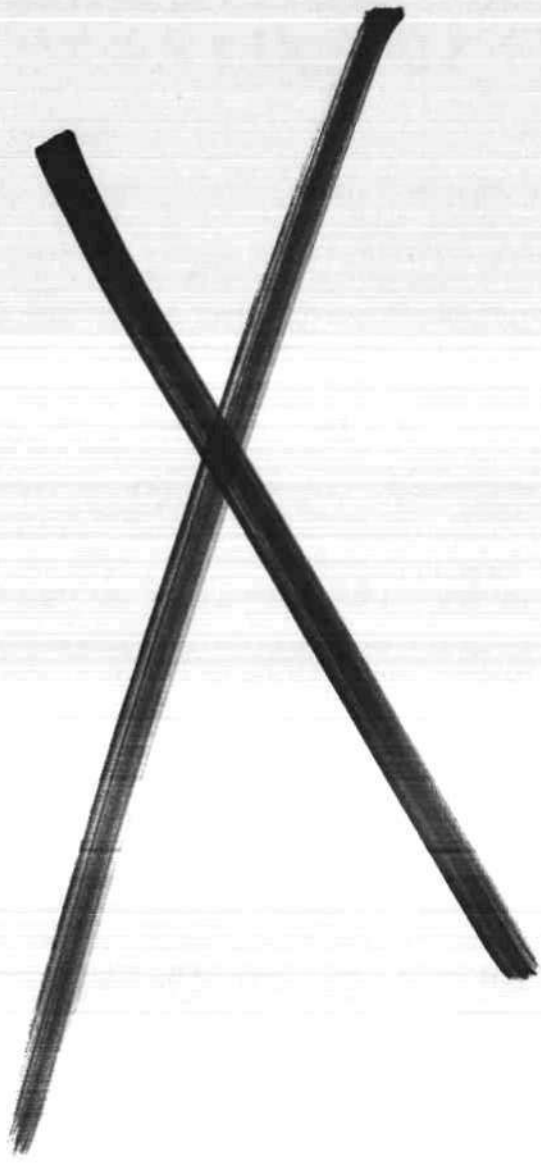


Dataquest

Dataquest Perspective

Software

CAD/CAM/CAE/GIS Worldwide

In This Issue

CAD/CAM/CAE/GIS Forecast: 8.9 Percent Software Market Growth Expected in 1994, Revised Up from 8.2 Percent

This forecast update uses the market share update as the basis of a new forecast, incorporating any new information available since April, including currency changes and GDP growth rates. The market share update reduced the growth in software revenue from 1992 to 1993 from 7.3 percent to 6.5 percent. This forecast update increases the expected growth in software revenue from 1993 to 1994 from 8.2 percent to 8.9 percent. Table 1 outlines the 1994 CAD/CAM/CAE/GIS forecast summary.

Figure 1 provides a comparison of our preliminary forecast to this updated forecast, by application, region, and platform. Table 2 provides the corresponding revenue figures and growth rates. This additional growth resides primarily in Asia, in the technical workstation platform, divided among all application segments except for Mechanical.

Dataquest

a company of The Dun & Bradstreet Corporation

Program: CAD/CAM/CAE/GIS Worldwide
Product Code: CCAM-WW-DP-9404
Publication Date: September 19, 1994

Table 1
CAD/CAM/CAE/GIS 1994 Forecast Summary

	Software Revenue 1993 ($M)	Software Revenue 1994 ($M)	Growth Rate (%)	Total Revenue 1993 ($M)	Total Revenue 1994 ($M)	Growth Rate (%)	Unit Shipments 1993	Unit Shipments 1994	Growth Rate (%)
Application									
Mechanical	2,294.6	2,450.2	6.8	7,861.6	8,170.3	3.9	304,002	321,306	5.7
AEC	794.1	867.2	9.2	2,439.8	2,578.9	5.7	198,169	225,395	13.7
GIS/Mapping	662.2	749.9	13.2	2,178.7	2,420.6	11.1	102,299	121,470	18.7
Electronic CAE	797.1	881.1	10.6	2,269.9	2,503.7	10.3	95,739	101,907	6.4
IC Layout	202.4	234.9	16.1	675.7	724.0	7.2	12,767	13,183	3.3
PCB/Hybrid/ MCM	271.2	285.9	5.4	900.0	875.1	-2.8	36,422	37,103	1.9
Total	5,021.5	5,469.2	8.9	16,325.7	17,272.5	5.8	749,398	820,365	9.5
Region									
North America	1,754.6	1,942.4	10.7	5,671.3	6,116.9	7.9	324,587	358,314	10.4
Europe	1,608.7	1,687.6	4.9	5,382.6	5,523.0	2.6	239,175	259,140	8.3
Asia	1,534.0	1,694.2	10.4	4,875.3	5,187.4	6.4	160,181	172,682	7.8
Rest of World	124.3	145.0	16.6	396.5	445.2	12.3	25,455	30,229	18.8
Total	5,021.5	5,469.2	8.9	16,325.7	17,272.5	5.8	749,398	820,365	9.5
In Local Currencies									
Europe (ECU)	1,378.0	1,444.7	4.8	4,610.8	4,728.3	2.5			
Asia (Yen)	170,038	174,639	2.7	540,427	534,719	-1.1			
Platform									
Technical Workstation	3,312.8	3,651.2	10.2	10,455.6	11,221.8	7.3	194,787	216,252	11.0
Host-Dependent	306.0	248.6	-18.8	1,754.1	1,448.4	-17.4	28,544	24,234	-15.1
Server	176.1	204.1	15.9	1,056.3	1,218.0	15.3	13,403	15,787	17.8
Personal Computer	1,226.7	1,365.3	11.3	3,059.8	3,384.3	10.6	512,663	564,092	10.0
Total	5,021.5	5,469.2	8.9	16,325.7	17,272.5	5.8	749,398	820,365	9.5

Note: Columns may not add to totals shown because of rounding.
Source: Dataquest (September 1994)

The U.S. Dollar Is Weak against Most Foreign Currencies

We do not forecast exchange rates, but we do use the best information available. We assume that the June 1994 exchange rate will continue into the future. The annual exchange rate is the arithmetic mean of the 12-month exchange rate, assuming the June rate for the remainder of the year. Since March, the U.S. dollar has weakened against most foreign currencies, so the same growth abroad in March translates into inflated growth in the U.S. dollar in June. Table 3 provides the currency exchange rates used for this forecast.

Table 2
Comparison of Software Revenue in Forecast versus Forecast Update

	Preliminary Forecast					Update Forecast				
	Software Revenue ($M)			1993-1994	1993-1998	Software Revenue ($M)			1993-1994	1993-1998
	1993	1994	1998	Growth (%)	CAGR (%)	1993	1994	1998	Growth (%)	CAGR (%)
North America	1,804.5	2,008.2	3,120.5	11.3	9.2	1,754.6	1,942.4	3,085.6	10.7	9.7
Europe	1,755.2	1,862.8	2,412.4	6.1	5.3	1,608.7	1,687.6	2,231.4	4.9	5.7
Asia	1,496.6	1,589.7	2,093.9	6.2	5.7	1,534.0	1,694.2	2,381.2	10.4	7.0
Rest of World	132.9	153.1	258.3	15.3	11.0	124.3	145.0	257.9	16.6	12.2
Technical Workstation	3,361.8	3,640.2	5,271.6	8.3	7.7	3,312.8	3,651.2	5,390.2	10.2	8.1
Host Systems	318.7	287.7	204.9	-9.7	-6.6	306.0	248.6	175.7	-18.8	-6.7
Servers	215.6	250.5	408.8	16.2	10.3	176.1	204.1	343.8	15.9	11.0
Personal Computer	1,293.1	1,435.5	1,999.8	11.0	6.9	1,226.7	1,365.3	2,046.4	11.3	8.4
Mechanical	2,391.1	2,567.9	3,234.1	7.4	4.7	2,294.6	2,450.2	3,124.5	6.8	5.0
AEC	830.1	899.2	1,234.8	8.3	6.5	794.1	867.2	1,260.0	9.2	7.8
GIS/Mapping	656.8	737.0	1,186.2	12.2	10.0	662.2	749.9	1,235.1	13.2	10.5
ECAE	786.9	857.2	1,330.5	8.9	9.2	797.1	881.1	1,519.7	10.6	11.5
IC Layout	233.9	263.4	567.0	12.6	16.6	202.4	234.9	456.7	16.1	14.2
PCB/MCM/ Hybrid	290.4	289.3	332.6	-0.4	2.8	271.2	285.9	360.0	5.4	4.7
Total Market	5,189.2	5,613.8	7,885.1	8.2	7.0	5,021.5	5,469.2	7,956.1	8.9	7.8

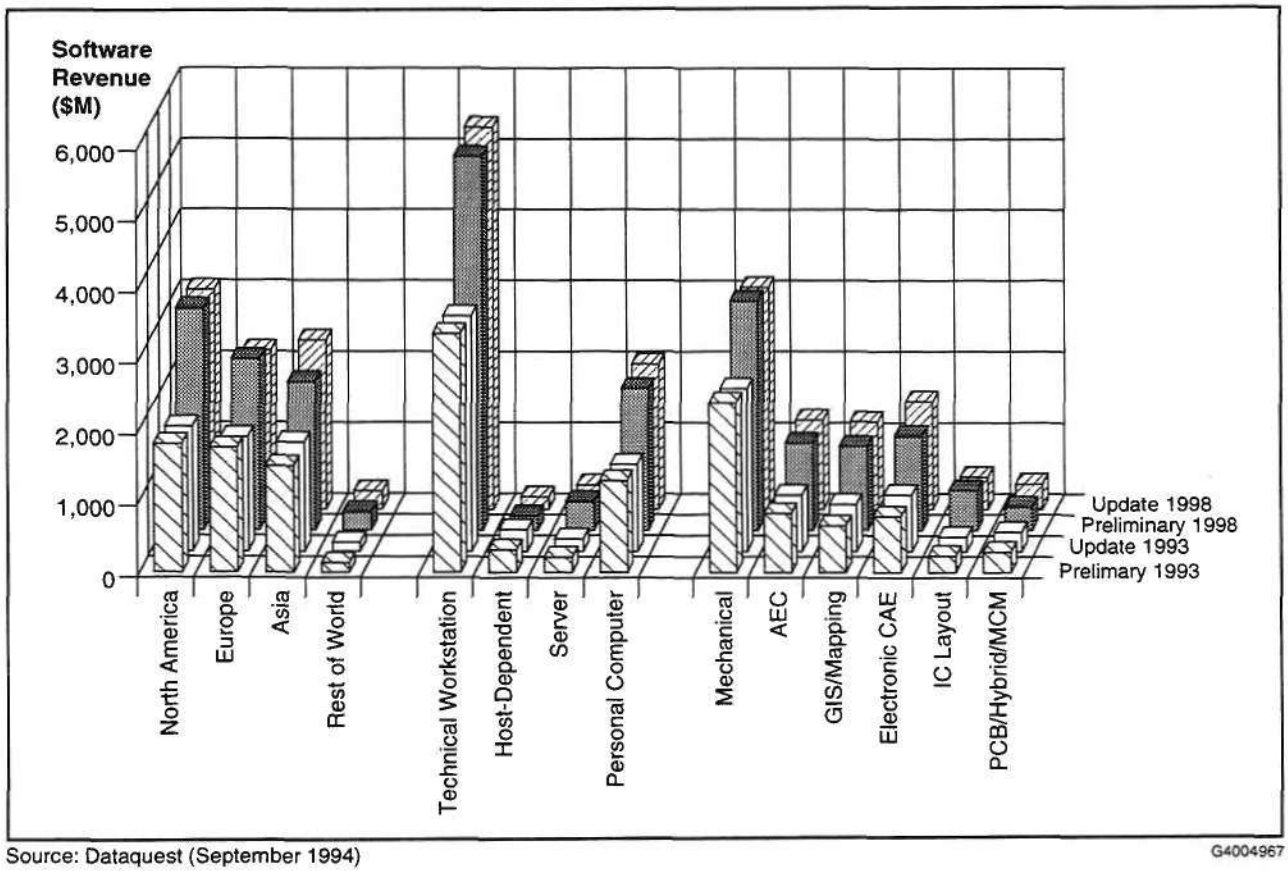
Note: Columns may not add to totals shown because of rounding.
Source: Dataquest (September 1994)

Table 3
Foreign Currency/U.S. Dollar

Country	Currency	Actual 1990	1991	1992	1993	Current 1994	Current 1995-1998	Year-to-Year Change (%) 1990-1991	1991-1992	1992-1993	1993-1994	1994-1995
European Community	ECU		0.8079	0.7686	0.8566	0.8561	0.8419		-5	11	0	-2
France	Franc	5.4277	5.6183	5.2571	5.6641	5.6343	5.5346	4	-6	8	-1	-2
Germany	Mark	1.6111	1.6523	1.5513	1.6543	1.6485	1.6163	3	-6	7	0	-2
Italy	Lira	1,195.03	1,235.03	1,220.85	1,575.05	1,610.71	1,584.79	3	-1	29	2	-2
Netherlands	Guilder	1.81	1.86	1.75	1.86	1.85	1.8126	3	-6	6	0	-2
Spain	Peseta	101.70	103.48	101.50	127.10	135.40	133.39	2	-2	25	7	-1
Sweden	Krona	5.9137	6.0314	5.7770	7.8003	7.7955	7.7340	2	-4	35	0	-1
UK	Pound	0.5599	0.5658	0.5652	0.6665	0.6604	0.6549	1	0	18	-1	-1
Japan	Yen	144.05	134.59	126.34	110.85	103.08	101.56	-7	-6	-12	-7	-1
Hong Kong	Dollar	7.7900	7.7712	7.7399	7.7351	7.7271	7.7280	0	0	0	0	0
Singapore	Dollar	1.8129	1.7277	1.6284	1.6155	1.5481	1.5300	-5	-6	-1	-4	-1
Taiwan	Dollar	26.64	26.49	24.93	26.15	26.77	26.98	-1	-6	5	2	1
Korea	Won	242.70	730.67	782.41	799.42	806.49	805.80	201	7	2	1	0
China	Renminbi	4.7912	5.3340	5.5076	5.7580	8.5534	8.6895	11	3	5	49	2

Source: Dataquest (September 1994)

Figure 1
Comparison of Preliminary and Updated Forecasts



Source: Dataquest (September 1994)

G4004967

An Aging Installed Base Is Generating a Massive Replacement Market

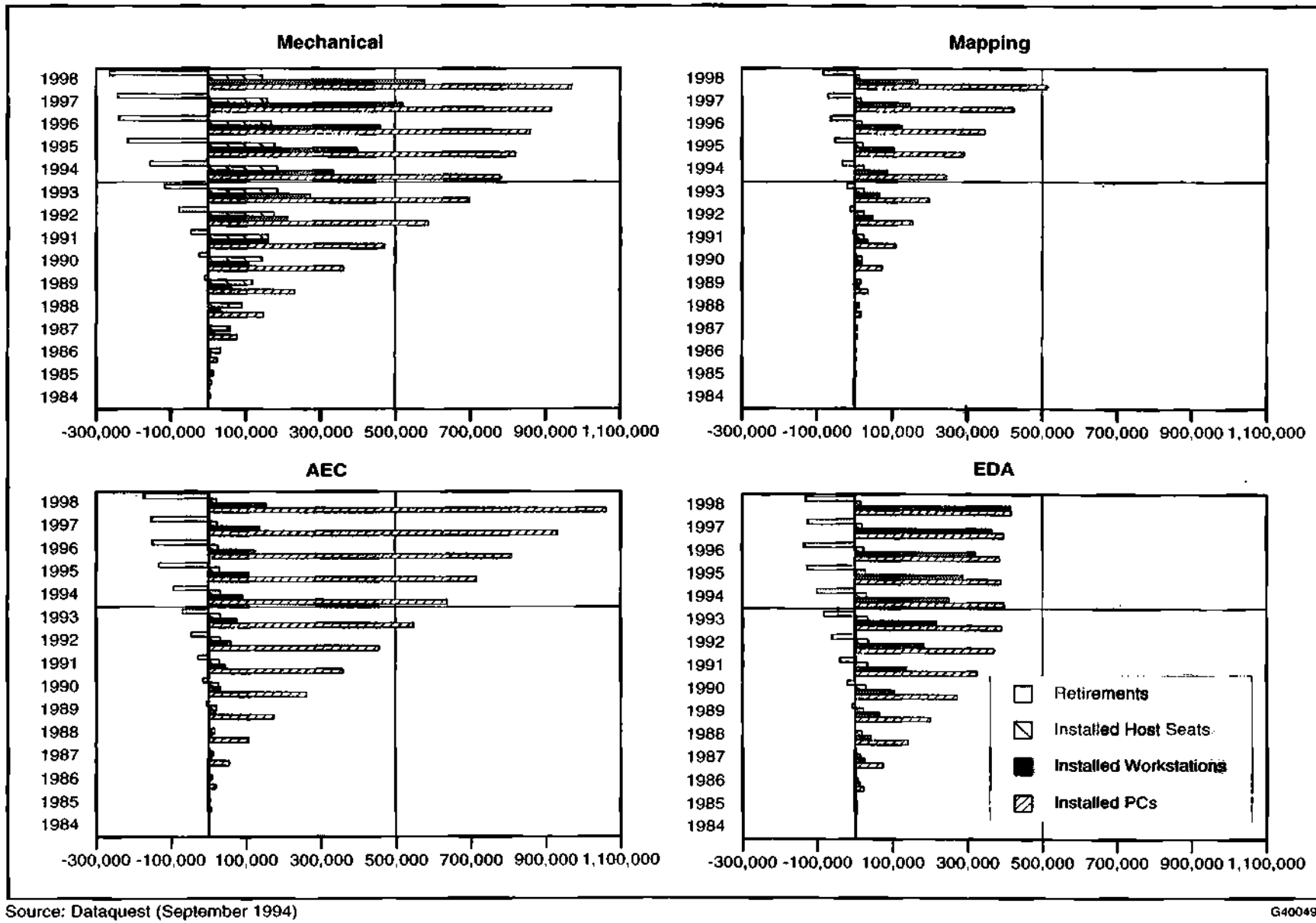
Replacements hit half of sales in 1993. Over the next five years, owing to the aging installed base of these technical markets, replacements will dominate sales at over 60 percent. Except for the GIS/mapping market, early adoptions are complete: sales are to the initiated.

Figure 2 provides a view of installed base and retirements by platform. These graphs reveal the dramatic differences in these four major application segments.

Mechanical

The age of the mechanical market gives rise to an enormous chunk of sales to the replacement market: 70 percent in 1994 growing to 80 percent in 1998. The migrating of host seats to workstations coupled with the huge block of PCs being retired gives rise to new adoptions evenly split between PCs and workstations. Workstations are maintaining a competitive edge in computing and graphics performance while also maintaining a low enough price point to remain indispensable for many high-end mechanical applications. Survey data has shown this trend with an annual retirement rate in the 6 to 9 percent range. Both software and hardware products are being retired.

Figure 2
Installed Base versus Retirements, by Application Segment



Source: Dataquest (September 1994)

G4004968

AEC

The AEC market is steadily maturing, with computer retirements expected to reach nearly 60 percent of shipments in 1994—up from 47 percent in 1993 and dramatically higher than the 20 percent in 1990. From 1994 on, a majority of buyers will come from the existing user base unless compelling new products appear that attract new types of users. On its current course, the future of the AEC market will be PC based, with over 90 percent of new adoptions on the PC platform.

GIS/Mapping

Despite slowing growth in the GIS market, workstation and server shipments are primarily sold to new users; only 19 percent of these systems were sold as replacements in 1993. At the low end, the commercialization of the GIS market is attracting a high volume of new users. As a result, only one-third of seats sold in 1993 were to replace existing systems, and we expect sales of new adoptions to exceed sales to existing users through 1998.

Electronic Design Automation

The growth in the EDA market stalled six years ago, leading to a growing percentage of retirements today. The demand for faster/bigger/smarter has outpaced the speed, size, and functionality of the PC platform in most medium and large electronics companies. While there is a "wait and see" attitude with the Pentium and other RISC PCs, the workstation software vendors are moving right along and creating what these sophisticated users demand. The installed base of workstation users in the EDA market is forecast to exceed that of the PC users by 1998. The Windows NT operating system is the wild card. The present release of Windows NT does not have the power to maintain the PC's market share. Until the Daytona release of Windows NT hits the market, we will be unable to predict its impact.

Regional Forces: An Amalgam of Economic Activity

Not only do the foreign currency exchange rates play havoc with markets, but the economies of many different countries also have an impact. Table 4 provides a GDP forecast for the regions and countries covered by our CAD/CAM/CAE/GIS service.

United States

The U.S. economy is expanding and unemployment is falling, with inflation the main threat to U.S. prosperity. The automobile industry is regaining market share from the Japanese, and the telecom industry is experiencing robust growth. Cost-cutting and productivity improvements continue to encourage capital expenditures, boding well for the computer industry. The emergence of European and Japanese markets from recession provides additional impetus to growth.

Europe

Europe is emerging slowly from its recession, led by the United Kingdom. Factories are underutilized, modest demand is projected, and investment

Table 4
GDP/GNP Growth Rate (Percentages)
(Constant Prices and Exchange Rates, Local Currencies)

		1993	1994	1995	1996	1997	1998
North America	Canada	2.4	3.4	3.6	3.3	3.0	2.8
	United States	3.0	3.6	3.2	3.3	3.0	2.8
Europe	France	-0.9	1.5	2.5	2.8	3.0	3.2
	Germany	-1.4	1.4	2.3	3.1	3.4	3.6
	Italy	-0.7	1.4	2.4	2.5	2.8	3.1
	Netherlands	0.2	1.0	2.1	2.5	2.8	2.8
	Spain	-1.0	1.0	2.2	2.6	3.7	4.0
	Sweden	-2.2	1.6	2.5	2.7	3.0	3.3
	UK	1.9	2.8	2.7	3.0	2.8	2.6
Asia	Japan	0.1	0.7	2.0	3.0	3.8	3.5
	China	13.1	11.5	11.0	10.0	9.0	8.0
	Hong Kong	5.4	5.0	5.5	6.0	6.0	6.0
	Korea	5.4	7.0	7.0	7.0	7.0	7.0
	Singapore	9.9	8.0	7.0	7.0	7.0	7.0
	Taiwan	6.2	5.5	6.0	6.5	6.5	6.5

Source: The Dun & Bradstreet Corporation (May 1994)

activity is past its lowest point. Burdened by high wages and restrictive labor laws, European companies are struggling to become competitive in the global arena, where Japanese and U.S. companies have already been. High government debt, high unemployment, and an onerous social welfare system continue to strain these diverse economies.

United Kingdom

GDP, industrial production, and business investment are gaining momentum in the United Kingdom. Manufacturing, energy, utility, and telecom sectors are all growing strongly, leading the way to an increasingly broad-based recovery. Low interest rates, low inflation, and increasingly flexible labor are leading indicators of the U.K.'s future. Recession-related pent-up demand and increased defense-related electronics spending will unleash growth in EDA. Windows-based EDA sales, especially among small and medium-size businesses, is a growing sector in the United Kingdom.

France

Modest improvements in GDP growth, business investment, and industrial production are expected in France for 1994, with growth expected to pick up in 1995. Booming car sales, growth in housing starts, and drop in interest rates are in the news. With a new president to be elected in the spring, uncertainty in future government policy creates uncertainties in the investment climate of nationalized industries. The EDA market, driven by a few very large, politically influenced electronics companies, is thus affected.

Germany

The German economy lags the rest of Europe by about a year. While the economy remains weak, rising manufacturing orders, a sharp fall in unemployment, and steadily improving business optimism point to broad-based recovery over the horizon. Recovery elsewhere is boosting German exports. Businesses have begun to address the high wages, long holidays, and generous benefits burdening their competitiveness. Telecommunications will continue to dominate the German market, but greater short-term growth is likely in the industrial sector. Over the next year, most business activity is likely to be in the small and medium-size company sector, which will lead the country out of the recession; large, more risk-averse companies will come onstream when the recession is over.

Italy

Scandals involving senior government officials have dashed the hopes for economic improvement promised by Italy's new government. However, industrial production is showing signs of improvement. As the situation stabilizes, investments should improve. Automobile production is growing, but the construction industry continues in decline; however, this decline should begin turning around next year. Copyright laws will drive growth in AEC as architectural firms must prove the legality of their software before doing business with construction companies. A telecommunications downturn, balanced by a boost from the transportation sector, leads to expectations of continued strong CAE and PC-based PCB layout markets.

Asia

Japan continues to slog through its debilitating recession while the other Asian countries are skipping and running into prosperity. Japan's strong yen, increased overseas production, and the loss of rapidly growing electronics markets have resulted in a decrease in electronics production in Japan. To protect the Japanese manufacturing industry, supplies are increasingly being chosen from other Asian countries where labor costs are lower than in Japan: Japan's economic woes are therefore feeding the growing economies of Asia.

China

China's huge and low-cost manufacturing labor pool, coupled with the world's largest potential markets and the tenuous opening of the doors to outside investment, is leading the way to economic explosion. The boom in telecommunications equipment manufacturing and the huge growth in PC sales are but two indications. China is one of Asia's hottest spots for the production of printed circuit boards, with its low-cost labor pool and ties to Taiwanese PC manufacturers.

Hong Kong

Outside of Japan, Hong Kong is the slowest growing of these Asian countries, with GDP growth expected to be 5 percent. Rising labor costs, expansion of China, political worries, and skyrocketing property costs are discouraging expansion.

Japan
The Japanese government's policy-induced recession, designed to eliminate the excesses of the country's "bubble economy," has unleashed more negative economic patterns than originally anticipated. After a long period of refusing to acknowledge the pain of returning to a more normal set of economic policies and structures, both Japanese business leaders and citizens have become increasingly pessimistic about economic prospects. The change of government and increased competitive pressure in international markets has further increased uncertainty, reinforcing the downward trend in optimism.

Singapore
Singapore's maturing Asian economy is the second-fastest-growing economy in Asia. By providing tax incentives, the government lures investors from Hong Kong and Taiwan. Singapore's productivity is offsetting rising labor costs as it shifts to higher value-added production.

South Korea
South Korea is struggling with the high cost of labor, land, and money and a high demand for quality goods and services. The economy is booming, as seen by investment in new plants and equipment, construction activity, large public works projects, and the purchase of finished South Korean goods by the Japanese. The downside is government red tape and corruption.

Taiwan
Taiwan's flexible, decisive organizational structures and highly technically competent, U.S.-educated workforce with strong ties to the U.S. high-technology industry have given rise to impressive computer-related industries that are diminishing Japan's leadership in the Asian markets. Despite being limited by a small population, Taiwan has made astounding economic progress.

The Different Flavors of CAD/CAM/CAE/GIS: Application Forecast Assumptions

As was stated in our earlier forecast, the growth in GIS, ECAE, and IC layout is adding significantly to the growth of this industry, while mechanical and PCB layout are growing more slowly than the industry. Table 5 shows the forecast growth of software revenue for 1994 by application segment.

Mechanical

The mechanical application segment is the largest of the CAD/CAM/CAE/GIS market, with 46 percent share of software revenue, declining to 39 percent in 1998. Mechanical software is forecast to grow 6.8 percent in 1994 to $2.45 billion. The main issues driving the mechanical forecast are a rich blend of market demand, new technology, emerging markets, and competition. Some application segments in mechanical, such as product data management, are growing by well over 25 percent per year. Other areas are much slower, such as drafting.

Table 5
Software Revenue Forecast for CAD/CAM/CAE/GIS

	1992	1993	1994	1995	1996	1997	1998	Growth (%) 1993-1994	CAGR (%) 1993-1998
Mechanical	2,170.4	2,294.6	2,450.2	2,620.1	2,783.3	2,954.4	3,124.5	6.8	6.4
AEC	746.9	794.1	867.2	961.0	1,061.1	1,164.3	1,260.0	9.2	9.7
GIS/Mapping	580.1	662.2	749.9	857.0	975.4	1,102.4	1,235.1	13.2	13.3
EDA	1,219.8	1,270.6	1,401.9	1,565.6	1,793.2	2,058.6	2,336.4	10.3	13.0
ECAE	741.3	797.1	881.1	988.6	1,140.8	1,324.6	1,519.7	10.6	13.8
IC Layout	212.6	202.4	234.9	273.2	327.8	390.9	456.7	16.1	17.7
PCB Layout	265.9	271.2	285.9	303.8	324.6	343.2	360.0	5.4	5.8
All Applications	4,717.1	5,021.5	5,469.2	6,003.7	6,613.0	7,279.8	7,956.1	8.9	9.6

Note: Columns may not add to totals shown because of rounding.
Source: Dataquest (September 1994)

Price Pressures Force Down ASPs
We expect the price pressure to continue to force the average selling price for software and hardware down in this market. Increased memory requirements and high performance needs in computing and graphics tend to keep the hardware cost elevated, but the net effect in the total market is a steady decline in average hardware cost. Software has a similar scenario. Growing complexity in geometric databases, and application software with a growing list of vertical applications, point to higher price points for specialized products. This specialization trend is being overshadowed by the general price erosion for the mainstream product. This is partially driven by volume discounts for large strategic orders from significant manufacturing enterprises worldwide.

Obsolescence Drives Replacements
The obsolescence factor is growing with the installed base. Considering this as a market driver implies that a significant portion of the installed base of product will be recognized as old technology and will need to be replaced. As a worldwide trend, we expect this to cause a surge in spending in the United States in 1994 and 1995. The surge will spread to Japan in another year or so depending on economic conditions. A delay will tend to make the pressure to change stronger and more dramatic when it finally occurs. The European market will evolve more slowly over the next five years because of the mix of fast- and slow-growth markets.

Emerging Markets Stimulate Growth
Emerging markets in China, South America, and eastern Europe will stimulate growth in the next five years. Localization, distribution, and support will be key factors for growth when combined with economic development. Industrial partners will help steer the implementation plan.

Product Data Management Emerges as High-Growth Area
Product data management is a high-growth area for all of the major and specialty vendors. We expect this interest to continue for the next three to five years.

Integrated design, analysis, and documentation applications seem to be the areas of highest interest. Integrated manufacturing continues with sluggish growth. This area of integration is expected to stabilize in the next two or three years, with subsequent higher growth.

Demand for New Technology
New technology infusion from industrial design, virtual reality, and simulation application will continue to raise the user requirements for ease-of-use, realism, and interactive environment.

AEC

AEC software revenue is expected to grow 9.2 percent in 1994 to $867 million. Two factors that should contribute to the long-term expansion of the AEC CAD market are listed here in decreasing order of importance.

CAD Is Becoming a Business Requirement
Large design firms are growing at the expense of smaller firms. These large end-users increasingly require their employees and suppliers to adopt automation tools in the design and construction process. Smaller design firms must increasingly buy CAD systems or risk being dropped from consideration as a partner.

CAD purchases are increasingly justified as a competitive advantage in both sales and design reviews. Electronic design data is also required downstream by the designer's client, from the federal government down to the small commercial developer.

New Features in AEC CAD Products Are Achievable
Data and database functions (versus graphics functions) are increasing in importance in AEC design systems, creating opportunities to sell users significant new functionality.

The trends summarized in the following paragraphs will inhibit growth in the AEC CAD industry.

Design Is Only Part of the Problem
AEC's one-design-build-one structure means that CAD provides fewer economic benefits to these users than does the one-design-build-many structure of manufacturing. Construction, which is essentially a prototype build, is fraught with uncertainties and delays that AEC systems are not addressing. Vendors have shown relatively little leadership in improving the situation.

Poor Cooperation among Users
Users are poorly organized to take advantage of improved products, partly because of competition between engineering constructors and partly because designs are often split among several different companies representing different and competing aspects of the design process.

GIS/Mapping

GIS/mapping software revenue continues to outperform the total market, with 13.2 percent growth to $750 million forecast for 1994. Factors that should contribute to the long-term expansion of the GIS market are listed here in decreasing order of importance.

An Abundant Supply of Prospective Buyers

Penetration is still moderately low among core users. Bread-and-butter prospects in government and utilities are charged with maintaining information on land and assets in perpetuity. Many of these prospective buyers are still using paper maps, which will degrade over time. This creates a certain inevitability to moving from paper maps to computer-based systems.

New Technologies Will Drive Growth

Faster, cheaper computers will be continually leveraged to support new software products. Widespread computer industry developments in open, distributed systems supporting high-speed networking will make it possible for GIS technology to broadly expand the user base. Lower-cost, higher-resolution satellite imagery holds the potential to drive another explosion in GIS market growth among users who cannot afford aerial photography. Advances in aerial photography, global positioning systems (GPSs), and laser range finders are making it possible to create GISs that are significantly cheaper, more accurate, and more complete than existing paper maps, giving experienced users some compelling reasons to reinvest. Portable and pen-based computers are bringing GIS to new users in field operations.

Data Will Drive Growth

The GIS business market is driving high growth on PCs. However, we see a wide band of uncertainty surrounding the clearly growing revenue opportunity from new applications. Several new applications in GIS are destined to become a relatively low revenue producing feature in another software program (and market), rather than a standalone product in the GIS market. At the same time, data is increasing in value relative to software in this low-end market.

GIS has attained a certain indispensability, particularly among federal users and in utilities. As a result, users are beginning to expect to share the data that lies in their various GIS systems. Within three years, we expect data to be readily exchangeable across different systems. At that point, sharable data will help drive market growth.

Two factors that seriously constrain the long-term expansion of the GIS market are listed here.

Hight Cost of Entry

There will remain an uncertain, but certainly high, cost of creating a working GIS system in traditional environments. No magic will emerge to create a low-cost, meaningful data set for mainstream customers in

government and utilities. Data conversion will remain costly because the cost of "conversion" inevitably bundles the significant cost of correcting prior errors and omissions on paper maps.

Price Pressures Inhibit Growth
Price pressure will hold down total revenue. Computer prices will drop slightly, even in technical applications such as GIS where higher-performance hardware will command a premium price. Software prices are likely to come under increasing pressure, despite the industry's current ability to hold overall seat prices relatively even.

Electronic CAE

ECAE software revenue is expected to grow 10.3 percent to $881 million in 1994. The following paragraphs describe factors that should contribute to the long-term expansion of the ECAE market.

Increased Complexity of Design
The increased complexity of today's designs is driving a migration from the gate-level design methodology to the RT-level methodology, requiring higher-cost tools. Today's power users will migrate from the RT level to the ES level.

Most of this migration is coming from the "second wave," the FPGA users who are now designing with over-10,000 gate FPGAs. With less than a year to finish designs and the constraint of 100 to 200 gates a week using gate-level methodology, the RT-level methodology is becoming essential (and boy are they confused!).

Will Equalization Continue?
The price of PC-based software is going up (with the increases in capability allowed by Windows NT), while workstation software prices are going down (with the discovery that the full power of UNIX is unnecessary). The threat of the Windows NT operating system drives this phenomenon, called "equalization." However, as UNIX is beginning to pick up the first part of the second wave, doubt is clouding this Windows NT scenario.

Hunger for Electronic Space Continues Unabated
As the power of both PC and UNIX software increases, the demand for more memory, storage, and speed drives up the cost of fully configured systems. One GB hard drives and a minimum of 129K main memory are standard.

Growth Overseas
Strengthening economies elsewhere will support growth in CAE. Europe is coming out of its slump, and Japan and other Asian countries are coming on strong.

IC Layout

The IC layout segment is the smallest but also the fastest-growing CAD/CAM/CAE/GIS segment. Growth in software revenue is forecast to be 16.1 percent, resulting in $235 million in revenue in 1994. The following

paragraphs describe the factors that should contribute to the long-term expansion of the IC market.

Double Drivers of Complexity and Volume
As the complexity of IC layout increases almost exponentially, costs will increase throughout the 1990s. The new fab activity in the Far East and Europe will increase demand.

It's a UNIX World
The PC is incapable of handling most IC layout jobs. Even the Far East, with the possible exception of China, is going UNIX for IC layout.

Floorplanners Are Hot
A hot new area for IC layout is floorplanners. This technology extends the market beyond the semiconductor industry to equipment manufacturers. This could be the major growth area as the customer base expands.

PC Board

Printed circuit board software revenue, earlier forecast with negative growth, has been revised to positive growth of 5.4 percent for a total of $286 million for 1994. The following paragraphs describe the factors that should contribute to the long-term expansion of the PCB market.

Uncertain Platform of Choice
PCB tools are so mixed between low-cost PC-based systems and high-cost workstation-based systems that the future is uncertain. For now, the two markets are counterbalancing each other. However, a new generation of UNIX-based PCB tools, including concurrent analysis tools, could foretell a shift in preference. Companies that have not invested in R&D and those too small to develop the next generation are in trouble.

Will Windows NT Fill the Bill?
New technology and Windows NT will impact the market, but in what way remains uncertain. Windows Chicago will not be powerful enough to handle the new packages, and Daytona is an unknown. In the meantime, the technology leaders (Unicad, Harris, Interconnectix, and Mentor) are sticking with UNIX.

Point Analysis Tools Will Continue to Flourish
At the same time as concurrent analysis tools will be making their mark at the high end of the PCB layout market, point tools for thermal, EMC, crosstalk, and other analysis tasks will continue to show high growth across the spectrum of PCB users.

By Linda Anderson

For More Information...

Linda Anderson, Market Research Analyst ..... (408) 437-8135
Internet address ..... landerson@dataquest.com
Via fax ..... (408) 437-0292

Dataquest Perspective

Software

CAD/CAM/CAE/GIS Worldwide

In This Issue

CAD/CAM/CAE and GIS Market Share Update

Following in-depth analysis of 1992 and 1993 market data, we have raised slightly the growth rate of the CAD/CAM/CAE and GIS total market from 2.4 percent to 2.5 percent, and reduced the software market growth rate from 7.2 percent to 6.5 percent. Our January 1994 market share data provided an accurate view of the macro markets early in the year. This updated market share, based upon data gathered after vendors completed their year-end analysis, provides the micro perspective of this highly segmented market. These changes confirm the size and growth rates of the CAD/CAM/CAE and GIS market and allow for greater scrutiny at the segment level of application, platform, and region/country.

This *Dataquest Perspective* announces the July 31, 1994, publication of the *1993 Market Share Update* for the CAD/CAM/CAE and GIS markets to replace the earlier publication, *1993 Market Share*.
By Linda Anderson

CAD/CAM/CAE and GIS Market Share Update

Software Market Grew 6.5 Percent in 1993, Revised Down from 7.2 Percent

This market share update essentially revisits the companies in our database, following their year-end, for refinement of the previously reported market share data. Whereas much of the data from the initial survey came from vendor projections, early year-end results, and last year's segmentation, this update represents actual 1993 results and the integration of secondary sources, including Dataquest's hardware vendor totals.

Table 1 provides a view of growth rates in software revenue by application, by region, and by platform, as well as the total market. The actual revenue figures for both 1992 and 1993 have been updated from the best information available and are less than reported in our *1993 Market Share*. Some of the major changes made are as follows:

- Projected fourth-quarter performance from performance of the first three quarters overstated revenue for Autodesk and Computervision.
- Year-end analysis altered Intergraph's application splits.

Dataquest
a company of The Dun & Bradstreet Corporation

Program: CAD/CAM/CAE/GIS Worldwide
Product Code: CCAM-WW-DP-9403
Publication Date: June 27, 1994

Table 1
CAD/CAM/CAE/GIS 1993 Market Summary

	Software Revenue 1992 ($M)	Software Revenue 1993 ($M)	Growth Rate (%)	Total Revenue 1992 ($M)	Total Revenue 1993 ($M)	Growth Rate (%)	Unit Shipments 1992 ($M)	Unit Shipments 1993 ($M)	Growth Rate (%)
Application									
Mechanical	2,170.4	2,294.7	5.7	7,988.2	7,862.7	-1.6	302,347	303,364	0.3
AEC	746.9	794.1	6.3	2,356.5	2,444.0	3.7	178,629	198,075	10.9
GIS/Mapping	580.1	662.2	14.2	2,005.6	2,179.1	8.7	86,513	102,624	18.6
Electronic CAE	741.5	797.1	7.5	2,086.4	2,271.7	8.9	94,176	99,129	5.3
IC Layout	212.7	203.0	-4.6	628.4	676.4	7.6	9,771	13,049	33.5
PCB/Hybrid/MCM	265.9	271.2	2.0	870.9	900.2	3.4	35,110	38,030	8.3
Total	4,717.4	5,022.2	6.5	15,936.0	16,334.2	2.5	706,546	754,271	6.8
Region									
North America	1,562.5	1,754.6	12.3	5,253.5	5,690.7	8.3	286,939	325,318	13.4
Europe	1,693.8	1,608.9	-5.0	5,755.5	5,432.7	-5.6	231,062	240,603	4.1
Asia	1,352.7	1,534.4	13.4	4,601.2	4,830.6	5.0	169,839	163,620	-3.7
Rest of World	108.5	124.3	14.6	325.9	380.2	16.7	18,706	24,730	32.2
Total	4,717.4	5,022.2	6.5	15,936.0	16,334.2	2.5	706,546	754,271	6.8
In Local Currencies									
Europe (ECU)	1,301.8	1,378.2	5.9	4,423.7	4,653.7	5.2			
Asia (Yen)	170,895	170,093	-0.5	581,318	535,468	-7.9			
Platform									
Technical Workstation	3,060.1	3,312.8	8.3	9,640.0	10,458.3	8.5	173,705	194,848	12.2
Host-Dependent	360.2	306.1	-15.0	2,436.6	1,754.7	-28.0	34,524	28,573	-17.2
Server	140.0	176.2	25.9	906.3	1,056.8	16.6	11,566	13,381	15.7
Personal Computer	1,157.1	1,227.1	6.1	2,953.2	3,064.4	3.8	486,751	517,469	6.3
Total	4,717.4	5,022.2	6.5	15,936.0	16,334.2	2.5	706,546	754,271	6.8

Source: Dataquest (June 1994)

- Restatement of software and service revenue and elimination of ASI revenue through history, according to public documents, changed Cadence and the EDA market considerably.
- Significant analysis using Dataquest hardware shipment data and other secondary sources resulted in restatement of hardware shipments.
- Our survey provided considerable revision of regional information, particularly at the country level.

Regional Data

Our *Market Share Update* survey revisits companies with a particular focus on revenue splits for region/country, providing considerable insight at this fine level of detail.

Caution is the watchword when evaluating European and Asian growth rates. With the dollar appreciating against the European currencies from 1992 to 1993, contraction of the market in U.S. dollars converts to growth

in local currency. Conversely, the dollar's depreciating against the yen from 1992 to 1993 has the opposite effect, with growth in U.S. dollars converting to contraction of the market in yen (see Table 1). The enormous growth outside Japan, while a sluggish economy continues to suppress growth in Japan, further shrouds the Asian market. Table 2 provides the growth rates of each application in each European and Asian country in local currency, with exchange rates.

The growth rates in local currency of the Asian countries other than Japan are startling. There are several reasons for this growth, as follows:

- Particularly in China, companies are negotiating with the government for compensation for the huge amounts of pirated software being used.
- Many vendors have provided us with Asian country splits for the first time. This new level of detail creates distortions in our growth rates from revenue lacking refinement to that having greater refinement, creating larger-than-real growth rates.
- There is in fact enormous growth in usage of CAD/CAM/CAE/GIS software in these other Asian countries.

Table 2
Software Growth Rates by Application for European and Asian Countries in Local Currency

		1992 per	1993 per		Growth Rates in Local Currency (%)			
	Currency	U.S.$	U.S.$	Change (%)	Mech	AEC	GIS	EDA
Europe:								
Benelux	Franc	31.94	34.61	8.4	10.1	18.8	30.3	-15.4
France	Franc	5.2571	5.6641	7.7	-2.3	-5.9	33.2	7.9
Germany	Mark	1.5513	1.6543	6.6	-9.2	-0.4	8.7	7.0
Italy	Lira	1,220.85	1,575.05	29.0	4.1	0.1	3.9	39.5
Spain	Peseta	101.5	127.1	25.2	8.6	7.7	20.1	-5.4
Scandinavia	Krone	6.1652	7.0972	15.1	6.4	8.8	19.9	45.4
U.K.	Pound	0.5652	0.6665	17.9	10.7	3.8	37.1	22.3
ROE	ECU	0.7686	0.8566	11.4	3.4	18.0	45.2	-21.8
Asia								
Japan	Yen	126.34	110.85	-12.3	-3.1	0.7	-8.0	-11.5
Hong Kong	Dollar	7.7399	7.7351	-0.1	67	186	147	-27
Singapore	Dollar	1.6284	1.6155	-0.8	154	385	30	13
Taiwan	Dollar	24.93	26.15	4.9	195	844	449	38
Korea	Won	782.41	799.42	2.2	172	859	286	71
China	Renminbi	5.5076	5.758	4.5	73	516	2	204

Source: Dataquest (January 1994)

Company Additions and Deletions

Since the early market share, five new companies have been added to our database: ARCSYS, AT&T, Eagle Point, Speed, and ULTimate, for a total of U.S.$12.2 million in 1992, and U.S.$19.7 million in 1993. The disappearance of four companies, Asicom, CADLYNX, NCR Microelectronics, and Quicklogic, offset this growth. A number of company changes will be instituted next year, pending final purchase, including Viewlogic's purchase of Chronologic, Synopsys' purchase of Logic Modeling, Softdesk's purchase of ASG, Unisys' purchase of Computervision's GIS software product, ICEM Technologies' purchase of CDC's Mechanical software product, MacNeal-Schwendler's purchase of PDA, the merger of Sysdeco and SysScan, the change of GDS to Convergent Group, and Zuken's purchase of Racal-Redac.

Analysis of Workstation Distribution

Dataquest continues to fine-tune the vendor workstation shipments by juxtaposing the previous analysis from CAD/CAM/CAE/GIS software revenue by operating systems with Dataquest's workstation shipment data, taking care not to double-count shipments, and refining the average selling price model to acknowledge the differing computer configuration requirements for each application. The result is our restatement of the top six vendor shipments as shown in Table 3. Sun is the clear unit shipment leader, with a 33 percent share of the market. Sun is also the leader in CPU revenue, with U.S.$1.11 billion, but HP follows closely with $1.03 billion.

Table 3
Vendor Shipments of Technical Workstations (Including Units Sold through OEMs and VARs) by Application Segment, by Top U.S. Vendors

	Mechanical	AEC	Mapping	ECAE	IC	PCB	All Applications	Share of Worldwide Market (%)
Sun Microsystems	25,500	4,000	4,900	17,700	6,800	5,800	64,700	33
Hewlett-Packard	21,300	6,000	4,300	9,800	2,300	5,100	48,800	25
IBM	10,200	3,400	2,900	2,400	1,400	700	21,000	11
Digital Equipment	8,300	1,300	2,000	3,200	800	700	16,300	8
Silicon Graphics	11,600	500	800	200	0	0	13,100	7
Intergraph	1,700	4,800	4,500	200	0	100	11,300	6
Total Worldwide Sales	87,600	23,400	24,600	34,400	11,300	13,500	194,800	100
Application Distribution (%)	45	12	13	18	6	7	100	

Source: Dataquest (June 1994)

Market Share Update

The top 20 CAD/CAM/CAE/GIS vendors together grew slightly faster than the total market, as shown in Table 4. Parametric Technology and ESRI are new to the top 20 list. They replace Compaq (removed because we no longer follow Intel-PC clone vendors) and CDC. Sun leapfrogged Intergraph, HP, and Digital to become the No. 2 CAD/CAM/CAE vendor, virtually tying HP for that spot. These top 20 vendors represent 75 percent of the service revenue, 72 percent of the hardware revenue, and only 55 percent of the software revenue.

Table 4
1993 Top 20 CAD/CAM/CAE and GIS Vendors in Total Factory Revenue

	1992 Total Revenue ($M)	1992 Share of Market (%)	1993 Total Revenue ($M)	1993 Share of Market (%)	Change in Total Revenue (%)
IBM	1,977.6	12.4	2,023.5	12.4	2.3
Sun Microsystems	1,017.2	6.4	1,193.2	7.3	17.3
Hewlett-Packard	1,057.7	6.6	1,189.7	7.3	12.5
Intergraph	1,115.8	7.0	1,000.1	6.1	-10.4
Digital	964.0	6.0	983.5	6.0	2.0
Computervision	775.7	4.9	554.0	3.4	-28.6
Fujitsu	439.7	2.8	523.7	3.2	19.1
NEC	348.0	2.2	402.9	2.5	15.8
Autodesk	341.2	2.1	400.6	2.5	17.4
Silicon Graphics	244.0	1.5	380.1	2.3	55.7
Cadence	409.9	2.6	361.1	2.2	-11.9
Mentor Graphics	350.6	2.2	340.7	2.1	-2.8
EDS Unigraphics	227.4	1.4	274.7	1.7	20.8
Nihon Unisys	261.0	1.6	266.1	1.6	2.0
Siemens Nixdorf Info systeme	269.9	1.7	222.6	1.4	-17.5
Hitachi	174.0	1.1	187.9	1.2	8.0
Apple Computer	207.2	1.3	185.1	1.1	-10.7
Parametric Technology	100.3	0.6	184.1	1.1	83.6
SDRC	149.9	0.9	177.0	1.1	18.1
ESRI	116.9	0.7	135.0	0.8	15.5
Top 20 Companies	10,547.8	66.2	10,985.7	67.3	4.2
All Companies	15,936.0	100.0	16,334.2	100.0	2.5

Source: Dataquest (June 1994)

Mechanical

The top 10 mechanical software vendors drove the expansion of this market (see Table 5). The total growth of this group was 12.3 percent, more than double the total growth of the market, which grew 5.7 percent. Autodesk moved to the No. 2 spot, and Parametric Technology leaped up from the lower tier to the No. 3 spot, where it is poised to dislodge both market leaders. North America led the expansion of mechanical software, with 19.2 percent growth. These top vendors, nine of which are North American companies, have an aggregate 70 percent of the North American market. The German and Japanese economies slowed the growth of mechanical CAD in Europe and Asia, respectively.

AEC

The AEC software market grew 6.3 percent, driven by the top 10 vendors who grew in aggregate a total of 10.4 percent (see Table 6). This U.S.$794 million market continues to be dominated for the foreseeable future by Autodesk, with Intergraph coming in a strong second. In Europe, Autodesk, Intergraph, Nemetschek, and IEZ constitute 54 percent of the market. The phenomenally hot growth segment is AEC in Asia, growing 24.6 percent in U.S. dollars.

Software on the PC platform grew nearly 13 percent, compared with negligible growth on other platforms—which means that PC-based software provided virtually all the net growth in AEC. The message here is that workstation-based software is not yet providing a broad-based compelling advantage over the somewhat less sophisticated PC software. Workstation-based vendors must either create that advantage or continue to lose market share.

Table 5
Top 10 Mechanical Software Companies Worldwide

	1992 Software Revenue ($M)	1992 Share of Market (%)	1993 Software Revenue ($M)	1993 Share of Market (%)	Change in Software Revenue (%)
IBM	308.7	14.2	325.5	14.2	5.4
Autodesk	136.5	6.3	160.2	7.0	17.4
Parametric Technology	81.2	3.7	151.0	6.6	85.9
Computervision	193.6	8.9	147.5	6.4	-23.8
EDS Unigraphics	106.9	4.9	129.2	5.6	20.9
SDRC	94.4	4.3	120.7	5.3	27.9
MacNeal-Schwendler	59.5	2.7	74.1	3.2	24.6
Hewlett-Packard	72.8	3.4	70.8	3.1	-2.8
Intergraph	72.6	3.3	70.5	3.1	-2.8
Fujitsu	46.9	2.2	67.4	2.9	43.8
Top 10 Companies	1,173.0	54.0	1,316.9	57.4	12.3
All Companies	2,170.4	100.0	2,294.7	100.0	5.7

Source: Dataquest (June 1994)

Table 6
Top 10 AEC Software Companies Worldwide

	1992 Software Revenue ($M)	1992 Share of Market (%)	1993 Software Revenue ($M)	1993 Share of Market (%)	Change in Software Revenue (%)
Autodesk	146.7	19.6	172.3	21.7	17.4
Intergraph	113.1	15.1	110.0	13.8	-2.8
Fujitsu	35.4	4.7	47.3	6.0	33.4
Nemetschek	32.5	4.3	44.7	5.6	37.6
IBM	41.5	5.6	40.2	5.1	-3.1
IEZ	26.6	3.6	29.6	3.7	11.6
Computervision	26.3	3.5	20.0	2.5	-23.8
NEC	13.4	1.8	15.6	2.0	15.8
Kozo Keikaku Eng.	11.3	1.5	12.8	1.6	13.6
GDS	10.3	1.4	12.4	1.6	20.2
Top 10 Companies	457.1	61.2	504.8	63.6	10.4
All Companies	746.9	100.0	794.1	100.0	6.3

Source: Dataquest (June 1994)

GIS/Mapping

The GIS software market continues to be the fastest-growing segment with 14.2 percent growth and continues to have two market leaders, Intergraph and ESRI (see Table 7). In our *Market Share*, ESRI was reported to be No. 1. That spot has been reclaimed by Intergraph, by a hair, based on detailed final reporting from the company. These two companies account for 32 percent of the worldwide GIS software market and enjoy virtually identical market shares. Both companies can be expected to hold this neck-and-neck position through 1994. The game could change in 1995, however, when Bentley Systems begins selling MicroStation directly, potentially reducing Intergraph's software revenue in several applications.

With the exception of Siemens, the remaining top companies enjoyed phenomenal growth, led by Smallworld Systems in England, MapInfo and Landmark Graphics in North America, and Fujitsu in Japan. In general, the GIS software market is expanding on a U.S.$ basis in all regions and on all platforms but host systems.

ECAE

The ECAE software market, which grew 7.5 percent, continues to be a hotbed of winners and losers. Three of last year's top 10 companies, Racal-Redac, Wacom, and Intergraph, dropped from the list after suffering significant losses, and EEsof was purchased by Hewlett-Packard. Cadence and Mentor, at the top, continue to be hamstrung by their frameworks. In the meantime, the other top 10 companies, riding the wave of technological advancement, are enjoying significant revenue growth. North American companies make up almost 90 percent of this market and hold all of

Table 7
Top 10 GIS Software Companies Worldwide

	1992 Software Revenue ($M)	1992 Share of Market (%)	1993 Software Revenue ($M)	1993 Share of Market (%)	Change in Software Revenue (%)
Intergraph	95.4	16.3	112.0	16.9	17.4
ESRI	93.3	16.1	108.9	16.4	16.7
Siemens Nixdorf Info systeme	53.4	9.1	51.4	7.8	-3.7
Landmark Graphics	29.8	5.1	45.3	6.8	52.0
Autodesk	37.5	6.4	44.1	6.7	17.4
GDS	24.1	4.1	26.4	4.0	9.5
Fujitsu	12.6	2.2	20.2	3.1	60.9
MapInfo	9.2	1.6	17.3	2.6	87.2
Genasys II	13.1	2.2	15.1	2.3	15.2
Smallworld Systems	5.8	1.0	15.0	2.3	159.3
Top 10 Companies	374.1	64.5	455.5	68.8	21.7
All Companies	580.1	100.0	662.2	100.0	14.2

Source: Dataquest (June 1994)

the top 10 slots. In fact, the growth of this market centers in North America, which grew 10.1 percent, from U.S.$365.8 million to U.S.$403.0 million.

IC Layout

Cadence has long dominated this smallest segment, with U.S.$203 million software revenue. Its contraction of 4.6 percent from 1992 to 1993 is the loud roar of dissatisfaction from the customer. With the customer investment in IC tools high and incentive to change low, Cadence lost touch with their customers. Mentor is taking up some of the slack. Here is a market ripe with opportunity for handsome rewards for companies with really good tools and an ear to the customer.

PCB/Hybrid/MCM Layout

The PCB software market is small, with U.S.$271.2 million, but is poised for big changes. Regionally, this market declined in North America 2.6 percent, was flat in Europe when converted to ECU, declined 3.1 percent in Asia when converted to yen. This is a market that is at the end of its life cycle and ready for the next-generation tools. The top 10 vendors have 83 percent of the workstation software share of market but only 28 percent of the PC software share of market. While 74 percent of the PCB software revenue is on workstations, 60 percent of the unit shipments were PCs. Juxtapose this with the convergence of PCs and workstations in the new desktop incarnations and this looks to be a market primed for some cataclysmic changes. Stay tuned for next year's market share.

Table 8
Top 10 ECAE Software Companies Worldwide

	1992 Software Revenue ($M)	1992 Share of Market (%)	1993 Software Revenue ($M)	1993 Share of Market (%)	Change in Software Revenue (%)
Cadence	165.4	22.3	120.3	15.1	-27.2
Mentor Graphics	81.1	10.9	85.5	10.7	5.3
Synopsys	48.4	6.5	82.0	10.3	69.5
Viewlogic Systems	41.0	5.5	61.9	7.8	51.0
Hewlett-Packard	20.0	2.7	33.7	4.2	69.0
Logic Modeling Corp.	14.5	2.0	32.2	4.0	121.4
Quickturn Design Systems	12.9	1.7	27.4	3.4	112.6
COMPASS Design Automation	15.3	2.1	22.7	2.8	48.4
Autodesk	17.0	2.3	20.0	2.5	17.5
Altera	11.1	1.5	14.1	1.8	27.0
Top 10 Companies	426.7	57.5	499.8	62.7	17.1
All Companies	741.5	100.0	797.1	100.0	7.5

Source: Dataquest (June 1994)

Table 9
Top 10 IC Layout Software Companies Worldwide

	1992 Software Revenue ($M)	1992 Share of Market (%)	1993 Software Revenue ($M)	1993 Share of Market (%)	Change in Software Revenue (%)
Cadence	122.5	57.6	100.1	49.3	-18.3
Mentor Graphics	24.8	11.7	32.1	15.8	29.2
COMPASS Design Automation	16.5	7.7	15.1	7.5	-8.1
Cascade Design Automation	5.9	2.8	6.7	3.3	13.7
Sagantec	6.7	3.2	6.1	3.0	-9.7
Silvar-Lisco	6.6	3.1	5.9	2.9	-10.5
Integrated Silicon Systems	2.4	1.1	5.6	2.8	136.0
Fujitsu	3.4	1.6	4.7	2.3	37.6
High Level Design Systems	0.6	0.3	2.7	1.3	350.0
Intergraph	1.4	0.7	1.8	0.9	28.6
Top 10 Companies	190.8	89.7	180.8	89.1	-5.3
All Companies	212.7	100.0	203.0	100.0	-4.6

Source: Dataquest (June 1994)

Table 10
Top 10 PCB/Hybrid/MCM Software Companies Worldwide

	1992 Software Revenue ($M)	1992 Share of Market (%)	1993 Software Revenue ($M)	1993 Share of Market (%)	Change in Software Revenue (%)
Mentor Graphics	38.4	14.5	41.6	15.3	8.3
Zuken	35.4	13.3	34.3	12.7	-3.0
IBM	20.7	7.8	23.0	8.5	11.3
Racal-Redac	21.1	7.9	17.2	6.3	-18.7
Yokogawa Digital Computer	11.9	4.5	15.7	5.8	32.7
Fujitsu	8.0	3.0	14.4	5.3	80.1
CADIX	12.3	4.6	14.2	5.2	15.2
Cadence	18.4	6.9	13.1	4.8	-28.6
Harris EDA	12.2	4.6	12.0	4.4	-2.0
Intergraph	12.0	4.5	9.5	3.5	-20.6
Top 10 Companies	190.3	71.6	195.1	71.9	2.5
All Companies	265.9	100.0	271.2	100.0	2.0

Source: Dataquest (June 1994)

Market Analysis

Figure 1 provides the final view of all of this activity, with the market size and market growth rate for each segment in the CAD/CAM/CAE and GIS software industry. In this figure, the heavy horizontal line indicates the industry average for software revenue growth; the size of the bubbles reflects market share; and the bubbles are centered over their segment growth rate (x-axis) and segment size (y-axis) for 1993. In the case of Asia and Europe, arrows indicate the segment growth rates when converted to local yen and ECU, respectively.

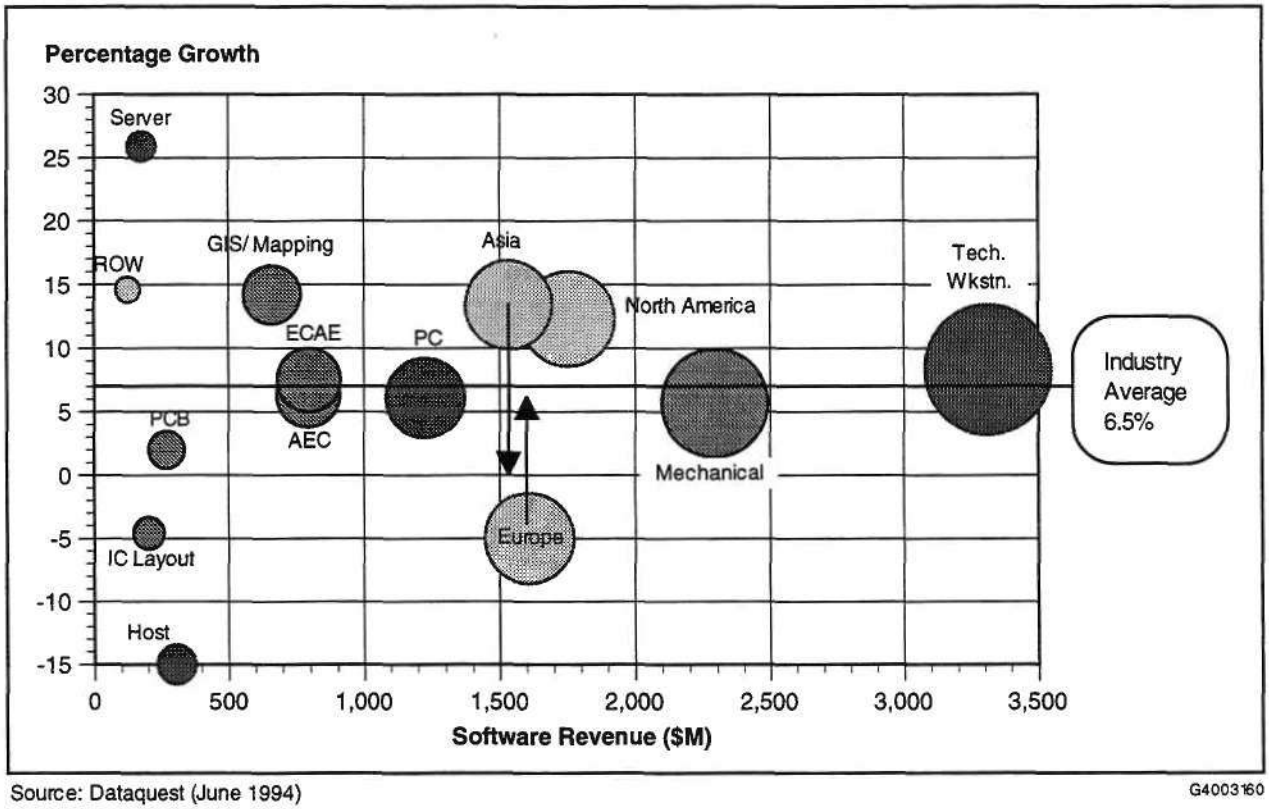
Little has changed in this picture since last year's *Market Share Update* except for the position of the regional bubbles. However, when considering the impact of currency changes on these growth rates both this year and last, they would be about the same, with Asia having negative growth and Europe having growth closer to the industry average. The IC Layout bubble has moved from very high growth rate to a negative growth rate.

Dataquest Perspective

From the macro perspective, the overall market has changed very little from the market share reported in February. However, the micro view of the CAD/CAM/CAE and GIS market reveals the following considerable refinements:

- Companies have adjusted their revenue and distributions by region/country, platform, and application from earlier estimates. Most companies cannot provide such a perspective until accounting procedures are

Figure 1
CAD/CAM/CAE/GIS Market Portfolio for Software Revenue for 1993



Source: Dataquest (June 1994)

G4003160

completed in March or April. Our database is then updated to reflect this new information, often resulting in a closer look at the previous year's performance as well. We open our CAD/CAM/CAE and GIS database to historical changes in the first six months of the year to provide a clear view of the market. It is now frozen for a fixed view of the market for our final forecasting.

- Currency changes continue to assert themselves in this global market. When looking at growth rates by regions and by countries, consider exchange rates.
- Asia is no longer a substitute name for Japan: other Asian countries are growing into full-bodied markets. The growth in CAD/CAM/CAE and GIS in these other Asian countries is huge, albeit not as huge as we are showing.
- Whether by merger or acquisition, by technological advancement or innovation, the scramble for market share continues to be the fuel of this market. There is no place to rest.

The market dynamics of the total CAD/CAM/CAE and GIS market comprises many factors based on application-specific market trends, diverse geographical issues, ubiquitous computing growth, and fierce competition for technological leadership. A more detailed analysis of each segment

must be made to thoroughly understand the forces driving the entire market. Besides publishing the market statistics books, such as the *Market Share Update* in late July and *Forecast Update* in September, Dataquest provides an in-depth analysis of CAD/CAM/CAE and GIS application specific trends, regional issues, technology trends, and vendor profiles in other publications.

By Linda Anderson

For More Information...

Linda Anderson, Market Research Analyst ..... (408) 437-8135
Via fax ..... (408) 437-0292

Dataquest Perspective

Software

In This Issue

CAD/CAM/CAE/GIS Forecast: 5.2 Percent Growth Seen in 1994

Our early estimates of the CAD/CAM/CAE/GIS market share show that the total factory revenue in 1993 slowed to a 2.5 percent growth rate. The total factory revenue growth rate is expected to double in growth to 5.2 percent this year—an increase worth more than $860 million in revenue, an amount that is almost the total market of 12 years ago. The total market size this year is targeted at more than $17.3 billion in software, hardware, and services revenue.

Economic Forces Continue to Force Tough Decisions

The economic health of the world is improving slowly. The U.S. market is showing significant signs of growth, with renewed optimism and increased capital spending, albeit with a critical eye toward returns. The United Kingdom is leading Europe toward recovery, with many of Europe's largest countries improving slowly. Germany continues to be burdened with reunification issues, a sluggish local economy, and reduced exports. Emerging markets in eastern Europe are showing some evidence of business development and growth of consumer markets. Japan, battling with a strong yen against the dollar, cannot yet see the end of its recession. Meanwhile, the other Asian countries are enjoying robust growth. These

Dataquest
a company of The Dun & Bradstreet Corporation

Program: CAD/CAM/CAE/GIS Worldwide
Product Code: CCAM-WW-DP-9402
Publication Date: April 25, 1994

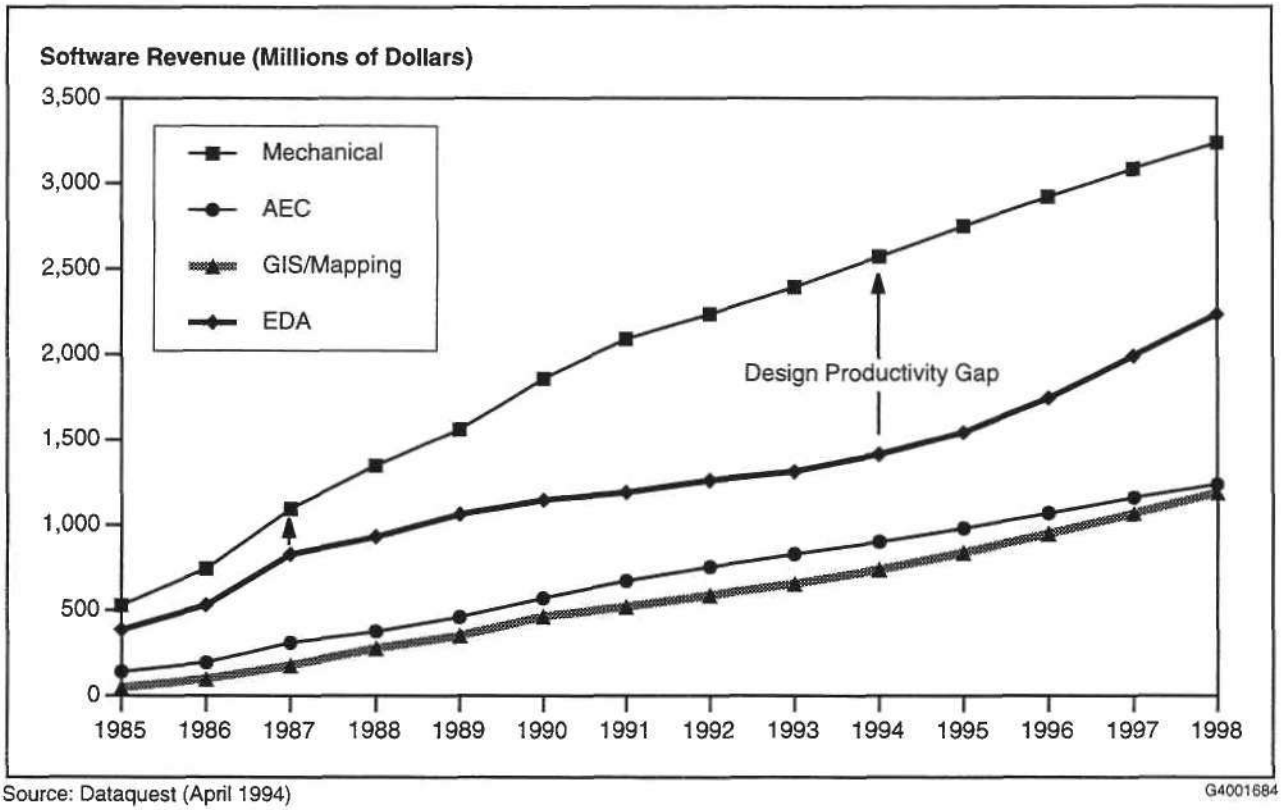
economic forces create a slippery landscape to navigate into the future, forcing difficult decisions.

The Cost of Arrogance

For the past few years, Dataquest has been tracking the growing gap between the number of gates and the speed of today's silicon available to the designer versus the ability of EDA tools to use those gates and silicon speed. Dataquest calls this the Design Productivity Gap. This gap is especially visible in the growth of EDA software revenue relative to that of mechanical software revenue (see Figure 1). EDA software tracked that of mechanical until 1987, slowed in 1988, and went flat from 1990 to 1993. Dataquest believes that this flattening of sales has been caused by the EDA industry's preoccupation with controlling the market rather than producing the tools that would allow design to take advantage of the possibilities in complexity and speed that the silicon provides.

This can be traced to the framework movement of the late 1980s led by Mentor, Daisy, and Valid. These No. 1, No. 2, and No. 4 EDA companies decided that the answer to complexity was to tie their tools into one large package, providing one solution for all design, effectively locking out their competition. The resulting money, engineering time, and R&D effort required to maintain market control diverted the industry from the

Figure 1
The Cost of Arrogance



Source: Dataquest (April 1994)

G4001684

fundamental problem: The gate level design methodology of the 1980s was not sufficient to design the 100,000-gate arrays being introduced by the ASIC suppliers. The solution came from the user community: RTL methodology. It is interesting to notice that the companies that listened to the users were Cadence, Synopsys, and Viewlogic, in the No. 1, No. 2, and No. 4 positions in market share today. But still the gap is growing.

Dataquest does not foresee the EDA market getting back on its growth track until 1996, when ESDA tools become a factor in the market. Where it took the RTL methodology to design silicon with 100,000 gates, it will take ESL methodology to design 1 million gates. Imagine what the market could be today if that money, engineering time, and R&D effort had been directed to advancing the state of the art rather than maintaining control. Perhaps the Design Productivity Gap should be renamed the Arrogance Gap.

The lesson for vendors in all applications can be found in conventional business wisdom: Focus on growing your market by listening to your customers and delivering products that meet their needs.

Fluctuating Exchange Rates Mask True Market Performance

Measured with the dollar, the Asian and European market growth was nearly flat. The picture is quite different if local currency is used (see Table 1).

Japan is plowing through its worst recession in 50 years. The dollar growth rate of 3.3 percent for Japan is actually a decline of 9.9 percent when measured in yen. Local prices have fallen. Lower-cost products are the most often purchased. Planned purchases are delayed or postponed indefinitely. Competitive pressures and planned system expansion are keeping the CAD/CAM/CAE/GIS markets moving at a much slower pace. The pent-up demand forming in the wake of this recession should fuel significantly higher future demand.

The European market decline of 1.3 percent in dollars is actually a growth of 10.0 percent in local currency. Europe is now being led by strong growth in the United Kingdom. Eastern Europe is crackling with alliances trying to bring east to west. Discrete manufacturing, R&D, and telecommunications will be the lead forces bringing these markets together in the short term.

Worldwide revenue estimates include data from many countries, each with a different and fluctuating exchange rate. Dataquest uses the dollar as the common denominator in the worldwide market analysis. Care should be taken in making comparisons to first reference local currency fluctuations relative to the dollar.

Although Dataquest does not forecast currency exchange rates, we do forecast with the most current information available. The exchange rate is calculated as the simple arithmetic mean of the 12 average monthly rates for each country. For the purpose of this forecast, Dataquest assumes the February exchange rate will apply for all future months of 1994 (see Table 2).

Table 1
Comparison of Growth in CAD/CAM/CAE/GIS Revenue in U.S. Dollars versus Local Currency for Both Europe and Japan

	1992	1993	Forecast 1994	Growth (%) 1992-1993	Growth (%) 1993-1994
Europe (Millions of U.S. Dollars)					
Software Revenue	1,709	1,755	1,863	2.7	6.1
Hardware Revenue	2,778	2,629	2,624	-5.4	-0.2
Service Revenue	1,088	1,119	1,133	2.9	1.3
Total Factory Revenue	5,574	5,502	5,620	-1.3	2.1
ECU/U.S.$1 Exchange Rate	*0.7686*	*0.8566*	*0.8879**	*11.4*	*3.7*
Europe (Millions of ECUs)					
Software Revenue	1,313	1,504	1,654	14.5	10.0
Hardware Revenue	2,135	2,252	2,330	5.4	3.5
Service Revenue	836	958	1,006	14.6	5.0
Total Factory Revenue	4,284	4,713	4,990	10.0	5.9
Japan (Millions of U.S. Dollars)					
Software Revenue	1,317	1,435	1,514	9.0	5.5
Hardware Revenue	2,478	2,428	2,446	-2.0	0.7
Service Revenue	601	677	702	12.6	3.7
Total Factory Revenue	4,395	4,540	4,662	3.3	2.7
Yen/$U.S. Exchange Rate	*126.34*	*110.85*	*106.54**	*-12.3*	*-3.9*
Japan (Millions of Yen)					
Software Revenue	166,328	159,076	161,314	-4.4	1.4
Hardware Revenue	313,033	269,122	260,565	-14.0	-3.2
Service Revenue	75,943	75,023	74,791	-1.2	-0.3
Total Factory Revenue	561,236	505,527	493,689	-9.9	-2.3
North America (Millions of U.S. Dollars)					
Software Revenue	1,629	1,805	2,008	10.8	11.3
Hardware Revenue	2,920	2,951	3,184	1.1	7.9
Service Revenue	932	1,039	1,133	11.5	9.0
Total Factory Revenue	5,481	5,795	6,325	5.7	9.1
Worldwide (Millions of U.S. Dollars)					
Software Revenue	4,836	5,189	5,614	7.3	8.2
Hardware Revenue	8,501	8,323	8,607	-2.1	3.4
Service Revenue	2,739	2,969	3,122	8.4	5.2
Total Factory Revenue	16,076	16,481	17,342	2.5	5.2

*1994 currency calculated by projecting February exchange rate to end of year.
Source: Dataquest (March 1994)

Table 2
Foreign Currency versus U.S. Dollar

Country (Currency)	Actual 1990	Actual 1991	Actual 1992	Actual 1993	Current 1994	Year-to-Year Change (Percent) 1990-1991	1991-1992	1992-1993	1993-1994
Eropean Community (ECU)	-	0.8079	0.7686	0.8566	0.8879	-	-5	11	4
Belgium (Franc)	33.31	34.01	31.94	34.61	35.46	2	-6	8	2
France (Franc)	5.4277	5.6183	5.2571	5.6641	5.8422	4	-6	8	3
Germany (Mark)	1.6111	1.6523	1.5513	1.6543	1.7204	3	-6	7	4
Italy (Lira)	1195.03	1235.03	1220.85	1575.05	1689.22	3	-1	29	7
Norway (Krone)	6.2383	6.4641	6.1652	7.0972	7.4249	4	-5	15	5
Spain (Peseta)	101.7	103.48	101.5	127.1	139.8	2	-2	25	10
United Kingdom (Pound)	0.5599	0.5658	0.5652	0.6665	0.6698	1	0	18	1
Japan (Yen)	144.05	134.59	126.34	110.85	106.54	-7	-6	-12	-4
Hong Kong (Dollar)	7.79	7.7712	7.7399	7.7351	7.7244	0	0	0	0
Singapore (Dollar)	1.8129	1.7277	1.6284	1.6155	1.5851	-5	-6	-1	-2
Taiwan (Dollar)	26.64	26.49	24.93	26.15	26.45	-1	-6	5	1
Korea (Won)	242.7	730.67	782.41	799.42	808.34	201	7	2	1
China (Renminbi)	4.7912	5.334	5.5076	5.758	8.5616	11	3	5	49

Source: Dataquest (March 1994)

Regional Forecast Assumptions

The following sections describe the main forces that drive the CAD/CAM/CAE/GIS forecast.

Worldwide Forecast Drivers

The worldwide CAD/CAM/CAE/GIS market will maintain steady growth during the next five years. Table 3 provides GDP/GNP growth rates for countries worldwide. Table 4 shows the worldwide forecast by region.

Table 3
GDP/GNP Growth Rate Percentages (Constant Prices and Exchange Rates, Local Currencies)

	1993	1994	1995	1996	1997	1998
North America						
Canada	2.6	3.6	3.7	3.3	3.0	3.0
Mexico	0.7	3.0	4.0	5.0	5.0	5.0
United States	3.0	3.9	3.0	3.4	3.0	2.8
Europe						
Austria	-0.7	1.2	2.5	2.9	3.1	3.1
Belgium	-1.4	0.7	2.1	2.4	2.5	2.7
Denmark	-0.3	1.9	2.3	2.8	3.1	3.4
France	-0.8	1.0	2.3	2.8	3.0	3.2
Germany	-1.4	1.0	1.9	2.5	3.4	3.6
Italy	-0.4	1.6	2.4	2.5	3.0	3.4
Netherlands	-0.1	1.0	2.1	2.5	2.8	2.8
Norway	1.3	2.4	2.9	3.1	2.9	2.8
Spain	-0.9	1.0	2.2	2.5	3.7	4.0
Sweden/Finland	-2.4	1.4	2.1	2.3	2.5	2.8
Switzerland	-0.6	1.2	1.9	2.2	2.4	2.5
United Kingdom	1.9	2.5	2.7	3.0	2.8	2.6
Asia						
Japan	0	0.4	2.0	3.0	3.8	3.5
China	11.5	13.0	12.0	11.0	10.0	9.0
Hong Kong	5.3	5.0	5.0	5.0	5.0	5.0
Korea	5.2	6.5	6.5	6.5	6.5	6.5
Singapore	9.2	7.0	6.5	6.5	6.5	6.5
Taiwan	6.2	6.5	6.5	6.5	6.5	6.5

Source: The Dun & Bradstreet Corporation (February 1994)

Table 4
CAD/CAM/CAE/GIS Worldwide and Regional Revenue Forecast, All Applications and All Platforms (Millions of Dollars)

	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1993-1998
Worldwide								
Software Revenue	4,835.9	5,189.2	5,614	6,101	6,668	7,288	7,885	8.7
Total Factory Revenue	16,086.0	16,481.3	17,342	18,449	19,851	21,532	23,222	7.1
Seat Shipments	651,874	731,129	797,900	871,800	953,000	1,035,500	1,111,900	8.7
North America								
Software Revenue	1,629.3	1,804.5	2,008	2,240	2,516	2,825	3,120	11.6
Total Factory Revenue	5,482.4	5,794.6	6,325	6,955	7,747	8,681	9,612	10.7
Seat Shipments	265,829	310,088	343,100	379,900	420,400	463,100	504,100	10.2
Asia								
Software Revenue	1,372.6	1,496.6	1,590	1,687	1,808	1,950	2,094	6.9
Total Factory Revenue	4,586.5	4,740.8	4,902	5,081	5,333	5,681	6,045	5.0
Seat Shipments	158,642	165,704	175,000	184,500	196,200	209,500	222,800	6.1
Europe								
Software Revenue	1,708.6	1,755.2	1,863	1,995	2,139	2,281	2,412	6.6
Total Factory Revenue	5,582.6	5,502.6	5,620	5,853	6,137	6,461	6,783	4.3
Seat Shipments	208,211	233,697	255,200	278,800	303,300	325,300	343,100	8.0
Rest of World								
Software Revenue	125.5	132.9	153	178	205	232	258	14.2
Total Factory Revenue	434.6	443.3	495	561	634	710	783	12.0
Seat Shipments	19,192	21,639	24,700	28,700	33,100	37,700	41,900	14.1

Source: Dataquest (April 1994)

The following factors influence the entire CAD/CAM/CAE/GIS worldwide forecast.

Technology

Computing performance is continuing to improve at an exponential rate. The resulting technological improvements drive further demand for improved software solutions. The cycle continues.

Indispensability

As complexity increases in both the design and the design process, the benefits of automation improve dramatically. This, coupled with market pressures to produce higher quality and to reduce production cycle time, is making CAD/CAM/CAE/GIS a necessity.

Late Buyers

A significant pool of untapped users still exists in mechanical, AEC, and GIS applications, driving additional growth. These conservative buyers will favor market leaders and installed systems for compatibility. For vendors, therefore, the value of high market share and customer satisfaction will increase.

Desktop Dominance

The turf war for desktop dominance is building steam with the introduction of the Pentium chip and Windows NT, which will fight to take market share from the higher-priced, multiple UNIX operating systems with RISC technology. The decline of host-dependent systems also is continuing, with replacements going to networked, desktop systems. Vendors, whose business models depend upon high-priced workstations, are threatened by these powerful new PCs. At the same time, the replacement of host systems provides them with opportunity for growth.

Unbundling of Software

With software vendors porting to multiple platforms, software is no longer the hinge upon which hardware swings. The market is quickly moving from proprietary to open systems, resulting in a shift from bundled to unbundled software.

Replacement Market

The replacement market is gaining importance as replacement seats exceeded 50 percent of unit sales in 1993. This saturation implies that many parallel manual systems can be eliminated and new applications developed, since everyone in a company needing access to the engineering database can have it in electronic format. The savings potential is tremendous. This also implies a growing sophistication in buyers that are more informed of the strategic importance of this technology.

Mergers and Acquisitions

The continuing lust for market share, the increased demand for better software solutions, and the pressure to develop new channels of distribution are driving a parade of acquisitions and mergers.

North American Forecast Drivers

North America CAD/CAM/CAE/GIS software revenue grew a robust 10.8 percent to $1.8 billion in 1993 and is forecast to have an 11.6 percent CAGR through 1998 to $3.1 billion. The following paragraphs describe the main factors driving the North American forecast.

Economy

According to The Dun & Bradstreet Corporation's quarterly survey of business expectations, sales optimism is up and the profits index is up in North America. No dramatic impact is expected in 1994 from the North American Free Trade Agreement, which will gradually strengthen the economies of all three trading partners. The improved economic conditions in the United States are expected to be the engine of growth for this year.

Capital Spending

Capital spending on equipment is expected to receive a 12 percent boost this year. However, in this climate of slow sales growth, corporations are expecting a return on their investment in the form of higher and more immediate cost savings.

Cuts in Defense Spending

Cuts in defense spending will tend to soften the market. However, a focus on fewer, more sophisticated weapons systems will promote use of the latest design optimization and simulation capabilities.

European Forecast Drivers

For three years Europe was the No. 1 region in CAD/CAM/CAE/GIS total factory revenue. Since Germany accounts for 35 percent of the European market, Germany's economic struggle is affecting the size of the entire European market, which is once again No. 2 with $5.5 billion. North America, with $5.8 billion, has regained the No. 1 spot. However, improvements in the other European economies are expected to ripple through the German economy for the long-term benefit of all.

The following paragraphs describe the main factors driving the European forecast.

Troubled Germany

The German economy has been under enormous stress during the past two years. The burdens of the merger between the former East and West Germany has diverted far more resources than anticipated and the unresolved status of the social welfare system has reduced Germany's global industrial competitiveness. Business optimism among German managers is likely to remain at low levels until export markets show strong gains and domestic consumption picks up.

Business Optimism

Overall expectations for higher sales, profits, and selling prices continue to rise in the rest of Europe. Business leaders in the United Kingdom believe that the recession has ended and a patchy recovery is in progress. Spain has experienced a remarkable recovery of business optimism. Lower

interest rates in France have positively impacted that country's optimism. And the results of Italy's election also give rise to hopes of investment activity in the public sector, probably aided by a series of privatization of some of the large publicly held institutions.

Currency

One major problem that seriously affected our forecast for 1993 was the exchange rate fluctuation. On average it had an 11 percent negative impact on the European market, and even 29 percent in the case of Italy. These exchange rate fluctuations are unpredictable and continuing and, together with continuing political uncertainty in central and eastern Europe, add to the confusion in Europe.

Asian Forecast Drivers

The Asian CAD/CAM/CAE/GIS software market grew 9.0 percent to $1.5 billion for 1993 when measured in U.S. dollars. However, the software market in Japan declined 4.4 percent when denominated in yen. With Japan constituting about 90 percent of the Asian market, the appreciation of the yen against the dollar impacts the Asian growth rate considerably.

The following factors influence the Asian forecast.

Japan's Troubled Economy

The economic news from Japan remains grim. A Sanwa Bank survey of 142 companies reported that profits for the next year will be only about 10 percent of those in fiscal 1989, the final year of the "bubble" economy. This drop in profits is driving a drop in capital investment spending from 10 percent to 20 percent. This is the third straight year for a drop in capital investing. Recovery is not expected until fiscal 1995.

Growth in Other Asian Countries

According to Kenichi Inada, an emeritus professor of economics at Osaka University, economic growth in the other Asian countries is taking over some of Japan's economic growth potential. A Sanwa Research Institute survey reports that Japan will lose 5 percent of its manufacturing jobs as manufacturing moves offshore. China, Hong Kong, Korea, Singapore, and Taiwan will all benefit from Japan's beleaguered economy.

Currency

The 12 percent depreciation of the dollar against the yen exerts pricing pressure on Japanese goods in competition with U.S. goods. If the currency were to remain stable for the rest of 1994, there would be an additional 4 percent depreciation to add to this cauldron of price competitiveness.

Replacement Market

The capital spending cuts of Japanese companies will drive a large replacement market. Competitive pressures will drive companies to finally purchase long-delayed upgrades to their computer equipment.

Application Forecast Assumptions

The expected growth in the next five years in GIS, ECAE, and IC applications is adding significantly to the total growth of the industry while growth of the mechanical applications has slowed to less than the industry growth (see Table 5).

Mechanical Forecast Assumptions

The mechanical application area is the largest of the CAD/CAM/CAE/GIS market, with 46 percent share of software revenue and software revenue growth of 7.4 percent forecast for 1994. The main issues driving the mechanical forecast are detailed in the following paragraphs.

Indispensability

As mechanical CAD/CAM/CAE technology reaches its 25th year of commercial application, the indispensability factor continues to ratchet higher. Many examples of large and small manufacturing companies are strategically striving to implement and integrate this technology. The realization of a potential competitive advantage is the fundamental driver behind the steady evolution of mechanical CAD/CAM/CAE. Continued maintenance and enhancement of this competitive edge, in the face of varied economic forces, is the basic challenge ahead.

Information Highway

The impact of global high-speed data communications is having a positive impact on the utility of mechanical CAD/CAM/CAE applications. Corporate- and industry-sponsored cooperation will lead the development of this activity for international manufacturing operations.

Table 5
CAD/CAM/CAE/GIS Software Revenue Growth by Application (Millions of Dollars)

	1992	1993	1994	1995	1996	1997	1998	Growth (%) 1992-1993	CAGR (%) 1993-1998
Mechanical	2,233	2,391	2,568	2,746	2,916	3,080	3,234	7.1	6.2
AEC	755	830	899	979	1,067	1,157	1,235	9.9	8.3
GIS/Mapping	588	657	737	838	947	1,065	1,186	11.7	12.5
Electronic Design Automation	1,260	1,311	1,410	1,538	1,738	1,986	2,230	4.1	11.2
Electronic CAE	740	787	857	932	1,048	1,191	1,330	6.3	11.1
IC Layout	228	234	263	310	381	473	567	2.5	19.4
PCB/Hybrid/MCM	291	290	289	296	309	322	333	-0.3	2.7
All Applications	4,836	5,189	5,614	6,101	6,668	7,288	7,885	7.3	8.7

Source: Dataquest (April 1994)

Replacement Market

More than half of new systems sales are being used to replace retired hardware and software. This technology refreshment is essential to the future success of any CAD/CAM/CAE operation. Planning this upgrade path for most system managers is perhaps the most important decision to be made.

Downsizing

Recent downsizing has softened market demand for low-cost systems for part-time users. Older systems are being deployed to these less-demanding users, maintaining direct compatibility with existing systems.

Mass Appeal

CAD for the masses, namely AutoCAD, is evolving with the basic expectations of the market. Thousands of people will get access to solid modeling and advanced surfacing capability in the next two years. As the value of these features become well utilized, another wave of product enhancement will follow, increasing the level of expectation for ease of use, product simulation, and testing.

Standardization

The maturing MCAE market is solidifying opportunities for the large systems integration suppliers as well as the niche solution developers. Strong product development during the last few years has produced many new product families that work together more effectively with more predictable results. Partnerships at this level are becoming more important. We expect this trend to continue with common user interfaces, integrated databases, and enhanced simulation capability becoming the norm.

Tool Development

A related element of growing importance is the geometric tool kit. Spatial Technology, Ricoh, Computervision, and others are working hard to promote this concept. The movement has reached critical mass and will evolve to a more influential force in the industry. This could reduce the cost of development for next-generation application development.

Product Data Management (PDM)

PDM is identified as one of the hottest application areas in support of the enterprise. PDM should be viewed as a positive multiplier in understanding the value of the use of CAD/CAM/CAE tools. It is a key element in making concurrent engineering a reality in an electronic environment. Use across the enterprise is the goal.

AEC Forecast Assumptions

The AEC application area is expected to have software revenue growth of 8.3 percent in 1994. Factors that should contribute to the long-term expansion of the AEC CAD market are detailed in the following paragraphs, in decreasing order of importance.

Low Market Penetration

A significant pool of untapped users still exists, particularly in regions where developing economies require new infrastructure construction. The

current relatively low market penetration of AEC CAD systems should allow steady worldwide growth during the next five years.

Large End Users Want More

Large design-and-build companies are growing at the expense of design-only companies. These large end users are demanding a new generation of design products that help reduce risk and uncertainty in construction.

Also, the owners of new construction are demanding electronic design data in a form that will help them manage and upgrade their facilities while meeting growing government regulations on those facilities. These owner operators increasingly will require their employees and suppliers to adopt more sophisticated automation tools in the design and construction process.

Partnering

Designers in the AEC industry are finding themselves in markets that are more regionally and globally competitive, markets that favor partnering across design disciplines. Smaller design companies increasingly will buy CAD systems, or risk being dropped from consideration as a partner.

CAD as a Sales Tool

CAD purchases can increasingly create a competitive advantage during sales negotiations and design reviews. The architect who cannot produce the fourth iteration of a proposed design before signing up a client will lose out to the group that can use changes in a proposal to gradually ratchet a prospect toward closure.

CAD Addresses Regulatory Requirements

Design documentation increasingly is used in North America to support regulatory requirements. European environmental legislation, effective by the end of the century, will result in redesign in the process industry, which will have a positive effect on the growth rates for plant design and management systems.

The trends detailed in the following paragraphs will inhibit growth in the AEC CAD industry.

AEC Is Not Manufacturing

AEC's one-design-one-build structure means CAD provides fewer economic benefits to these users than does the one-design-build-many structure of manufacturing. Construction, which is essentially a prototype build, is fraught with uncertainties and delays that are hard to control using design systems as they exist today.

Lack of Standardization

Much of the AEC industry is not structured to take advantage of shared electronic design data. Projects often involve several companies, each representing a different aspect of the design and construction process. These discrete and often competing companies also may have different CAD systems, resulting in multiple inhibitors to communication.

Low-Cost Solutions

Because most AEC design is still focused on drafting, which requires relatively little computing power, PC-based growth will be strong for the foreseeable future. PC-based solutions produce less revenue than do other platforms.

Attitudes

Attitudes of potential users inhibit market growth. Many experienced architects resist change in both the design and construction process. As this self-destructive mode erodes the viability of the profession, the CAD market is also impacted because many architects who were once prospects for CAD systems are now simply unemployed.

Europe

Long-term AEC growth partly depends on availability of public sector funds, which are depressed by the huge budget deficits of most European governments. An exception is Germany, which had to invest heavily in housing and infrastructure in the east after reunification. Italy will be interesting to watch this year because it has just elected a right-wing government holding a clear majority. Growth for AEC solutions in Italy now depends on the government's plans to privatize certain parts of the public sector, and on how quickly the country is able to recover from the corruption scandals.

GIS/Mapping Forecast Assumptions

The GIS/mapping application segment continues to have high growth, with software revenue growth forecast of 12.2 percent in 1994. Factors that should contribute to the long-term expansion of the GIS market are described in the following paragraphs, in decreasing order of importance.

Low Market Penetration

Penetration is still low among core users. Bread-and-butter prospects in government and utilities are charged with maintaining information on land and assets in perpetuity. Many of these prospective buyers are still using paper maps, which will degrade over time. This creates a certain inevitability to moving from paper maps to the more readily changed and renewed computer maps—which is a first step to building a GIS system. A large number of utilities and sovereign and local governments all over the world still are stuck with tabular data and paper maps; the supply of prospective buyers remains plentiful.

Technological Advances

Several new technologies will drive growth in the GIS market. Faster, cheaper computers will be continually leveraged to support new software products. Widespread computer industry developments in open, distributed systems supporting high-speed networking will make it possible for GIS technology to broadly expand the user base. Advances in aerial photography, global positioning systems, and laser range finders are making it possible to create GISs significantly more accurate and complete than existing paper maps, giving experienced users some compelling reasons to reinvest. Lower-cost, higher-resolution satellite imagery holds the

potential to drive another explosion in GIS market growth among new users who cannot afford aerial photography. Portable and pen-based computers are bringing GIS to new users in field operations. Although many markets will take advantage of these technologies, few other markets are as ready, willing, and able to put to work such a wide range of technology enhancements.

New Applications

New applications in the private sector will drive growth. Wherever there is competition for a limited prize, GIS can create a competitive edge. Wherever assets or investments are geographically dispersed, GIS offers significant management capabilities. However, we see a wide band of uncertainty surrounding the clearly growing revenue opportunity from new applications. Several new applications in GIS are destined to become a relatively low revenue-producing feature in another software program (and market), rather than a standalone product in the GIS market.

Accumulating Data and Knowledge

Building a GIS will get somewhat easier and cheaper. Inexpensive spatial data, both public and private, is accumulating, and its reuse will help dissolve a traditional obstacle to growth in GIS. This increasingly accurate knowledge base can be passed on to new users. Successful multiparticipant projects are growing, creating larger data sets that can be profitably resold by government and industry consortia. Also, although we do not envision the technology miracle that will eliminate development costs, implementation of GIS in new sites is regularly getting easier and cheaper.

Solution to Known Problem

GIS addresses the information age's growing problem of information overload. Any product that addresses a visible problem is more certain to grow than are solutions still looking for the problem.

Governmental Policy

Governments are recognizing their role in helping the GIS market grow. GIS is one of the rare markets where relatively simple government action can directly fuel industry growth. In fact, the GIS industry depends on government cooperation for land base data development. Governments all over the world are beginning to realize they can create a competitive advantage for their citizens by changing policies that obstruct GIS market development.

Europe

European copyright laws will continue to inhibit GIS growth by limiting the handling and acquisition of digital map data. There is now pressure from the business community to modify these laws to make them similar to U.S. copyright laws, opening the market to greater availability of digital map data at lower costs. The European initiatives such as IMPACT and EUROGI are addressing standards and data availability. Consortia such as European Geographic Technologies (EGT) and the European Digital Road Map Association (EDRA) are about to complete all-digital road maps of Europe. The European Community's Centre for Earth Observation (CEO)

program will encompass both satellite and nonsatellite data, contributing to a wider European Earth Observations System (EEOS) alongside systems planned by the European Space Agency (ESA), NASA in the United States, and NASDA in Japan. This improvement in the European data bottleneck provides reason for optimism in European GIS.

The several factors described in the following paragraphs seriously constrain the long-term expansion of the GIS market.

High Cost

There will remain an uncertain, but certainly high, cost of creating a working GIS system in traditional environments. No magic will emerge to create a low-cost, meaningful data set for mainstream customers in government and utilities. Data conversion will remain costly because the significant cost of correcting prior errors and omissions on paper maps is inevitably bundled into the cost of "conversion."

Negative Reputation

Stuck projects will reduce market growth. The negative publicity created by troubled projects chills the buying impulse among nonusers, reducing the ability of GIS projects to compete with other applications for capital equipment dollars.

Price Pressure

Price pressure will hold down total revenue. Computer prices will certainly drop, even in technical applications such as GIS where higher-performance hardware will command a premium price. Software prices are likely to come under increasing pressure, despite the industry's current ability to hold overall seat prices relatively even.

Electronic Design Automation (EDA) Forecast Assumptions

The EDA application segment is the second largest, as a whole. With forecast growth of 7.5 percent in software revenue to $1.4 billion in 1994, the longer term view is one of accelerating growth, with an anticipated five-year CAGR of 11.2 percent to $2.2 billion. Factors that should contribute to the long-term expansion of the EDA market are described in the following paragraphs, in decreasing order of importance.

Economy

The economy is a driving force in the EDA market. Therefore, Germany and Japan are the millstones holding back the growth expected in the electronic markets, while North America and the United Kingdom will be leading the charge.

Telecommunications

Growth in the telecommunications industry will continue to drive sales in the EDA market. This will continue to influence growth in the top-down, DSP, and high-speed design sectors.

Service Becomes the Victim of Cost-Cutting

Service revenue will become flat in the short term as smaller electronics companies cut costs by canceling their maintenance contracts.

Europe

Defense equipment expenditure is unlikely to reduce further during the next 2 years, despite the end of the cold war, as equipment still needs replacing after the Gulf War and armed forces continue to trade personnel for technology (smart bombs, communications equipment, and missiles). Also, armed forces need to reorient their equipment for rapid response in preparation for current and future threats in urban and desert scenarios. This will help France, the United Kingdom, Italy, and Germany, in that order.

Electronic Computer-Aided Engineering (ECAE) Forecast Assumptions

The EDA application segment is further divided into three segments. The ECAE market is expected to grow 8.9 percent to $857 million software revenue in 1994 with a five-year CAGR of 11.1 percent to $1.3 billion in software revenue in 1998. Factors that should contribute to the long-term expansion of the ECAE market are described in the following paragraphs.

Increasing Complexity

The increasing complexity of today's designs will create demand in the ECAE market by driving migration from the gate-level design methodology to the higher-cost Register Transfer (RT)-level methodology. Today's power users will migrate from the RT level of the even higher-cost Electronic System (ES)-level tools.

ESDA

With power users migrating to ES-level tools, growth is healthy and expected to stay that way for Electronic System Design Automation (ESDA), trailing off toward the end of the decade. ESDA is the smallest part of the market, but it will experience the highest growth.

Equalization

The price of PC software is rising as its power expands toward the potential of the Windows NT operating system. The price of workstation software is dropping to drive demand for the higher-powered UNIX-based software at a time when the lower-cost, high-powered NT solutions are coming to market. Consequently, the cost of software for Windows NT and for UNIX is converging or equalizing.

Hardware Prices Respond

Meanwhile, the software battle is driving demand for increased memory and hotter systems (with graphics accelerators and floating-point processors, among others) leading to higher costs. Hardware revenue will rise in both the PC and workstation markets.

Floating Licenses

The use of floating licenses has proved to be a greater problem than CAD managers expected. Although some tools are only used for limited times during the design process (such as design for test tools), they tend to be needed by everyone at the same time. As a result, floating licenses are not the cost-saver that companies anticipated.

Europe

Workstation sales will be dominated by replacement software because of technological obsolescence and vendors going out of business.

Analysis Tools

Demand for tools such as thermal analysis, transmission line simulation, and EMC analysis is being driven by the fact that after 50 MHz, the world is no longer flat and digital but starts to look three-dimensional and analog. This demand will drive workstation growth during the next year, with strong growth during the following 2 years.

IC Layout Forecast Assumptions

The IC segment of the EDA market is the smallest but fastest growing. Growth is expected to be 12.6 percent in software revenue in 1994 to $263 million, and a five-year CAGR of 19.4 percent in software revenue to $567 million is forecast. Factors that should contribute to the long-term expansion of the IC market are described in the following paragraphs.

Complexity

The complexity of IC designs is increasing almost exponentially, driving demand for more sophisticated tools at higher costs. It is also becoming critical in designs of more than 80 MHz for place and route to be accomplished on site, driving demand for more tools. This revenue growth will increase through the 1990s.

Technical Workstations

The PC, even with the Pentium chip and Windows NT operating system, is incapable of handling most IC layout jobs. There remains some PC use in Asia and Rest of World, but North America and Europe use exclusively technical workstations for this work.

Servers

This could be the major growth area for computer servers. As design jobs are becoming larger, more computer resources are required. One solution is for high-end compute servers; another, for a server farming out jobs to a bank of workstations.

Europe

Multinational semiconductor companies will continue to get closer to their customers in Europe by increasing their design in Europe. This will boost IC layout and somewhat boost CAE sales.

PC Board/MCM/Hybrid Forecast Assumptions

The PC board (PCB) segment of the EDA market is forecast with negative growth for the next two years. The longer-term view is for software revenue to grow with a five-year CAGR of 2.7 percent to $333 million in 1998. Factors that should contribute to the long-term expansion of the ECAE market are described in the following paragraphs.

Mixed Bag

With PCB tools mixed between low-cost, PC-based systems and high-cost workstation-based systems, clear trends are clouded. Market dominance

depends on what is counted. Unit shipments of PCs exceed those of workstations, while the highly competitive workstation software market is four times that of PCs.

Uncertainty on the Desktop

It is clear that this market will show marked change in the next few years as Windows NT provides additional opportunity for technological advances on the PC platform. But how it will change is yet unclear. In addition to equalization, there is emerging a pattern of channelization: as UNIX software prices decline, companies are exploring lower-cost sales channels to compete price-wise with PC solutions.

Europe

PC-based PCB has a healthy future in Europe during the next two years. Small and medium-size companies will be the first to resume spending after the recession. These users predominantly favor the lower-cost PC solutions.

Dataquest Perspective

The strategic nature of this market is constantly pushing it forward. New applications, new technology, and new competitive pressures are forcing invention, integration, and involvement at an increasing rate. Virtually every CAD/CAM/CAE/GIS tool being used today will be obsolete in three years. All of these products will be enhanced, upgraded, replaced, or retired as the technology moves forward. Industrial giants to mom-and-pop businesses are all involved. Every manufacturing operation, government agency, and educational institution has heard the word. Once the purview of industry experts, CAD/CAM tools are becoming as common as air bags and antilock brakes. Once everyone that needs access to these tools has access on a regular basis, the market will just then become a new beast.

Remember, 1984 was the first year AutoCAD gained some recognition as a basic CAD supplier. Ten years later, Autodesk shipped its one millionth seat. The next 10 years will easily witness more dramatic changes in the tools brought to market and the environment where the tools are used.

By Linda Anderson

For More Information...
Linda Anderson, Market Research Analyst ..... (408) 437-8135
Via fax ..... (408) 437-0292

Dataquest
a company of The Dun & Bradstreet Corporation

Guides

Dataquest