing by solid-state electronic logic and circuitry. These are desktop devices; this definition does not include portable or compact electronic typewriters. Nor does it include half-screen electronic typewriters.

Appendix B

CONNECTION TECHNOLOGIES

Generally speaking, a connection is defined as what the device is directly connected to, not what the device ultimately communicates with. Therefore, any device that has both a remote connection and another type of connection is counted under the other type of connection. Further, if a device has two types of connections, neither of which is remote, the most heavily used type is counted.

Private branch exchanges (PBXs) are customer premises telephone–switching systems that, by the dialing of an access code, permit telephones to interface to the public telephone central exchange of office. A PBX includes desktop end–user terminals, attendant consoles, switching cabinets, and interconnections between switching cabinets. An integrated voice/data PBX can switch both voice and data through the same equipment.

Local area network (LAN) Connections are combinations of hardware and software that enable connection of a device to a cable–based network system that serves a building or campus environment. Excluded are connections that are point–to–point, through PBXs or through data PBXs or data–over–voice products.

Data PBXs are digital electronic switches that allow terminals to switch and contend for computer ports by providing RS–232–C connections. Data PBXs do not provide for voice switching as a PBX or voice/data PBX would.

Hard–wired connection is a point–to–point connection from a device to a CPU, either directly or via a direct or nonintelligient intermediate communication controller or a multiplexer.

Remote connection is a connection to a modem, packet assembler/disassembler (PAD), wide area network or other device for transmitting data over remote–communication lines.

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EUROPEAN PC PRODUCTION CAPABILITY SHOWS EMERGING STRENGTH

INTRODUCTION

Dataquest estimates that PC production in Europe grew, in unit terms, 12 percent in 1987, reaching an estimated 2 million units. More than 75 percent of all PCs sold in Europe are manufactured locally; approximately 275,000 units produced in Europe will be exported outside the Continent.

Dataquest's wholly owned subsidiary, Intelligent Electronics Europe, shares its perspective of this strengthening commitment by PC manufacturers to produce in Europe.

PC MANUFACTURERS

Two broad categories of PC makers have a presence in Europe: the non-European multinational PC vendors that operate in Europe and the European companies. Currently, of the main PC manufacturers in Europe, 11 are non-European; of these, the only non-American vendor is the Japanese company Fujitsu, which manages a microcomputer plant in Malaga, Spain. Fujitsu Spain operates through a joint venture, Fesa, with a government-controlled agency. This is fairly typical of the Spanish computer industry, whereby the company can be considered a local company—and all the more valuable—since its microcomputer production is targeted essentially at the Spanish market.

Table 1 shows the main PC manufacturers in Europe, the location of their production facilities, and their product ranges.

Many U.S. multinational computer companies with ambitions to have significant presence throughout the world have established wholly owned PC-manufacturing plants in Europe. Companies such as Apple, Commodore, Hewlett-Packard, IBM, NCR, NorthStar, Unisys, Wang, and Zenith have all expressed their dedication to the European countries through their direct investments. Compaq is the latest to follow suit, and its plant located in Scotland will be operational this month. This European production facility should give the company a more committed image in the minds of the European end users.

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Table 1

European PC Manufacturers

Manufacturer	Country of Origin	Plant Location	Product Range
APD	Spain	Madrid, Spain	Europa, APD Uno 32/4, 32XX, 32/40
Apple	United States	Cork, Ireland	Apple II, Macintosh
Apricot	United Kingdom	Glenrothes, Scotland	Apricot Xen
Bull	France	Villeneuve, France	PC range, terminals
Bull	France	D'Ascq, France	PC range, terminals
Bull	France	Barcelona, Spain	Micral
Commodore	United States	Braunschweig, West Germany	PCs, home computers, Amiga
Compaq	United States	Erskine,	PCs
Dava	Finland	Helsinki, Finland	PCs 286 & 386
Ericsson	Sweden	Sweden	Ericsson PCs
Ferranti	United Kingdom	Withershaw, United Kingdom	PC AT, PCs 1860 & 2860
Fesa	Spain/Japan	Malaga, Spain	Secorusa 20, Senda
Forum	France	Longwy, France	Multiuser systems
HP	United States	Grenoble, France	Vectra 150, PCs
IBM	United States	Greenock, Scotland	PCs, ATs, PS/2
ICL	United Kingdom	United Kingdom	Multiuser system
ICL	United Kingdom	United Kingdom	Series 25, 39
Leanord	France	Aubourdin, France	System 2966
NCR	United States	Augsburg, West Germany	Silz Elan, PCs
Nixdorf	West Germany	Padenborn, West Germany	PCs 710/810/916, NCR 3390, 3392
Nokia Luxor	Finland	Espoo, Finland	Nokia PC, ABC
Nokia Luxor	Finland	Rodja, Finland	Terminals, Nokia PC
Normerel	France	Granville, France	Vectra 150, PCs
NorthStar	United States	Cork, Ireland	Multiuser system
Olivetti	Italy	Italy	PC series
Olivetti	Italy	Spain	PC series
Philips	The Netherlands	Vienna, Austria	PCs
Regencentralen	Denmark	Presto, Denmark	Piccoline-Partner
Siemens	West Germany	Augsburg, West Germany	PCD, PCX, PCM
Siemens	West Germany	Karlsruhe, West Germany	PC 16
SMT Goupil	France	Montpelier, France	G40, G65
SMT Goupil	France	Redon, France	G4, G40, G5
SMT Goupil	France	Granville, France	G5
SMT Goupil	France	Soisson, France	G4 Club
Telenova	Sweden	Nynashamm, Sweden	Scandis/Compis
Tikidata	Norway	Nuremberg, West Germany	PC Tiki
Triumph Adler	West Germany	Nuremberg, West Germany	Alphatronics PCs
Tulip	The Netherlands	Den Bosch, The Netherlands	PC, Compact, 8386
Unisys	United States	Villers Ecale, France	B20, B25
Wang	United States	Stirling, Scotland	Wang PC
Zenith	United States	Kells, Ireland	Desktop PCs

Source: Intelligent Electronics Europe
Dataquest
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The U.S. multinational companies have integrated worldwide corporate production strategies, with the assignment of each of their plants to specific regions. Production facilities in Europe usually serve the European markets. Often, they also serve the Middle East and Africa, or, like the Wang factory in Scotland, the non-European Commonwealth countries such as New Zealand and Australia.

More rarely, as with both NorthStar and NCR, the European manufacturing bases of the U.S. corporations cater to worldwide markets. Since the NorthStar operation in Ireland now houses the company's only manufacturing facility, it supplies the whole world. The NCR plant, located in the southern German town of Augsburg, ships nearly half of its PCs outside Europe. The German NCR company is also responsible for most of the R&D activities in the PC area. Together with the European manufacturers Olivetti and Ericsson, NCR is the only Europe-based PC manufacturer to have produced significant volumes for the OEM markets. Through OEM contracts with the German companies Nixdorf, Olympia, and Siemens, and with HISI, now Honeywell Bull, from Italy, the firm has realized a large share of its sales through the OEM business.

A major effect of this large investment in Europe-based PC plants by foreign firms has been the relative absence of protectionism in the field of PCs by either the national and local governments or from the EEC. France is possibly the main exception, in that, until recently, the French national manufacturers have enjoyed almost a monopolistic position within the French government-controlled markets. In spite of this, there have been no protectionist moves to halt imports of PCs. In addition, as Europe has a positive trade balance as far as PCs are concerned, no real efforts have been made to institute any protectionist measures like those undertaken in the fields of typewriters, photocopiers, and, more recently, printers.

Olivetti is still the leading European PC manufacturer. After recently having stopped the production of PCs at its French Logabax factory in Meaux, the Italian company now has only two PC plants: one in Scarmagno, Italy, and one in Barcelona, Spain. In addition, Olivetti now uses some of its existing production capacity near Naples to manufacture its new home computer model, the PC1.

SEMICONDUCTOR ANALYSIS

Dataquest estimates that personal computers will consume approximately 7 percent of the $6,780 million semiconductor market in Europe. Table 2 shows a comparison of the integrated circuit content of an IBM PC AT, a Compaq 386, and the IBM PS/2 Model 50.

Overall, the growth of semiconductor revenue for the computer marketplace looks healthy. The ratio of semiconductor revenue to computer revenue is expected to remain relatively constant from 1988 through 1990, at about 5 percent for the market as a whole and at about 6 percent for just PCs. Dataquest believes that the greatest opportunities for IC manufacturers serving the PC market lie in separate areas. The first is a continued growth in application-specific ICs. As PC manufacturers attempt to introduce smaller, faster, and less expensive machines, the demand for highly integrated chips is inevitable. Those ASICs directed at integrating traditional motherboard logic and also at maximizing peripheral controller functions and high-resolution graphics capabilities hold great promise. Second, along with the growth of application-specific logic chips, there are opportunities for dedicated processors and microcontrollers, particularly in the areas of computer graphics and storage subsystems. Additionally, as notorious "memory munchers," these 32-bit machines will require ICs that are faster and have denser memories than their predecessors. Static RAMs and static column RAMs, as well as traditional DRAMs with densities of 1 megabit and above, will be consumed in ever-greater ratios within the PC market.

Table 2

The Integrated Circuit Content of PCs
Number of Integrated Circuits

Description	IBM PC AT	Compaq 386	IBM PS/2 Model 50
Standard Logic	128	115	82
Memory			
RAM	41	36	21
EPROM	N/A	2	5
Microdevices	9	14	4
Microprocessor	80286 (6 MHz)	80386	80286 (10 MHz)
Interrupt Control	x	x	x
DMA Control	x	x	
Counter/Timer	x	x	
I/O Port	x		
CRT Control	x		
Floppy Disk Control	x		x
Asyncronous Communications Control	x		
RTC plus RAM Upgrade		x	
RAM Control		x	
Peripheral Control		x	
ASICs	4	10	6

Note: x means that the chip is included in that model.
N/A = Not Available

Source: Dataquest
December 1987

DATAQUEST CONCLUSIONS

Although several of the European PC manufacturers already have built up markets outside their own countries, or even outside Europe, more European companies are now strengthening their activities in order to boost their export performances. In some cases, European companies have started to become significant worldwide players. A major reason for this change in marketing strategy is directly associated with production issues. Considering the high fixed costs of a manufacturing facility, it has become necessary, in order to remain competitive, to realize high sales volumes, which in turn require a deeper penetration of the home market and/or an increased marketing and sales effort aimed toward export markets. Companies such as APD, Bull, Ericsson, Goupil, Nixdorf, Nokia, Siemens, and Tulip are all increasing their marketing investments outside their home countries or traditional regional bases.

Jennifer Berg