Perspective

Mechanical CAD/CAM/CAE Worldwide

Competitive Analysis

Mechanical Applications Landscape

Abstract: *This Perspective outlines the 1997 mechanical CAD/CAM/CAE market by subapplication and vendor. Subapplication definitions and players under each category are identified.*
By Sharon Tan

Mechanical CAD/CAM/CAE Market by Subapplication

To gain a better understanding of what specific areas are driving market growth, Dataquest further subdivides the mechanical CAD/CAM/CAE market into a number of subapplications. These technology-based subapplications have been monitored over the years to give an up-to-date picture of where users are spending their CAD software dollars. Today, Dataquest tracks 12 subapplications within the mechanical CAD/CAM/CAE realm. This Perspective defines the subapplications and outlines the vendors participating in each area. Generally speaking, companies must have a minimum of $2 million in revenue to appear in our database, although we do make exceptions on a case-by-case basis. As always, comments and corrections are welcomed.

Subapplication Definitions

Computer Aided Design—CAD

- Design applications—Software applications used in the design of components and assemblies from conceptual design to detail design. This subapplication includes software for styling, conceptualization, assembly modeling, component design, and manufacturing tool and fixture design.

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CAM

Manufacturing Process Simulation

Numerical Control

Adra Systems
Anilam Electronics
Applicon
ASCAD
CG Tech
Cimatron
CNC Software
Computervision
Dassault Systemes/IBM
Delcam International
Deneb Robotics
DP Technology
EDS Unigraphics
Exapt
First Cadcam
Gerber Systems
Gibbs & Associates
Han Dataport
Hitachi Zosen
ICEM Technologies
Intergraph
Matra Datavision
MCS
MICROCADAM
NEC
Nihon Unisys
Parametric Technology
Pathtrace Engineering
Radan Computational
SDRC
Sescoi
Sharp
Straessle Informationssysteme
Surfware
Toshiba
Vero International Software

Part Processing Design

Dassault Systemes/IBM
DP Technology
EDS Unigraphics
Exapt
Intergraph
Matra Datavision
Parametric Technology
SDRC
Straessle Informationssysteme
Tecnomatix

Other Manufacturing Applications

Coordinate Measuring Machines

Dassault Systemes/IBM
Delcam International
Matra Datavision
Parametric Technology

Off-line Robotics

Dassault Systemes/IBM
Deneb Robotics
Tecnomatix

MISC.

Other

Knowledge-Based Engineering Tools

Concentra
Stone & Webster

Application Development Environments

Computervision
Dassault Systemes/IBM
EDS Unigraphics
Matra Datavision
Parametric Technology
SDRC

Product Data Management

Agile Software
Applicon
ASCAD
Autodesk
Autotrol B.A.
Intelligence Networks
BCT GmbH

Product Data Management (cont.)

Bentley Systems
CMstat
CoCreate/Hewlett-Packard
Computervision
ConsenSys Software
Contact GmbH
Dassault Systemes
EDS Unigraphics
Eigner + Partner
Formtek
IBM
ICEM Technologies
Intergraph
ISD Software
Matra Datavision
MatrixOne
Metaphase/SDRC
MICROCADAM
NEC
NovaSoft
PAFEC
Parametric Technology
PROCAD GmbH
Sherpa
Smart Solutions
Straessle Informationssysteme
Toshiba
Wiechers Datentechnik
Workgroup Technology

Component Information Systems

Aspect Development
Autodesk
CADIS
IHS

97687-4

The Mechanical CAD/CAM/CAE Landscape

CAD

Design Applications

- 3D/Eye
- Adra Systems
- Alias Research/SGI
- Applicon
- ASCAD
- Autodesk
- Baystate Technologies
- Bentley Systems
- CAD Distribution
- Cad.Lab
- Cimatron
- CIMLINC
- CoCreate/Hewlett-Packard
- Computervision
- Dassault Systemes/IBM
- Delcam International
- DP Technology
- EDS Unigraphics
- Gerber Systems
- Han Dataport
- Hitachi Zosen
- ICEM Technologies
- ICL
- Intergraph
- Investronica SA
- ISD Software
- Kubota Computer
- Matra Datavision
- MCS
- MICROCADAM
- NEC
- Nihon Unisys
- Parametric Technology
- PROCAD GmbH
- Radan Computational
- SDRC
- Serbi
- SolidWorks
- Straessle Informationssysteme
- Tebis
- Tecnomatix
- Toshiba
- Variation Systems Analysis
- Vero International Software
- Wiechers Datentechnik
- Ziegler Informatics

Drafting and Documentation

- 3D/Eye
- Adra Systems
- Applicon
- ASCAD
- Ashlar
- Autodesk
- Autotrol
- Baystate Technologies
- BCT GmbH
- Bentley Systems
- CAD Distribution
- CADIX
- Cad.Lab
- Cimatron
- CIMLINC
- CoCreate/Hewlett-Packard
- Computervision
- Dassault Systemes/IBM
- debis Systemhaus
- Delcam International
- Design Automation
- EDS Unigraphics
- Gerber Systems
- Graphtec Engineering
- Han Dataport
- Hitachi Zosen
- ICEM Technologies
- Intergraph
- ISD Software
- Just In Time Systems
- Kubota Computer
- Matra Datavision
- MCS
- MicroCADAM
- NEC
- Nihon Unisys
- Omron
- PAFEC
- Parametric Technology
- PROCAD GmbH
- Radan Computational
- SDRC
- Serbi
- Sharp
- SolidWorks
- Straessle Informationssysteme
- Tebis
- Technische Computer
- Toshiba
- Viagrafix
- Wacom
- Whessoe Computing
- Wiechers Datentechnik
- Ziegler Informatics

CAE

Analysis

- Adam Net
- Adina
- Algor
- Altair Computing
- Ansys
- CADSI
- Computational Mechanics
- Computervision
- CSAR Corporation
- Dassault Systemes/IBM
- EDS Unigraphics
- Engineering Mechanics
- ESI Group
- Framasoft
- Hitachi Zosen
- ICEM Technologies
- Intergraph
- Livermore Software
- MacNeal-Schwendler
- MARC
- Matra Datavision
- MCS
- Nihon Unisys
- Parametric Technology
- SDRC
- SRAC
- Toshiba
- Variation Systems Analysis
- Whessoe Computing

Linkage/Mechanism

- CADSI
- Computervision
- Dassault Systemes/IBM
- EDS Unigraphics
- Mechanical Dynamics
- Parametric Technology
- SDRC

- Drafting and documentation—Representation of a part in standard geometric drafting format, including all part geometry dimensions and notations describing mechanical, functional, and material characteristics. This also includes schematics and technical illustration.

Computer Aided Engineering—CAE

- Analysis—Analysis of a physical system, part, or assembly; including structural, thermal, vibrational, composite, fatigue, stack-up, and mass property analysis
- Linkage/mechanism—Motion simulation and analysis of an assembly of components with two or more movable parts

Computer Aided Manufacturing—CAM

- Manufacturing process simulation
  - Numerical control (NC) part programming—Programming of a numerical control machine tool or automated processing system
  - Part processing design–Design of a series of manufacturing steps
- Other manufacturing applications
  - Coordinate measuring machines—Programming of machines used to measure the physical dimensions of a part
  - Offline robotics—Process simulation that represents the sequence of steps to program a robot for a particular operation and downloads data to a robot to update its control program

Other Tools

- Knowledge-based engineering tools—Tools used to capture design intent and build standard practices for controlling, modifying, and automating design and manufacturing activities.
- Application development tools—Programming tools to aid in the generation of user-defined programs that drive or interface with CAD/CAM/CAE applications
- Product data management—Software typically used in an engineering or manufacturing environment to manage product data. Product data management includes product structure management, workflow, and vault/document management.
- Component information systems—Software used to navigate within and manage a repository of mechanical engineering parts and associated data

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THE HOME TECHNOLOGY SCORECARD

Dataquest talks to more than 7,000 households across the United States twice per year to measure core statistics of the U.S. home personal computer, printer, and online services markets. The Home Technology Scorecard is unique, primary research on the usage, intention to purchase, length of ownership, and measurement of conversion from intention-to-purchase to actual purchase, of these digital commodities and services. It is a strategic tool for personal computer and peripheral vendors, industry investors, and consumer services providers striving to understand the U.S. home market.

Key Topics

Want to learn more about Dataquest?

Please visit ***Dataquest Interactive*** *our Internet-based information service at:* ***www.dataquest.com***

The Home Technology Scorecard program provides detailed, quantitative analysis to help clients make successful business decisions. Publications include consumer statistics, analytical articles, and focused reports published on a regular schedule throughout the year. Briefings and conference presentations bring clients together with analysts to share insights and opinions.

Key home technology topics covered will include:

- How large is the U.S. home market for PCs?
- Who will be the next prospect for their first PC purchase?
- Are the households with intent to purchase a PC actually buying?
- How does stated intent to purchase convert to actual sales within the various consumer demographic segments in the U.S.?
- Which household income levels have the largest intent to purchase?
- What consumer segments offer the greatest growth potential?
- Are young buyers entering the U.S. home PC markets?

Market Coverage

Dataquest's consumer statistics and growth projections are indispensable tools for strategic planners.

Consumer Statistics

Installed base in U.S. households of personal computers, printers and online services by segments:

- PC households
- PC households with intent to purchase
- Non-PC households
- Non-PC households with intent to purchase

Consumer Statistics Variables

Each of these segments will be tracked by the following variables:

- Income
- Age
- Education
- Occupation
- Family status
- Technology psychographics (attitude, values, beliefs)
- PC usage

Complementary Research

Clients may wish to invest in a complementary research program—The Digital Consumer—which provides broad, qualitative analysis on the emergence and acceptance of digital technology in the U.S. consumer market. It looks not only at PCs but at digital television, cellular phones, digital cameras and camcorders, and other emerging digital product categories.

Dataquest

Please see email again on this. Thanks

WHAT YOU WILL RECEIVE AS A CLIENT

THE HOME TECHNOLOGY SCORECARD

Perspectives

Event Summary
Product Analysis
Market Analysis
Technology Analysis
Competitive Analysis
Vendor Analysis
End-User Analysis
Channel Analysis
Dataquest Predicts

Dataquest Perspectives — ***Published Monthly Throughout 1997***

These research documents provide analysis and commentary on key consumer patterns, market opportunities, events, usage and purchase trends, and strategic issues affecting the U.S. home PC market. A minimum of 12 Dataquest Perspectives will be delivered to you on a regular schedule throughout the year. Topical in nature, these documents provide additional targeted follow-on reports and cross-tabular analysis of survey data.

Consumer Trends

Home Consumer Trends — ***Available Fourth Quarter 1996***

This comprehensive annual report provides quantitative analysis of home consumer market trends year over year. A comprehensive analysis of the current market for personal computers, printers, and online services in the home; industry performance in 1996; analysis of demand-side issues, and an assessment of vendors' major opportunities and challenges.

Inquiry Support

Personalized inquiry support is a primary component of your research subscription. You have direct access to experienced analysts who can provide fast answers to fact and data questions, as well as advice tailored to the needs of your business.

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Clients may visit Dataquest information resource libraries to perform their own research using our extensive print and online resource collections.

Consumer Statistics

Consumer Baseline Report — ***Available Fourth Quarter 1996***

This report provides the base line for the year's analysis. It is used to size the home consumer personal computer, printer, and online services installed base. Segmentation based upon owners and non-owners, with purchase intentions and without purchase intentions. Variables tracked include demographics for geographic location, consumer attitudes, prior PC purchase, future purchase intent, and acquisition adversity.

Consumer Conversion Report — ***Available Second Quarter 1997***

Original survey subjects are re-surveyed to ascertain the conversion of intent-to-purchase to actual purchase.

Special Reports

Focus Report
User Wants & Needs Report
Competitive Trends Report
Industry Trends Report
Distribution Trends Report
Company Profile Report

Targeted Segment Survey Report: — ***Available Third Quarter 1996***

This report provides an indepth analysis of a single aspect or segment of the home consumer market. The specific topic is yet to be chosen and will be driven by issues that emerge from the broader analysis described above.

Conferences and Briefings

Dataquest hosts the computer industry's most-respected conferences and briefings in locations throughout the United States, Europe, and Japan. This year's North American PC Trends conference is scheduled for May1, in San Francisco. Contact Dataquest Global Events at 1-800-899-9599 for more information (conference seat is optional).

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All of Dataquest's published research is available via DQ on Demand, our monthly CD-ROM that contains a rolling 13 months of information and statistics (CD-ROM delivery optional).

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Program Code: HTSC-US

Dates are subject to change.

MKTG 1/97 (MLG)

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Date: 6/30/97 11:42 AM
Priority: Normal
TO: Daya Nadamuni at ~FredPO
TO: Sharon Tan at ~FredPO
Subject: Cynthia Moore's automotive industry report

------------------------------------ Message Contents ------------------------------------

Could be worth re-publishing parts of this report in the MCAD service.

Product Code: PSVM-NA-DP-9704

June 16, 1997
Vertical Market Opportunities North America
Market Analysis
Cynthia Moore

Automotive Manufacturing Industry

Automakers and suppliers are facing numerous challenges for which IT solutions offer a means to counter the negative business impact and optimize the business opportunities created by trends in globalization, consolidation, and environmental and safety regulations. This market analysis links the key business issues and trends that are driving IT opportunity within the automotive manufacturing industry for technologies and related IT services. Emphasis is placed on vehicle and related parts manufacturing.

Perspective

Mechanical CAD/CAM/CAE Worldwide

Competitive Analysis

Mechanical CAD/CAM/CAE Breaks Away from the Status Quo

Abstract: *This Perspective summarizes the recent acquisitions and mergers that have taken place in the mechanical CAD/CAM/CAE market and raises questions about the impact of these events on the future mechanical market landscape.*
By Sharon Tan

Introduction

For the past five years, the mechanical CAD/CAM/CAE market has been progressing in a stable, predictable manner. The top five players were the same top five players year after year, and vendors concentrated heavily on software functionality and features.

But times have changed. The mechanical CAD/CAM/CAE market has matured, and competition has increased. This Perspective explores the recent events that are shaking up the mechanical CAD/CAM/CAE market.

The Events

In the past five months, there have been three significant events involving the top players in the mechanical CAD/CAM/CAE market. First, in late June, Dassault Systemes and SolidWorks Corporation signed a definitive agreement whereby SolidWorks was acquired by Dassault Systemes in a stock transaction valued at about $310 million. At that time, Dassault Systemes stated that SolidWorks would operate as a separate subsidiary of Dassault Systemes, maintaining its own identity, products, distribution channel, and partner programs.

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Then, in early October, Electronic Data Systems Corporation (EDS) and Intergraph Corporation announced that they signed a letter of intent to form a new company (with majority ownership by EDS Unigraphics) to address the mechanical CAD market. The new company will combine EDS Unigraphics products (including Unigraphics, Parasolids, and IMAN) and Intergraph mechanical products (including Solid Edge and I/EMS).

Finally, during the U.S.-based Autofact conference in November, Parametric Technology Corporation (PTC) announced a definitive merger agreement with Computervision Corporation in a stock-for-stock transaction valued at $260 million. The deal is expected to close in January 1998. PTC has publicly stated that it will continue to develop, maintain, and support Computervision's products, which include CADDS, Medusa, and Optegra, independent of PTC's Pro/ENGINEER product line. Computervision's debt will also be assumed by PTC.

The new mechanical CAD landscape of the leading vendors is shown in Table 1.

Table 1
The New Mechanical CAD Landscape

Company	High-End Offering	Modeling Engine	Midrange Offering	Modeling Engine
Autodesk	NA	NA	Mechanical Desktop	ACIS
Dassault Systemes	CATIA	Proprietary Dassault Systemes	SolidWorks	Parasolid
EDS Unigraphics	Unigraphics	Parasolid	Solid Edge	ACIS today; Parasolid in future release
PTC	Pro/ENGINEER	Proprietary PTC	PT/Modeler	Proprietary PTC
	CADDS	Proprietary Computervision	DesignWave	Parasolid
SDRC	IDEAS Master Series	Proprietary SDRC	Artisan Series	Proprietary SDRC

NA = Not applicable
Source: Dataquest (November 1997)

On the Surface ...

Some questions have been answered as a result of these recent announcements. For instance, two rumors that have been circulating for years are finally put to rest: When will Intergraph sell off its mechanical CAD business, and when will EDS sell off its Unigraphics business? By purchasing Intergraph's mechanical division, EDS Unigraphics reaffirmed its commitment to the mechanical CAD market, and Intergraph is now able to concentrate on its more successful AEC and GIS divisions. Similarly, Computervision has found a way to unload its debt burden (onto PTC), and Dassault Systemes now has a midrange offering with SolidWorks' products.

Food for Thought

Beyond what has been discussed thus far, quite a lot remains unclear. The following sections discuss some of the issues that will be played out in the mechanical CAD/CAM/CAE market over the next year.

Solid Modeling Engines

One of the more pressing issues surrounds solid modeling engines. Currently, Intergraph's Solid Edge runs on Spatial Technology's ACIS. Of course, now that Solid Edge falls under the EDS Unigraphics' name, ACIS will be replaced by Parasolid in that product, allowing for uniform end-to-end data exchange between UG and Solid Edge. A best-case scenario for EDS Unigraphics would be if Dassault Systemes kept the SolidWorks product family on Parasolid, Bentley Systems completed its announced switch from ACIS to Parasolid for MicroStation, and PTC didn't make any changes to Computervision's newly announced DesignWave, which uses Parasolid as its modeling core. Of the midrange packages available today, this would leave only Autodesk's Mechanical Desktop and CoCreate's Solid Designer running on ACIS, and a few solutions running on proprietary modeling cores (such as SDRC's Artisan Series).

However, this scenario is not likely. No vendor wants to give EDS Unigraphics that much potential power (to have data compatibility with that many mechanical design applications). Furthermore, one of the promises of the midrange market is for vendors to tap those CAD opportunities in the extended enterprise (with suppliers and customers, for instance). The lure of end-to-end data compatibility without translation in the extended enterprise is a strong one. Further penetration of high-end, UNIX-based mechanical design software has been limited by cost, and lower-cost midrange solutions are one way to tap that potential market. Given some time, Dataquest suspects that DesignWave and SolidWorks will not remain on Parasolid.

The Midrange Market

What will all of this solid modeling kernel switching (in Solid Edge and MicroStation) mean to end users in the midrange market? This market is still in its infancy, so Dataquest does not believe that the switch will squelch any momentum that is building in the midrange market. It will be necessary for vendors to help facilitate their respective moves to Parasolid, in terms of supplying translators and technical support to these midrange users who typically do not have large IT and/or CAD staff nor money to spend on retraining users and translating legacy data. Also, the midrange mechanical design packages use their partners as a selling point, enabling them to say that they can do it all, from CAD to CAM to CAE. Both EDS Unigraphics/Intergraph and Bentley Systems are targeting 1998 as a release date for their Parasolid-based products, giving these third-party developers some time to digest the switch.

Distribution Channels

The VAR channel is absolutely crucial to the midrange market, because the lower price of these solutions prohibit a direct salesforce. The midrange vendors have all spent time building up and maintaining a working VAR channel. In light of these new acquisitions and modeling kernel changes to come, Dataquest suspects that the VAR channel will once again be shifting, with vendors losing some VARs and gaining others.

At the opposite end of the spectrum, direct salesforces in Computervision, EDS Unigraphics, IBM (sole CATIA reseller), and PTC will have to realign themselves in light of the new midrange VAR channels. It is highly probable that areas of overlap between VARs and direct sales will arise in the future, even though vendors have stated that they expect the channels and products to remain distinct.

However, there are significant upsell and downsell opportunities for the vendors, especially in the extended enterprise for both channels. There will be those users needing to migrate up in functionality as well as opportunities for capturing new users that might not otherwise be there if there was no CAD package at their price/performance ratio.

Automotive and Aerospace

Many of the multimillion dollar investments in mechanical CAD/CAM/CAE technology occur in the automotive and aerospace accounts worldwide. Here, companies tend to strategize on one vendor as their sole CAD supplier, developing partnerships that can extend over many years. Without question, IBM/Dassault Systemes and Computervision have dominated these two industries, and EDS Unigraphics also has claimed its share of contracts. PTC has worked hard at making headway into these industries, and it can say it is a player, too, now that it has bought Computervision's showcase of aerospace and automotive customers.

Aerospace and automotive companies tend to invest in CAD technology every five to seven years, either reaffirming their commitment to their current CAD vendor or switching to someone else. Dataquest thought the investments in automotive and aerospace were finally coming to the end of their current cycle, especially in Europe.

But, in light of recent events, this may no longer be the case, and Dataquest fully expects more account shuffling, particularly in Europe. EDS Unigraphics and IBM/Dassault Systemes have the most to gain (or lose) with PTC's acquisition of Computervision. Here, we must add that PTC has acquired the Optegra product line from Computervision, giving the company a recognized enterprisewide product data management solution. Optegra will be important to PTC's success in automotive and aerospace, where data management can be as important as software features and functionality.

Dataquest Perspective

Leadership in mechanical CAD/CAM/CAE continues to consolidate among the top players, with the bigger ones offering more, and the smaller ones becoming even more specialized. The near-term effects of these acquisitions and mergers are probably minimal; it will take some time for the vendors to digest their new businesses and assess their new powers. Looking further out, these events will create waves in what has largely been business as usual in the mechanical CAD marketplace.

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Perspective

Mechanical CAD/CAM/CAE Worldwide

Market Analysis

Europe Goes from Strength to Strength

Abstract: *This Perspective provides an overview of the European mechanical CAD/CAM/CAE software market, including statistics and tables. Dataquest discusses the impact of the Western European economy on the mechanical CAD/CAM/CAE market, as well as how fluctuating currency rates influence the market. This document provides an analysis of the European mechanical CAD/CAM/CAE market by region, component, and platform.*

By Petra Gartzen

The European Mechanical CAD/CAM/CAE Market at a Glance

The following characterizes the European CAD/CAM/CAE/GIS market in 1996:

- Overall, the European CAD/CAM/CAE/GIS market grew 6.7 percent to $6.3 billion in total factory revenue in 1996. Calculated in European Currency Units (ECU), the market grew 9.7 percent.
- CAD/CAM/CAE/GIS software revenue increased 10 percent to $2.2 billion. Based on ECU, software revenue grew 13 percent.
- The largest application sector in Europe is the mechanical segment, having some 51.1 percent of the total European CAD/CAM/CAE/GIS software market. It increased 15.4 percent growth in 1996 based on ECU.
- Europe-based vendors generated only 24.5 percent of the mechanical CAD/CAM/CAE software revenue, compared with 75.5 percent generated by U.S.-based vendors.

Dataquest

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- UNIX-based software still dominates the market, accounting for nearly 74 percent of mechanical CAD/CAM/CAE software sales in Europe in 1996. By 2001, this share will decrease to 60 percent as NT-based applications gain more ground.
- The largest regional market for mechanical CAD/CAM/CAE software in 1996 was Germany, with U.S.$406 million in software revenue, representing 35.3 percent of the European market.
- The top five vendors accounted for 59 percent of mechanical CAD/CAM/CAE software revenue in 1996, compared with 55 percent in 1995. Their combined revenue increased by 23.8 percent.

Figures 1 and 2 provide a snapshot of the European CAD/CAM/CAE and GIS market as a whole, and the mechanical CAD/CAM/CAE market in particular.

Western European Economic Prospects

The Impact of European Monetary Union

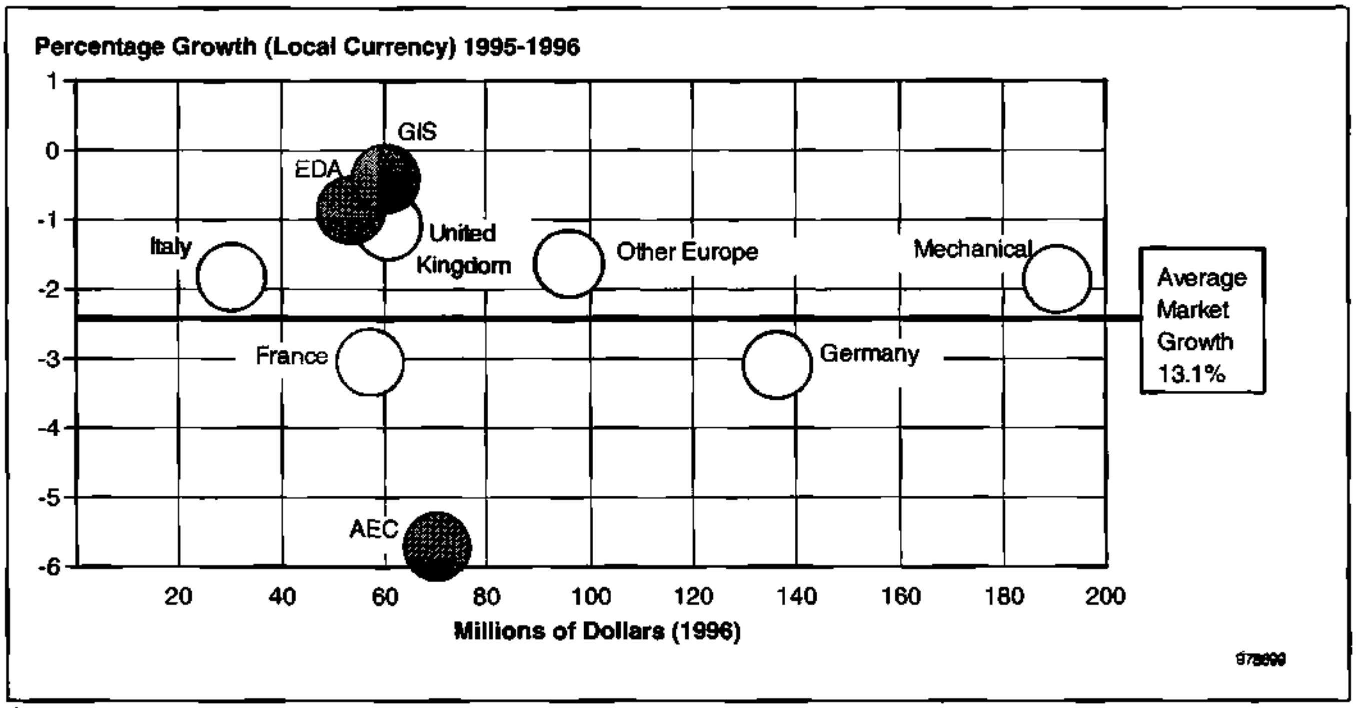
The European Monetary Union (EMU) planned for 1999 has depressed gross domestic product (GDP) growth in Europe, increasing consumer uncertainty. According to the Maastricht Treaty, for a member state to qualify for the Single European Currency (Euro), the following criteria must be met:

- The budget deficit (PSBR) must not be more than 3 percent of GDP. This criterion will be adhered to strictly as it is viewed as one of the most important factors for a stable EMU.
- The national debt stock must not be more than 60 percent of GDP, but it is believed that this will be interpreted liberally.
- The inflation rate must not be more than 1.5 percent above the average of the three lowest inflation rates.

The immediate result of countries attempting to meet convergence criteria is a restriction on their ability to grow and develop their economies according to national customs. Visible symptoms of convergence are as follows:

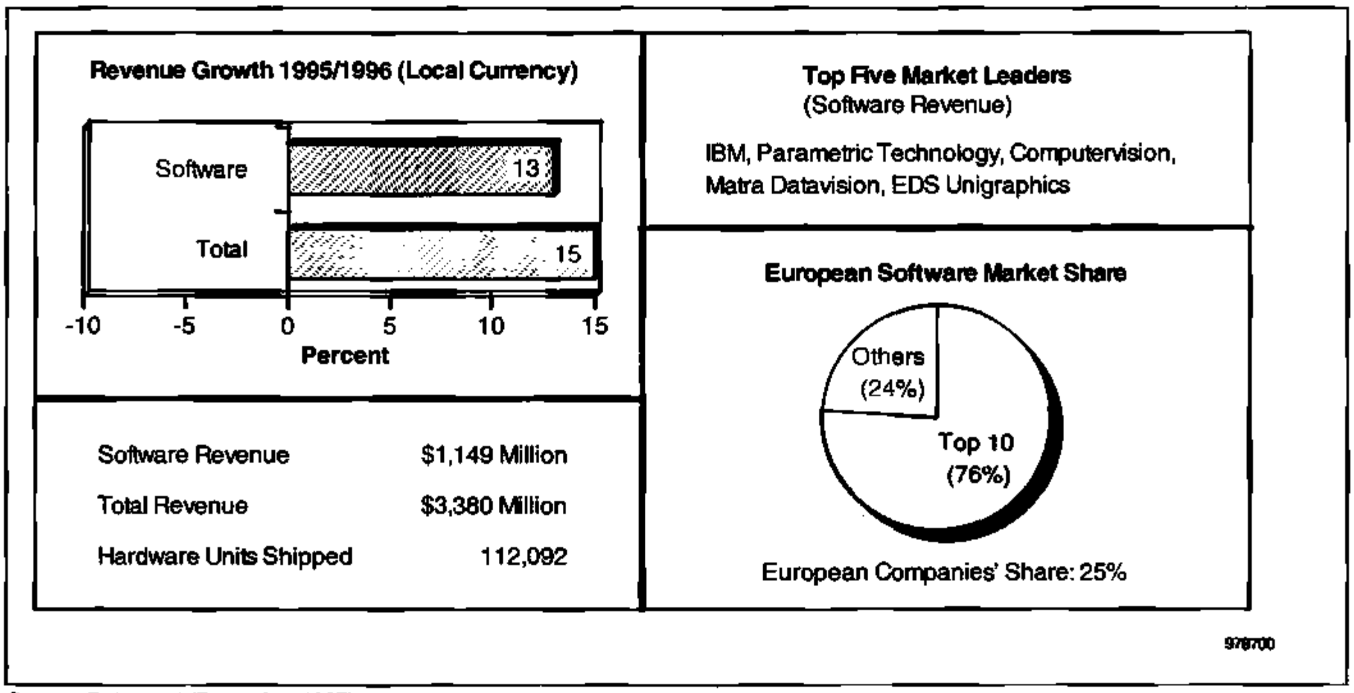
- Suppression of governmental/public sector spending
- Decreasing consumer confidence and spending
- Increasing unemployment (Germany recently reported the highest postwar unemployment level)
- Lower employment and spending and its consequent direct and indirect taxation revenue
- Increased social welfare costs driven by increasing unemployment benefit expenditure
- Restrained corporate investment and professional spending

Figure 1
European CAD/CAM/CAE/GIS Software Market Portfolio



Source: Dataquest (December 1997)

Figure 2
European Mechanical CAD/CAM/CAE Market Snapshot



Source: Dataquest (December 1997)

The criteria must be met by January 1, 1999, the intended implementation date of the European Monetary System (EMS). Although France and Germany are the two leading proponents of EMU, there is disagreement over the terms and conditions for entry beyond the baseline criteria outlined earlier. It is not likely, however, that all member states actually will fulfill the requirements by this date. On the other hand, the tight fiscal policies implemented by some European governments to meet the targets for EMU may slow growth.

A central feature of monetary union is that a central bank will have control over monetary policy, but both the French and British governments are unlikely to want to relinquish any political control.

Further clarification of the EMU process was made as follows at the Dublin Summit in December of 1996. There will be penalties for countries running budget deficits outside the agreed limits of 3 percent of GDP. The exceptional and temporary circumstances under which countries can escape penalties have been narrowed. Exceptions include national disasters and a fall in GDP of more than 2 percent in a year; a fall of between 0.75 percent and 2 percent will become a "gray zone." The pact on fiscal discipline has been officially named the "stability and growth pact."

Although there is a degree of corporate caution, organizations still have to implement the replacement and purchase of information technology (IT) to maintain the ongoing competitiveness of business processes. This will be at either a corporate level as part of an overall IT strategy or at a departmental level using discretionary purchases. There is an offensive/defensive opportunity in the making for vendors as IT departments redeploy their staffs to major projects.

The United Kingdom began shedding manual, clerical, and managerial labor in the early 1980s, with the numbers being shed as they bulged in the late 1980s and early 1990s. So far, this trend has not been seen to the same extent in other advanced industrial countries such as France and Germany, but unemployment is increasing. As some organizations in Europe wrestle with concepts and impacts of reorganizing working practices and labor shedding, IT spending will emerge high on the agenda to drive efficiency gains. Such IT expenditure will be a mixture of computing hardware, network infrastructure, and integration software.

Germany

Despite political and economic uncertainty about EMU, the German economy is slowly regaining momentum, but this upswing is mainly confined to the export-led manufacturing sector. Although most forecasts predict a growth in GDP in the range of 2.3 percent to 2.5 percent for 1997, these indicators contrast with a severely dented consumer confidence—owing to the high unemployment rate and the effects of the welfare-state reform. Thus, private-spending growth is expected to reach a moderate rate of about 1.3 percent this year.

During the coming quarters, Germany is likely to appear increasingly as a two-tier economy, with large, prosperous corporate accounts accompanied by flat or reduced public-sector spending and low consumer spending triggered by high unemployment. Furthermore, the international financial markets are watching very cautiously the struggle between the government and the Bundesbank about how to reach the Maastricht criteria. The recent argument about the revaluation of the gold reserves, interpreted as an assault on the independence of the Bundesbank, pushed the deutsche mark and government bonds down further. The awaited decisions about the fulfillment of the Maastricht criteria, the tax shortfall because of high unemployment, and the tax and pension reforms are all vital for the further development of the German economy, especially the depressed home market.

United Kingdom

The U.K. economy remains one of the strongest in Europe, with GDP forecasts standing at above 3 percent for 1997. The driver for this growth was the consumer sector, as the manufacturing sector continued to give cause for concern. The growth in retail sales was supported by demand for furniture and household electrical goods—a sign of the improvement in the housing market. This, together with a falling unemployment rate and higher average earnings growth, contributed to consumer boom. It is this strength in domestic demand that is fueling the manufacturing production growth, although this is still a modest 1.9 percent year-on-year rate. The continued strength of the pound combined with the expectation of further interest rate rises are other factors causing a drop in the forecasts for the manufacturing sector. Inflation remains modest, albeit with the increases in interest rates.

France

Unemployment in France hit a post-World War II record, which increases pressure on the hard-pressed, center-right government. This, combined with the release of poorer-than-expected industrial output data, underlined the tentative nature of the country's economic recovery. The government is relying on faster growth to reduce its budget deficit to qualify for membership of the proposed single European currency. Its prediction is for growth this year of 2.2 percent, up from a modest 1.4 percent in 1996. The negative message was underscored by an industrial survey, conducted by the French national statistics institute INSEE, that shows a deterioration in business confidence in March after recent improvements.

In a report published recently, the Paris-based Organization for Economic Cooperation and Development (OECD) called for an acceleration of banking reforms and "an entire package of major reforms" in the electricity and telecommunications sectors. It states that the property sector crisis that has forced many companies and financial institutions to set aside large provisions is not over.

However, according to the OECD report, improved macroeconomics policies have raised the government's credibility, with the sharp fall in interest rates since late 1995 likely to set the stage for stronger growth. On the vital issue of this year's deficit, the OECD's formal projection is for a general government borrowing requirement in 1997 of 3.2 percent of GDP—more than the 3 percent level required for France to qualify for the European single currency. But the report acknowledges that, even if there is some slippage from the government's projections, "there should be room to take the measures needed to bring it back on track."

Italy

Strongly committed to EMU, the Italian government inherited an economy that, in most respects, is doing no better than last year. Apart from low GDP growth, all major financial indicators are moving in the wrong direction, with inflation falling slowly and a relatively high government deficit and debt/GDP ratios. Reports already are circulating that the current trend in spending and receipts will produce a deficit of the equivalent of almost 3.8 percent of GDP. This compares to the 3 percent of GDP target laid down by the Maastricht Treaty. If this figure is confirmed, the government will face a tough task trying to find a politically acceptable package. The difficulty of forging a consensus within the government majority, combined with market nervousness about a delay to EMU, already has led to growing pressure on the lira. The problem is that the Italian economy is being squeezed to fit the Maastricht criteria. The repercussions for the IT market are quite clear, as private and professional demand will remain constrained by the restrictive thrust of fiscal policy.

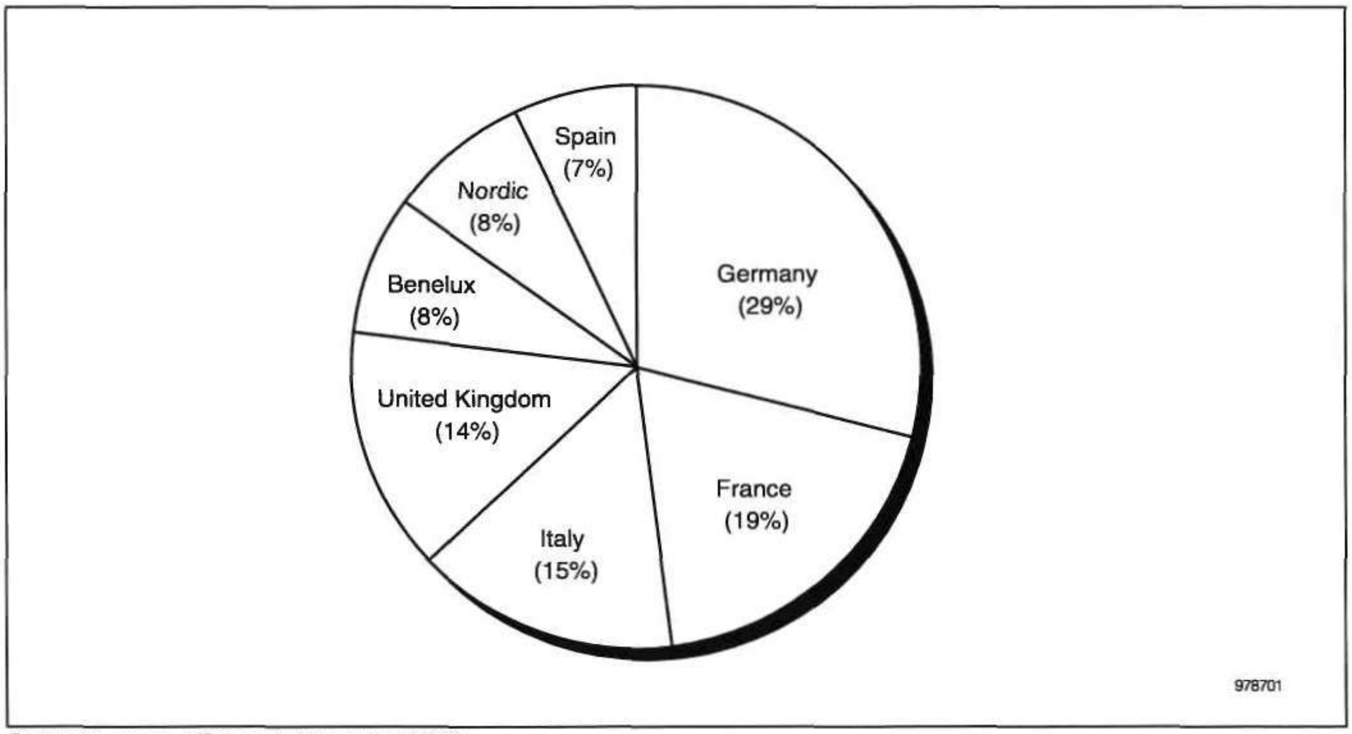
Spain

The Spanish economy continued its excellent performance in the first quarter. The government's convergence plan was a success, with all economic indicators moving in the right direction. There is growing consensus in the financial markets that Spain will be among the first wave of countries to join the EMU in 1999. GDP is expected to grow 3.1 percent in 1997, and inflation and interest rates have reached historic lows. The economic recovery is in the industry- and export-led sectors. Following the recent deregulation of the labor market, both consumers and corporations delayed purchasing decisions to assess the impact of the new regulations on employment. However, there is still a degree of uncertainty about the Spanish economy. Despite low interest and inflation rates for the first time in 20 years, there has not been a consumer boom; rather, there has been an increase in savings rates. Low interest rates, coupled with an increase in savings, can only mean a high level of uncertainty.

European Trends and Forecasts

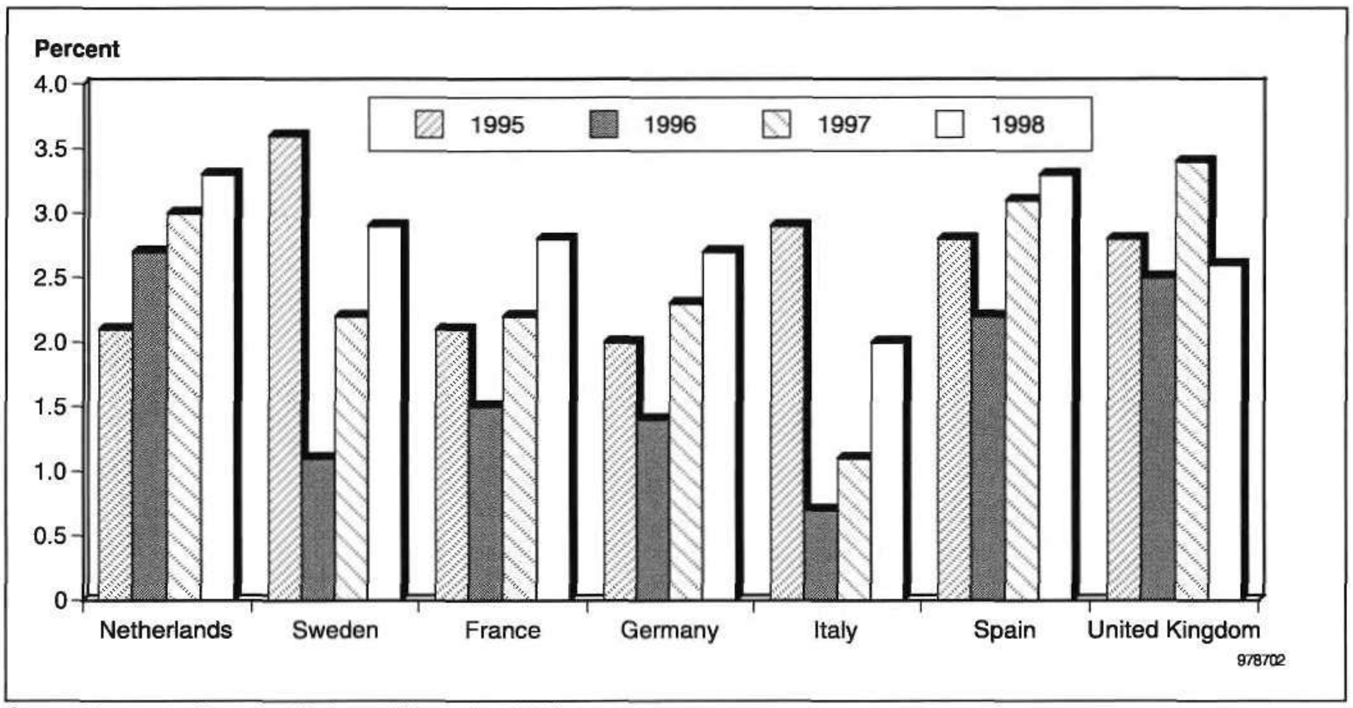
Figures 3 through 6 illustrate the economic trends for Europe as a whole. These forecasts are based on the average of more than 20 forecasting bodies in each country. As previously discussed, the economic cost of achieving EMU may be high in the run up to 1999, and this will dampen growth. The precise degree as to how this will affect the European economy as a whole is unknown.

Figure 3
Size of GDP for Major European Economies



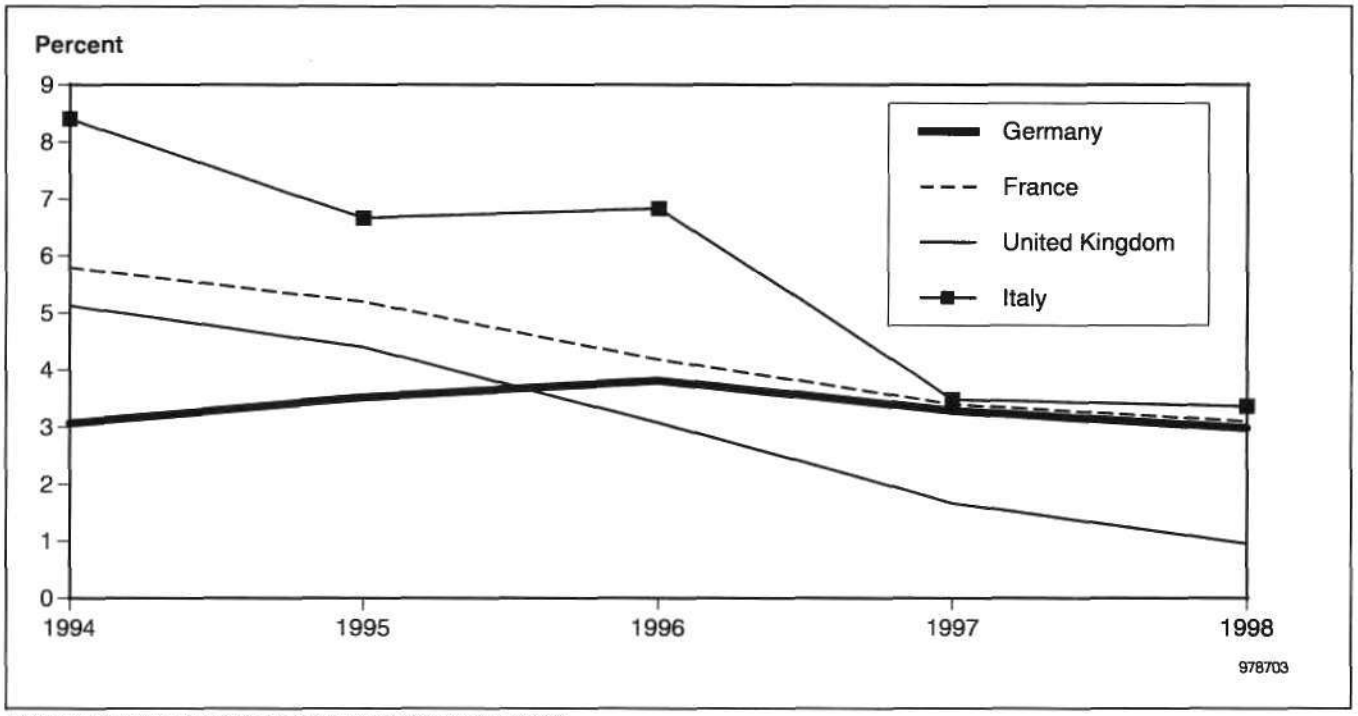
Source: Consensus Forecasts (December 1997)

Figure 4
GDP Growth Forecast for the Major European Economies



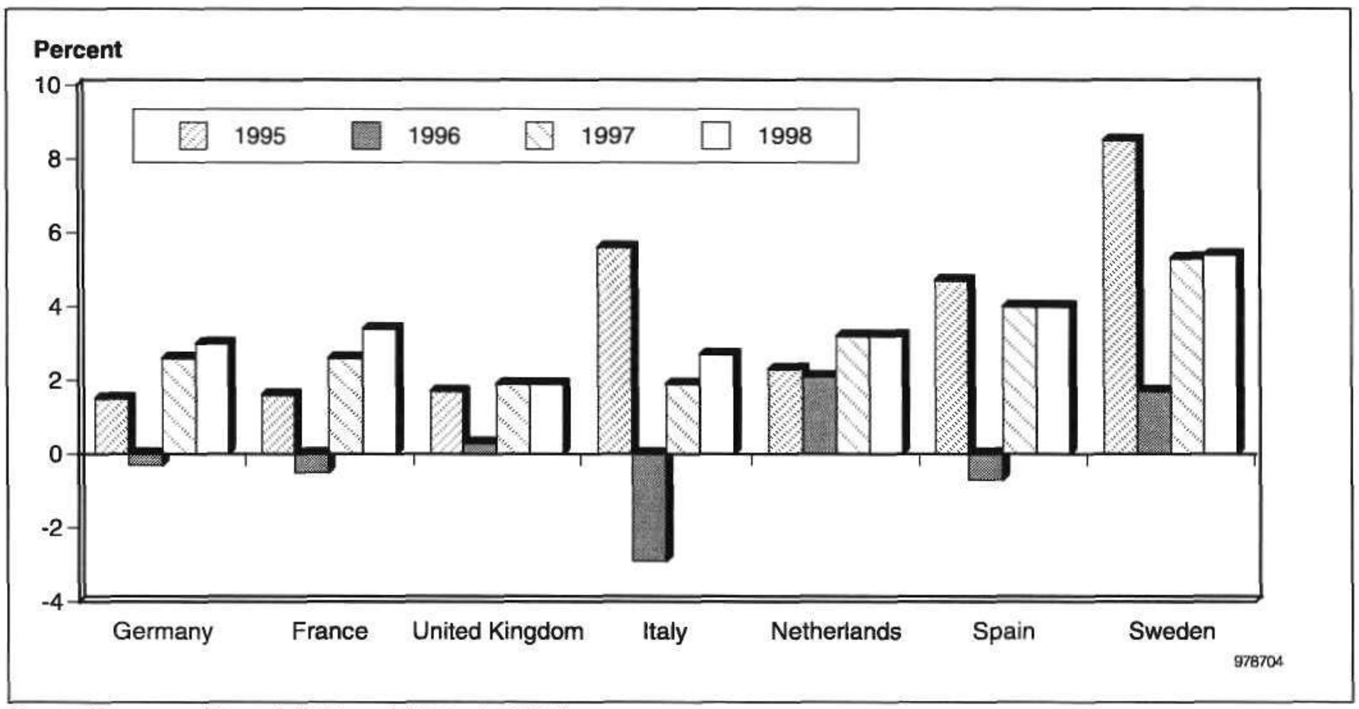
Source: Consensus Forecasts/Dataquest (December 1997)

Figure 5
Public Deficit as Percent of GDP



Source: Consensus Forecasts/Dataquest (December 1997)

Figure 6
European Industrial Production Growth Forecast



Source: Consensus Forecasts/Dataquest (December 1997)

The Continuing Impact of Currency Shift

Fluctuating exchange rates once again masked the true market performance in the 1996 CAD/CAM/CAE and GIS market. European CAD/CAM/CAE and GIS software grew 22 percent from 1995 to 1996 when measured in U.S. dollars. The dollar appreciated 3.2 percent against the European Currency Unit (ECU), so European CAD/CAM/CAE and GIS software revenue grew 11.8 percent from 1995 to 1996 when measured in ECU. Table 1 shows the U.S. dollar's performance over the last 3 years against the individual European currencies. Table 2 highlights the effect that the fluctuations in the dollar exchange rate had on the results of the European CAD/CAM/CAE/GIS market performance.

Looking ahead, currency fluctuations will continue to be felt in all global markets. The dollar has appreciated significantly during the early months of this year, so assuming a stable currency for the remainder of this year, 1997 will end with the dollar appreciating 12.5 percent against the ECU. This will have a negative impact on European revenue growth reported in dollars. Hence, it appears as if Dataquest has dramatically reduced its forecast for the European market for 1997. This is not the case.

In local currency terms, the European market is expected to turn in another high growth year in 1997. Although Dataquest does not forecast currency exchange rates, we do forecast with the best information available. The exchange rate is calculated as the simple arithmetic mean of the 12 monthly average rates for each country. For the purpose of this forecast, Dataquest assumes that the August exchange rate will remain stable in the future.

Table 1
U.S. Dollar Exchange Rates for European Currencies

							Appreciation of U.S. Dollar (%)			
Country	Currency	1994	1995	1996	1997[1]	1998[2]	1993-1994	1994-1995	1995-1996	1996-1997
Austria	Schilling	11.4	10.06	10.59	12.38	12.95	-11.7	5.2	16.9	4.6
Belgium	Franc	33.66	29.42	30.96	36.32	38.01	-12.6	5.2	17.3	4.6
Denmark	Krone	6.35	5.59	5.81	6.70	7.01	-11.9	3.9	15.4	4.6
Finland	Markka	5.21	4.37	4.59	5.26	5.50	-16.1	5.1	14.5	4.7
France	Franc	5.54	4.97	5.12	5.93	6.20	-10.3	2.9	16.0	4.5
Germany	D-Mark	1.62	1.43	1.50	1.75	1.84	-11.7	5.2	16.6	4.9
Italy	Lira	1,609.34	1,628.21	1,542.72	1,726.62	1,797.12	1.2	-5.3	11.9	4.1
Netherlands	Guilder	1.82	1.60	1.69	1.98	2.07	-11.9	5.2	17.4	4.6
Norway	Krone	7.04	6.33	6.46	7.23	7.62	-10.1	2.1	11.9	5.4
Spain	Peseta	133.48	124.40	126.68	148.64	155.51	-6.8	1.8	17.3	4.6
Sweden	Krona	7.7	7.14	6.71	7.75	7.99	-7.3	-6.0	15.5	3.1
Switzerland	Franc	1.37	1.18	1.24	1.47	1.51	-13.9	4.8	19.3	2.6
U.K.	Pound	0.65	0.63	0.64	0.62	0.62	-2.6	1.3	-3.9	1.3
Europe	ECU	0.84	0.77	0.80	0.90	0.94	-8.3	2.9	12.9	4.1

1 Preliminary estimates for 1997
2 Projected rates for 1998
Source: Dataquest (August 1997)

Table 2
Software Revenue History and Forecast, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1995-1996	CAGR (%) 1996-1997	CAGR (%) 1996-2001
European Revenue (U.S.$M)											
Mechanical	825	1,024	1,149	1,197	1,317	1,419	1,534	1,683	12	4	7.9
AEC	372	447	419	403	436	491	543	593	-6	-4	7.2
GIS/Mapping	245	294	348	386	438	489	543	594	19	11	11.2
EDA	249	281	332	382	429	458	516	594	18	15	12.4
All Applications	1,691	2,046	2,249	2,368	2,620	2,857	3,136	3,464	10	5	9.0
ECU/U.S.$ Exchange Rate	0.84	0.77	0.80	0.90	0.94	0.94	0.94	0.94	-	-	-
European Revenue (ECU M)											
Mechanical	696	792	915	1,063	1,169	1,260	1,363	1,495	15	16	10.3
AEC	314	346	334	358	387	436	482	527	-3	7	9.5
GIS/Mapping	206	227	277	343	389	434	482	527	22	24	13.7
EDA	210	217	264	343	401	428	483	556	22	30	16.0
All Applications	1,426	1,582	1,790	2,128	2,450	2,672	2,933	3,239	13	19	12.6

Source: Dataquest (September 1997)

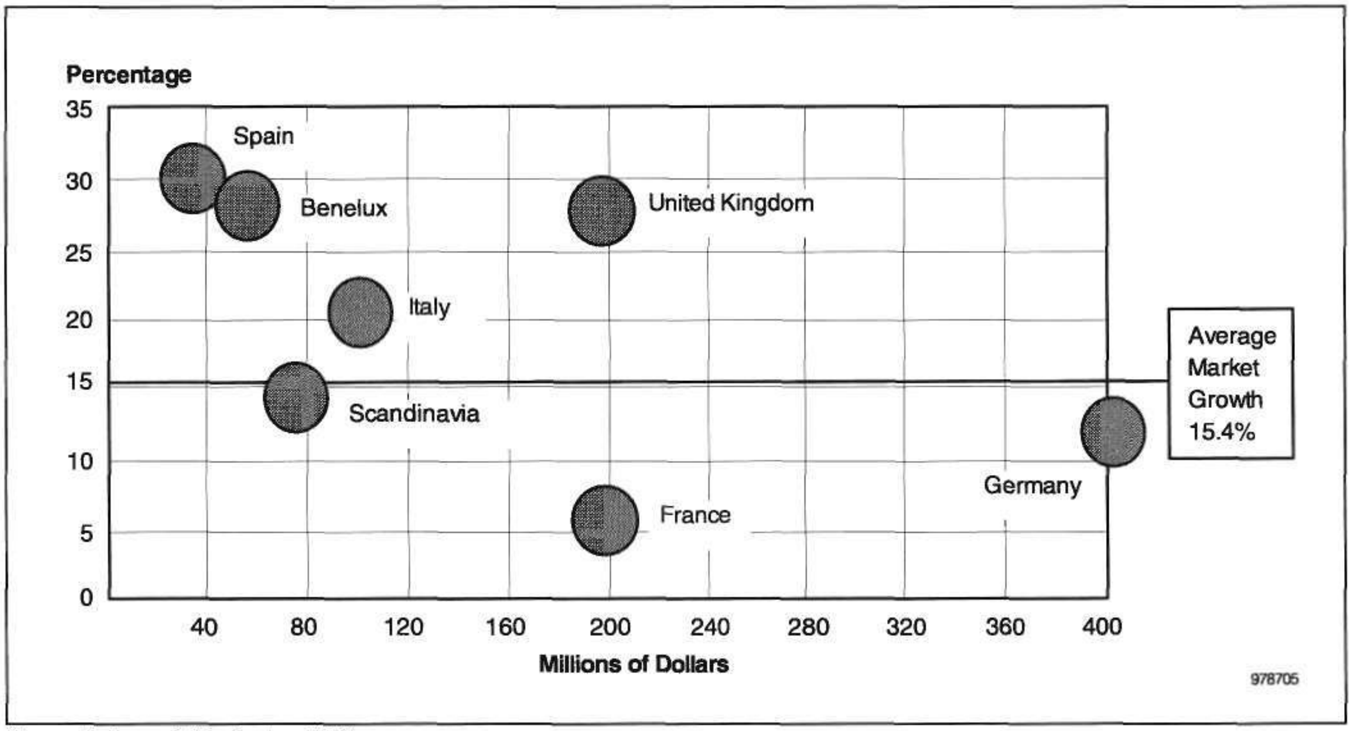
Mechanical CAD/CAM/CAE Market in Europe

Mechanical applications, which totaled $1.5 billion, had a 51 percent share of the total European CAD/CAM/CAE/GIS software market in 1996, compared with 50 percent in 1995, and increased by more than 15 percent in software revenue in 1996. The top 10 vendors actually grew nearly 22 percent and now control 76 percent of this market, compared with 72 percent in 1995. The market is expected to increase by another 16 percent to $1.2 billion in 1997 (all growth rates are based on ECU).

Overall, Dataquest expects the market for mechanical CAD/CAM/CAE to grow at a compound annual growth rate (CAGR) of 10.3 percent until the year 2001.

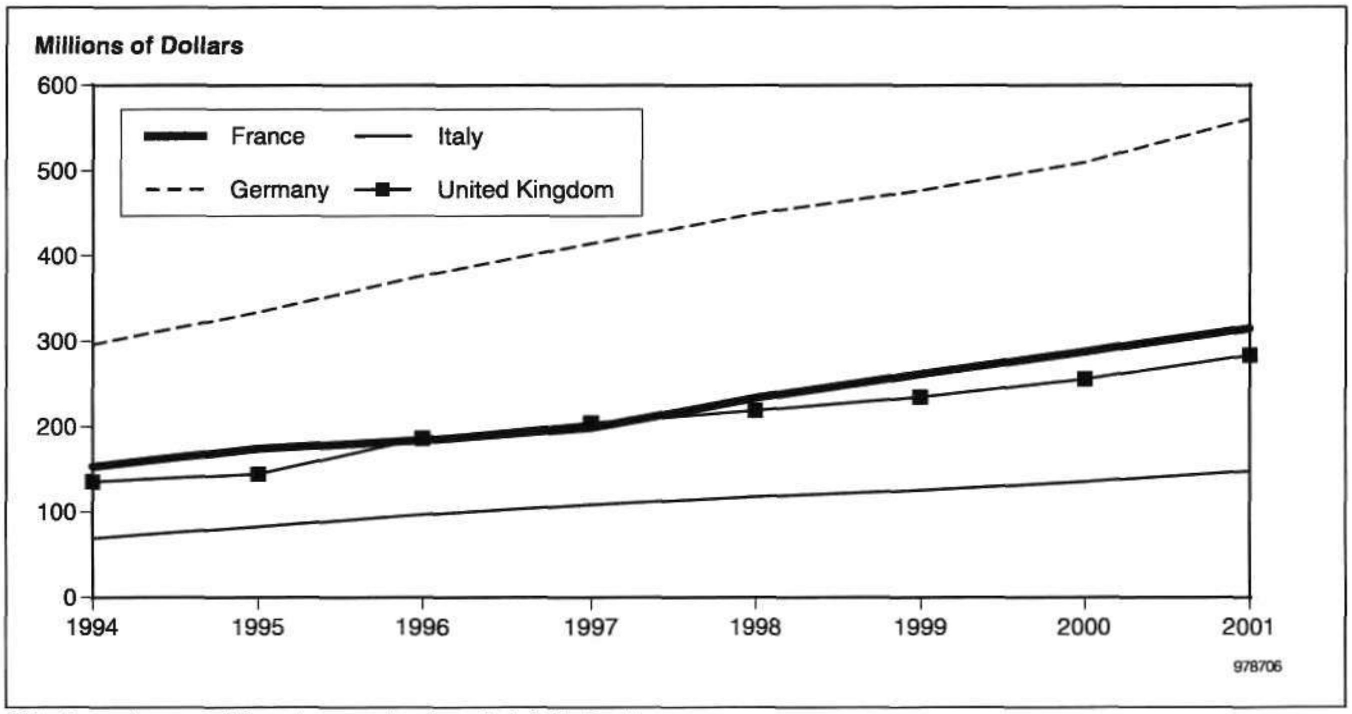
Figures 7 and 8 give a snapshot of the mechanical CAD/CAM/CAE software market in 1996 and Dataquest's predictions for the market by major European country.

Figure 7
European Mechanical CAD/CAM/CAE Software Market Portfolio



Source: Dataquest (September 1997)

Figure 8
European Mechanical CAD/CAM/CAE Software Revenue Forecast by Country

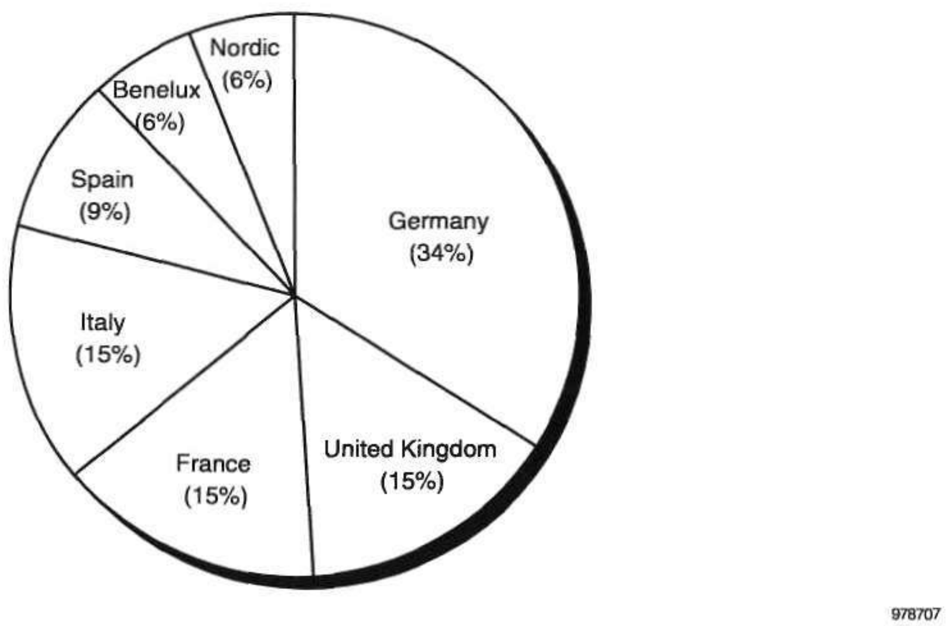


Note: Percentage growth based on growth rates calculated in local currency.
Source: Dataquest (December 1997)

Over the last three years (1995 through to 1997) there has been heavy investment in mechanical CAD/CAM/CAE tools from the automotive and aerospace industries across Europe. Most of the European companies have now completed their CAD renewal and we expect that these two sectors will slow down during 1998. In 1998 Dataquest expects the machinery industry to pick up growth investing mainly in NT-based solutions. However, as the automotive and aerospace industries are the main consumers of mechanical CAD/CAM/CAE tools, we expect software revenue growth to slow to less than 10 percent in 1998.

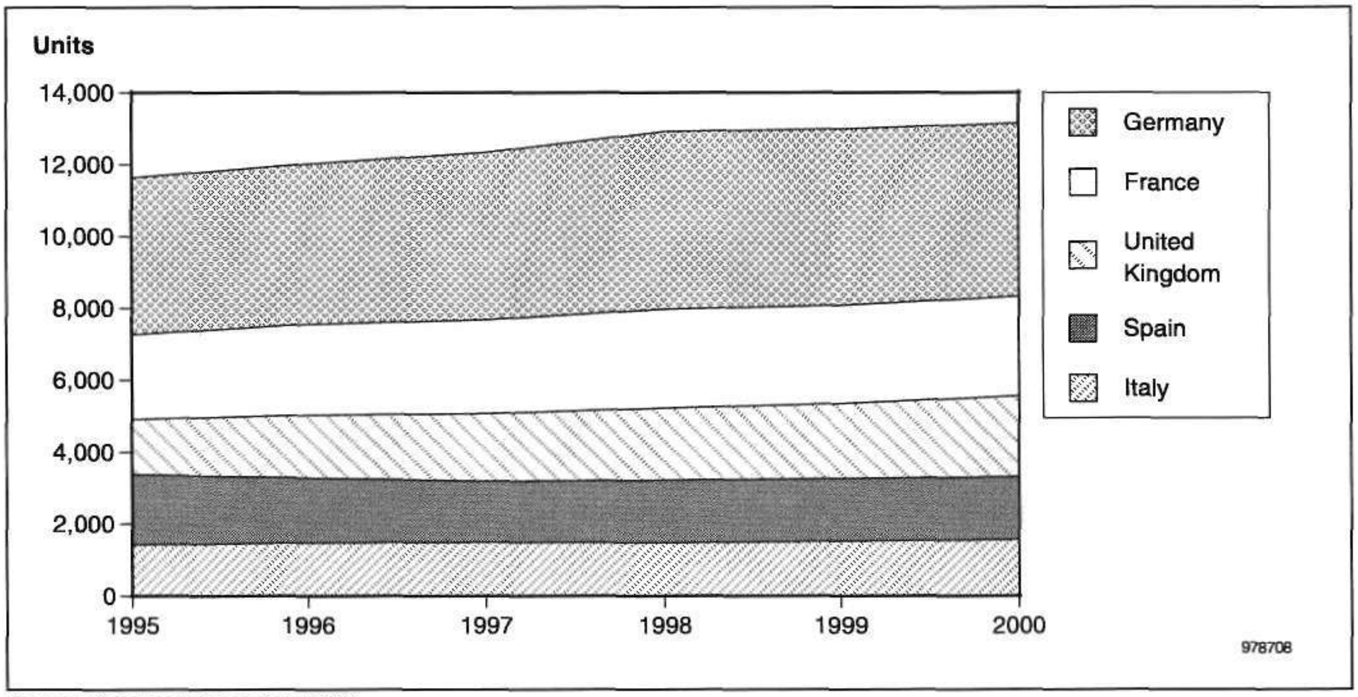
When looking at the economic statistics, it becomes evident that Germany plays a leading role in the European manufacturing industry, both in terms of the number of people employed in this industry and in terms of production (see Figures 9 and 10). This is also reflected in the 35 percent share Germany has of the European mechanical CAD/CAM/CAE software revenue. Any change in the German manufacturing industry has an impact on mechanical CAD/CAM/CAE software revenue growth. According to German economic statistics compiled by Commerzbank, German manufacturing production as a whole will grow more than 4 percent, and the machinery industry in particular will increase 5.5 percent in 1998.

Figure 9
European Manufacturing Industry, Percent of Workforce by Region



Source: Source: European Marketing Pocket Book 1996, NTC Publications Ltd.

Figure 10
European Car Production Forecast



Source: Dataquest (December 1997)

European Mechanical CAD/CAM/CAE Market by Component

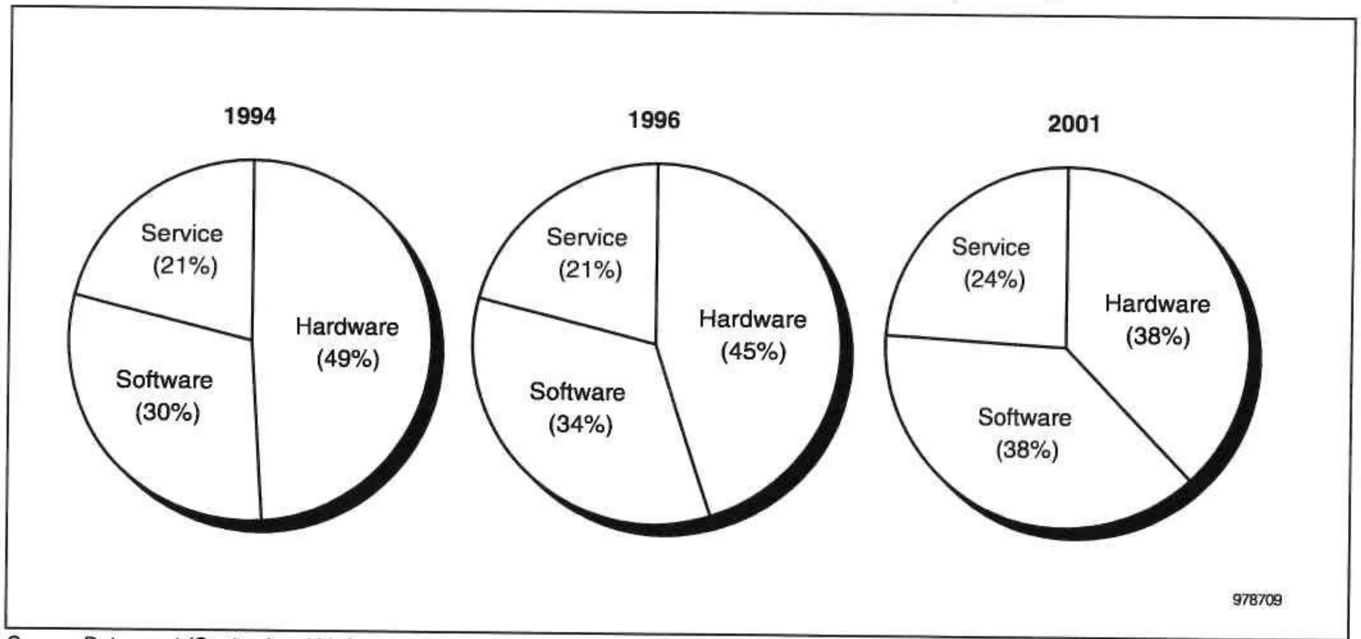
The share of software revenue of the total revenue for Mechanical CAD/CAM/CAE CAD applications has increased at the expense of hardware revenue. This trend is expected to continue in the future as the average selling prices (ASPs) of software are expected to increase slightly over the next 5 years whereas hardware ASPs are expected to remain relatively stable (see Figure 11).

Mechanical CAD/CAM/CAE Market by Platform

The Mechanical CAD/CAM/CAE market segment is still dominated by UNIX-based solutions, in terms of software revenue, which accounted for nearly 74 percent of European MCAD software revenue. In terms of seats, UNIX-based seats made up 43 percent and PC-based seats 49 percent of the MCAD installed base in 1996 (see Figure 12). Of the 350,000 MCAD seats installed in Europe at the end of 1996, 170,000 of them were PC s, compared to more than the 150,000 UNIX seats.

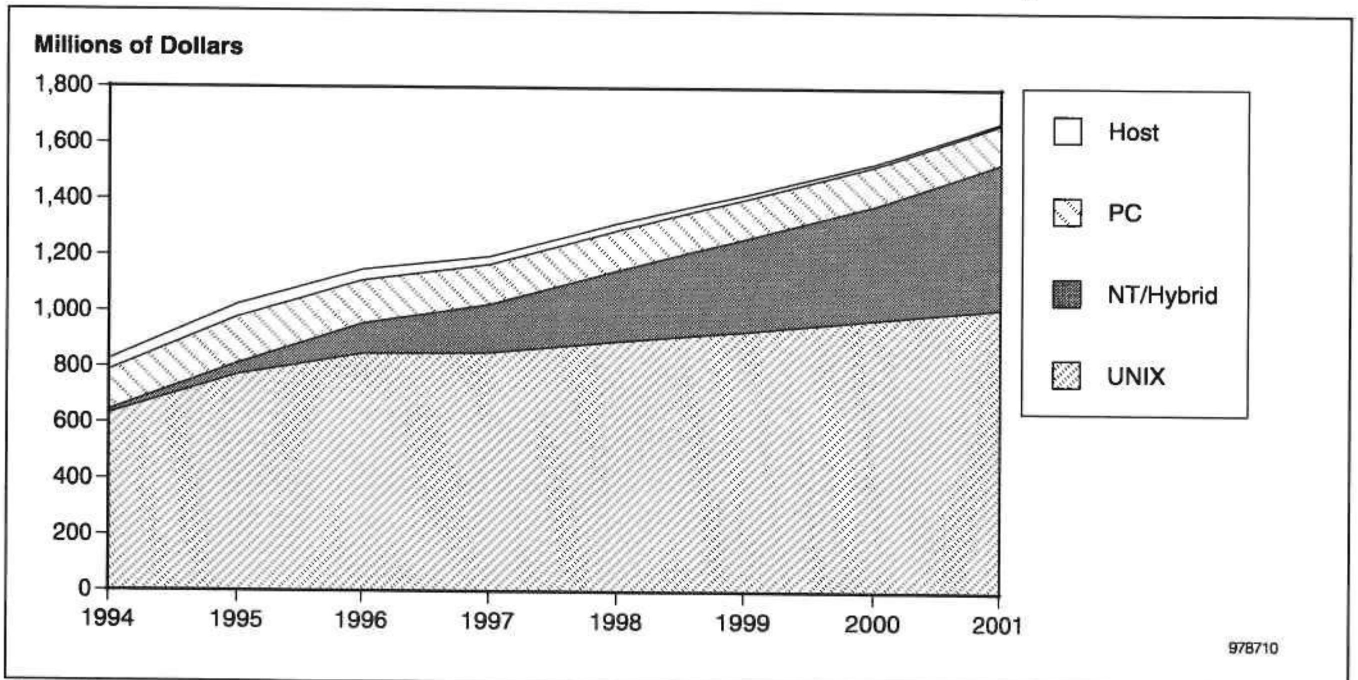
With growth of 169 percent in 1996, NT-based applications are beginning to encroach on revenue for applications on the other platforms, in particular PC-based applications. Revenue for mechanical CAD/CAM/CAE tools in 1996 and 1997 is primarily driven by large UNIX-based orders from the automotive and aerospace industries.

Figure 11
European Mechanical CAD/CAM/CAE Revenue Comparison by Component



Source: Dataquest (September 1997)

Figure 12
European Mechanical CAD/CAM/CAE Software Revenue Forecast by Platform



Source: Dataquest (September 1997)

In Europe, Dataquest does not expect NT to play a significant role in the MCAD market until 1998. And even then, growth for NT-based solutions will not come from the traditional users in the automotive and aerospace industries, but from other industry sectors made up by small to medium sized companies.

In the major industries such as automotive and aerospace, adoption of NT-based solutions will take longer as most of the large companies are right now investing in UNIX-based systems and looking at the long IT investment cycles in these industries, it will take a number of years until these new installations will be replaced.

Dataquest Perspective

There is a clear indication that the European manufacturing industry is going through a major transformation to remain competitive in a more and more global economy. High labor costs forced industry to change radically and increase productivity despite high labor costs. This change in the structure of the European manufacturing industry is one of the factors behind the large IT investment we are currently witnessing.

CAD investment in Europe is part of global corporate strategy. This means that when orders are placed in Europe, generally they are of a much bigger magnitude than in the United States. The various large orders that came in from Europe over the last three years show this. But this also means that the IT investment cycles are longer in Europe—in the automotive and aerospace industries these range from five to 10 years. Because now most of the large companies in the auto/aero industries have made their CAD renewal investments, Dataquest does not expect the mechanical CAD/CAM/CAE software market to continue to grow at the current pace. From 1998 onward, things will go back to normal, and the market will again display all the signs of a mature replacement market.

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Perspective

Mechanical CAD/CAM/CAE Worldwide

Channels Analysis

Channel Analysis of the Mechanical Applications Market

Abstract: *This Perspective presents different views of the mechanical CAD/CAM/CAE market. By using a number of metrics to see the relative rankings of vendor companies in this market, a better overall sense of the market and its channels is offered.*
By Daya Nadamuni

Market Overview

The mechanical CAD/CAM/CAE market is an amalgamation of sales of mechanical applications software through a number of different channels. Channel analysis in CAD is necessary because there are many different ways to view the market, and different metrics can potentially yield other claimants to the No. 1 position.

There are different ways of determining market leadership, how the companies are ranked, and how much they grew over the previous year. Some vendors depend heavily on the reseller channel and dealers. Others have invested in large direct salesforces. This Perspective paints a picture of the market in its different facets and presents a more complete view of the market's dynamics. This Perspective also ranks companies by several different metrics to give the reader a clearer picture of the market and of each company's position. The metrics used to rank the vendors are total distribution revenue, company software revenue, software product revenue, end-user spending, and software and service revenue.

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Market Ranking by Total Distribution Revenue

Total distribution revenue includes revenue from software, hardware, and services that are sold into the mechanical CAD market. (For detailed definitions of software, hardware and services revenue, please refer to *Dataquest Guide to CAD/CAM/CAE and GIS Market Definitions*, CMEC-WW-GU-9701, published February 26, 1996.)

Total distribution revenue for the worldwide mechanical CAD/CAM/CAE market was U.S.$10.5 billion in 1996. The market as a whole grew at 13.3 percent over 1995 in terms of total distribution revenue.

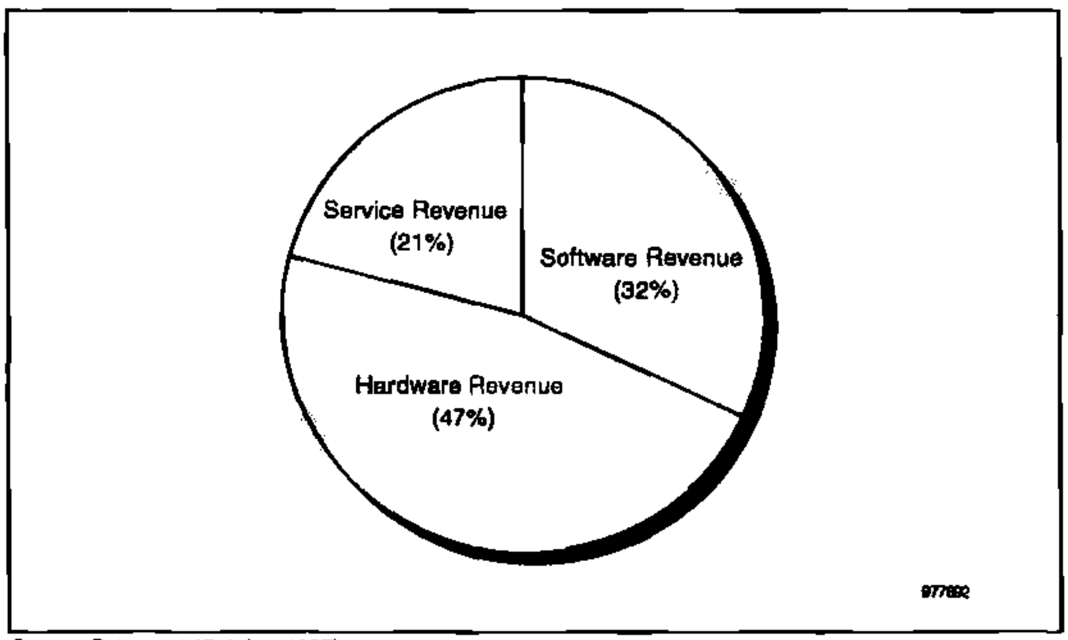
Table 1 divides the market among the three categories. Figure 1 illustrates the division of revenue among the three components of total distribution revenue. About 47.6 percent of the worldwide mechanical market revenue is derived from hardware sales, 31.5 percent is from software sales, and the remainder is service-based revenue.

Table 1
1996 Worldwide Mechanical CAD/CAM/CAE Distribution Revenue

Category	Revenue ($M)
Software Revenue	3,344
Hardware Revenue	5,041
Service Revenue	2,205
Total Revenue	10,576

Source: Dataquest (October 1997)

Figure 1
1996 Worldwide Mechanical CAD/CAM/CAE Distribution Revenue by Category



Source: Dataquest (October 1997)

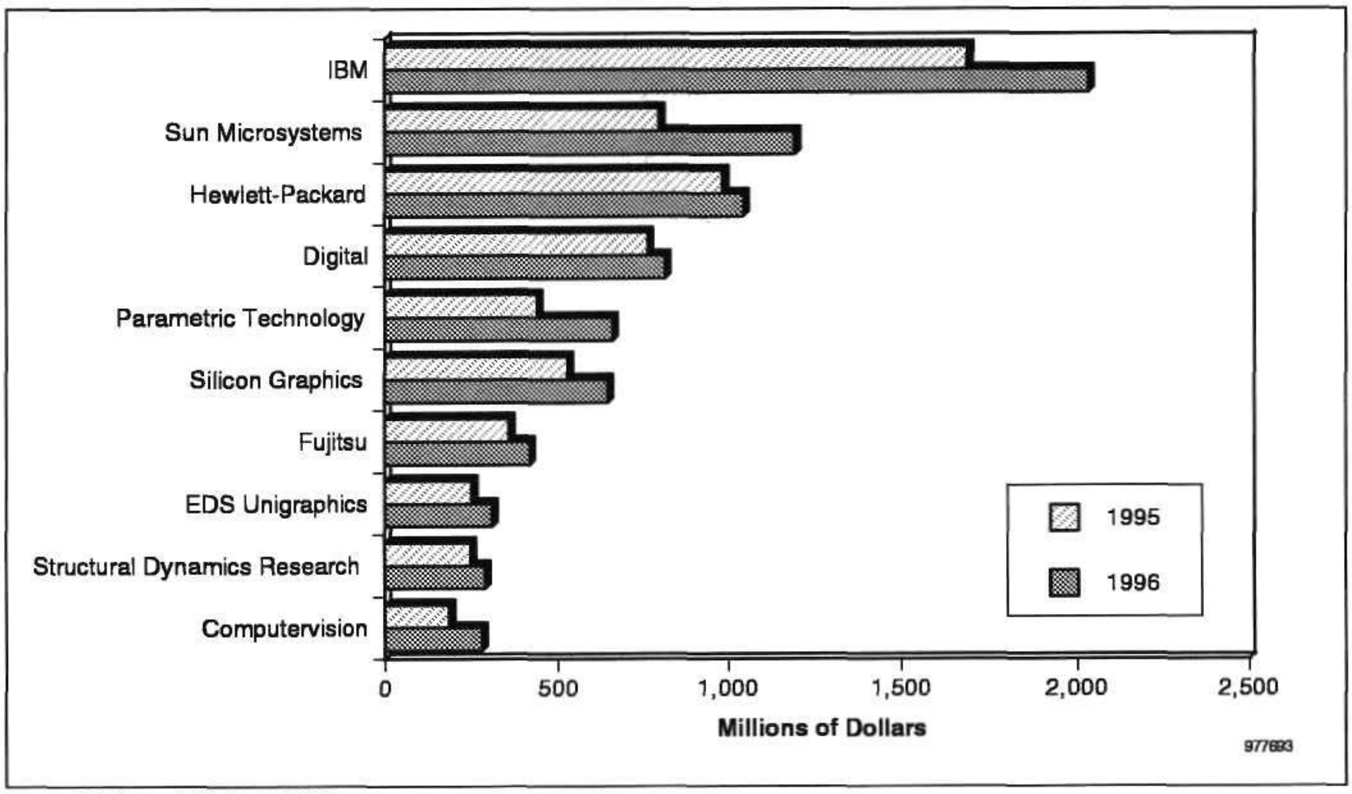
Many of the workstation vendors make it to the top in the market ranking by the total distribution revenue metric because hardware revenue is included. These are vendors like IBM Corporation, Digital Equipment Corporation, and Sun Microsystems Inc. Table 2 ranks the top 10 hardware and software revenue vendors for total distribution revenue. Figure 2 illustrates the rankings by the same metric.

Table 2
1996 Worldwide Mechanical CAD/CAM/CAE Distribution Revenue Vendor Ranking

Vendor	1995 Revenue ($M)	1996 Revenue ($M)	1995-1996 Growth (%)	1996 Market Share (%)
IBM	1,691	2,033	20	19
Sun Microsystems	800	1,190	49	11
Hewlett-Packard	983	1,042	6	10
Digital	767	818	7	8
Parametric Technology	440	660	50	6
Silicon Graphics	528	647	23	6
Fujitsu	356	417	17	4
EDS Unigraphics	247	305	24	3
Structural Dynamics Research	244	285	17	3
Computervision	183	276	51	3
All Companies	**9,307**	**10,576**	**14**	**100**

Source: Dataquest (October 1997)

Figure 2
1996 Worldwide Mechanical CAD/CAM/CAE Distribution Revenue by Vendor



Source: Dataquest (October 1997)

Table 2 underlines the importance of hardware to the mechanical CAD/CAM/CAE market. There has been some fluctuation in the rankings compared with 1995. IBM continued to be the market leader, but this year Sun Microsystems came in second, and HP moved to third. Parametric Technology moved to fifth, and SDRC came in ahead of Computervision, which was No. 8 last year. UNIX hardware vendors continue to occupy the top three spots on the list. This highlights the continued dominance of the UNIX operating system in the mechanical CAD market. Worldwide software revenue on the UNIX platform accounted for 72 percent of the total mechanical CAD software market.

Market Ranking by Company Software Revenue

Company software revenue is the aggregation of direct software revenue, indirect software revenue, OEM revenue, and reseller revenue—that is, all the channels from which a company derives revenue. A vendor may sell other companies' products through its value-added reseller (VAR) channel (in which case it shows up as reseller revenue for the vendor doing the reselling) or it may set up OEM deals for its outside products (in which case it shows up as OEM revenue for the company that set up an OEM agreement for its product).

It is important to note that the total market size is determined by the sales from the direct and indirect channels only and does not include OEM and reseller revenue. On the other hand, a given company's revenue includes sales from all channels (direct, indirect, OEM, and reseller). So, the sum of revenue for all companies is greater than the total market size. Similarly, the sum of market shares for all companies is greater than 100 percent because of the inclusion of OEM- and reseller-based revenue for each company (while market size excludes these two components).

Table 3 and Figure 3 rank vendors based on company software revenue.

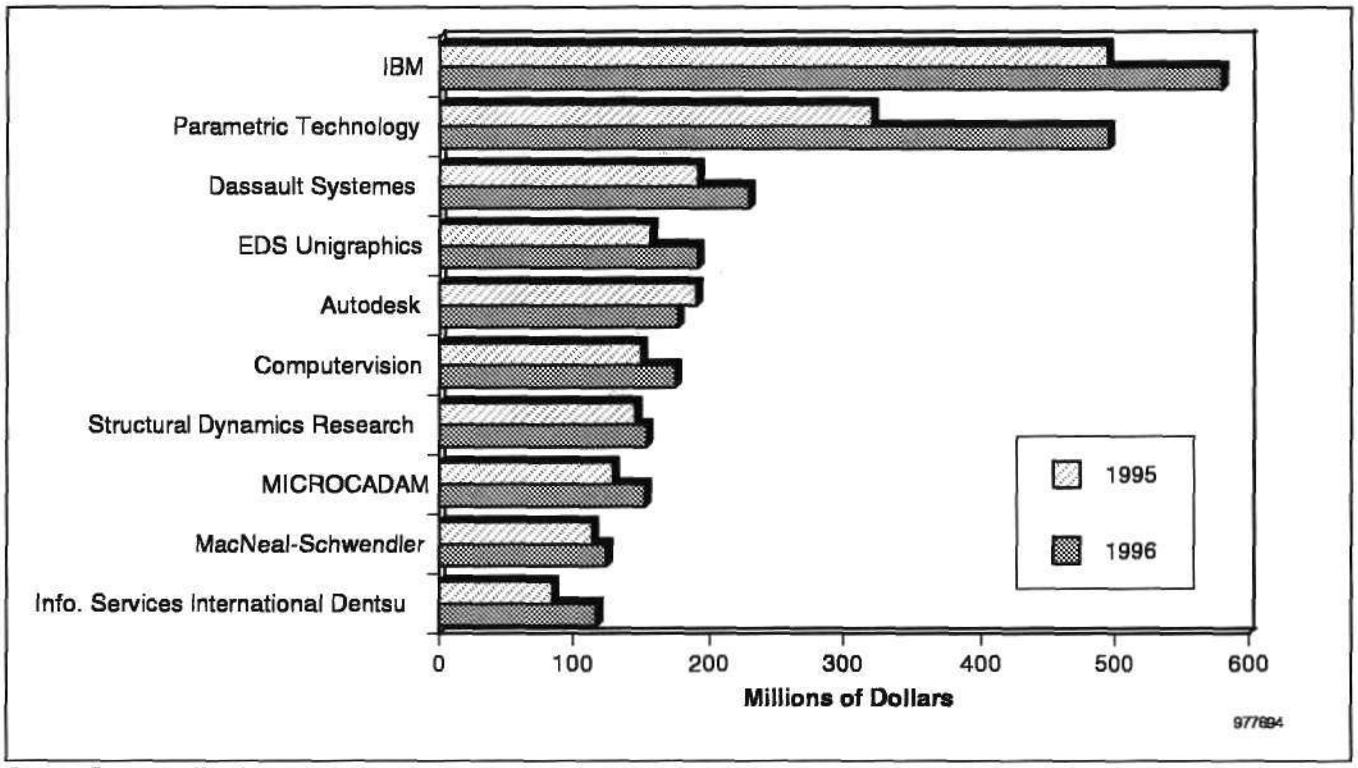
The market size is U.S.$3.3 billion for 1996, based on sales through the direct and indirect channels only (to avoid double-counting). An individual vendor's revenue and market share is based on what gets sold through all of its channels. IBM and Parametric Technology have retained their respective positions from 1995. However, Autodesk has been overtaken by Dassault Systemes, and EDS Unigraphics is now in fifth place. It is important to note that Dassault Systems generates revenue through its OEM arrangement with IBM. Similarly, under this methodology, Dentsu is in 10th place primarily because it is a reseller of other vendors' mechanical CAD products.

Table 3
1996 Worldwide Mechanical CAD/CAM/CAE Company Software Revenue Ranking

Vendor	1995 Revenue ($M)	1996 Revenue ($M)	1995-1996 Growth (%)	1996 Market Share (%)
IBM	494	580	17	17
Parametric Technology	321	495	54	15
Dassault Systemes	191	229	20	7
EDS Unigraphics	156	191	23	6
Autodesk	190	176	-7	5
Computervision	149	174	17	5
Structural Dynamics Research	145	153	6	5
MICROCADAM	129	152	18	5
MacNeal-Schwendler	114	124	9	4
Info Services International Dentsu	85	117	38	4
All Companies	**2,964**	**3,345**	**13**	**100**

Source: Dataquest (October 1997)

Figure 3
1996 Worldwide Mechanical CAD/CAM/CAE Company Software Revenue



Source: Dataquest (October 1997)

Market Ranking by Software Product Revenue

Software product revenue counts revenue derived only from direct and indirect sales channels. It represents what a company earns for selling its own products only. In this scenario the sum of market shares over all individual vendors totals to exactly 100 percent. Table 4 and Figure 4 show vendor rankings by this metric.

In this scenario, Parametric Technology is No. 1, followed by IBM and EDS Unigraphics. There is some change from last year in that IBM and PTC have exchanged places, as have EDS Unigraphics and Autodesk. Computervision has managed to keep fifth place, and SDRC comes in just ahead of MICROCADAM.

Table 4
1996 Worldwide Mechanical CAD/CAM/CAE Software Product Revenue

Vendor	1995 Revenue ($M)	1996 Revenue ($M)	1995-1996 Growth (%)	1996 Market Share (%)
Parametric Technology	321	495	54	15
IBM	432	486	12	15
EDS Unigraphics	156	191	23	6
Autodesk	188	175	-7	5
Computervision	149	174	17	5
Structural Dynamics Research	145	153	6	5
MICROCADAM	129	152	18	5
MacNeal-Schwendler	114	124	9	4
Matra Datavision	87	92	5	3
CoCreate	79	90	14	3
All Companies	2,965	3,344	13	100

Source: Dataquest (October 1997)

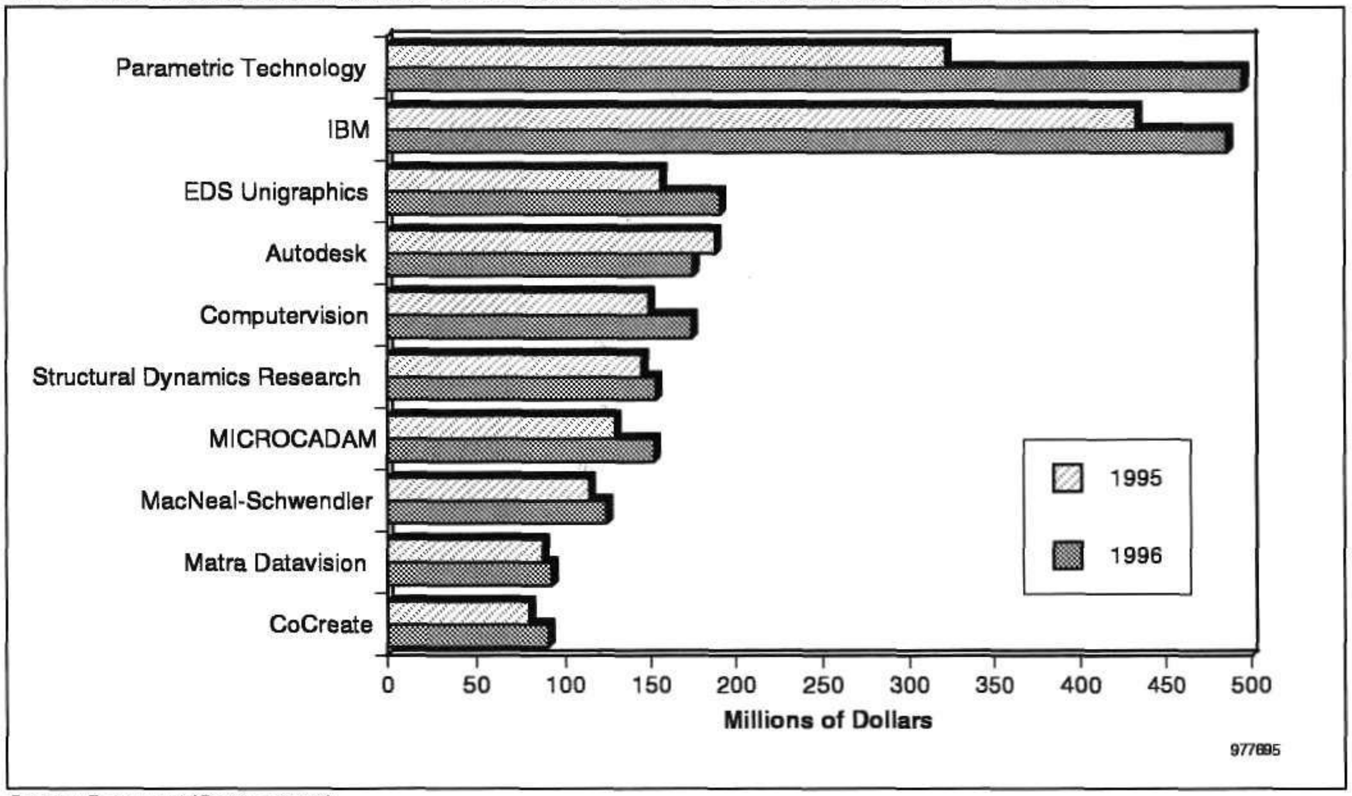
Market Ranking by End-User Spending

Thus far, this Perspective has not looked at what the end user—the designer or mechanical engineer—is paying for the software he or she uses, once dealer markups for indirect software sales are considered. Table 5 lists the ranking by end-user spending.

To calculate the statistics presented, Dataquest has used the dealer revenue channel. Dealer revenue is the multiplier of indirect revenue, which varies by vendor, region, and operating system. Dealer revenue always exists for every vendor with indirect sales, and it is always equal to or greater than indirect revenue. End-user spending for any given company in this table is the sum of revenue from direct, dealer, OEM, and reseller channels.

If dealer revenue is counted, the worldwide mechanical software market size goes up to U.S.$4.4661 billion as compared with U.S.$3.3445 billion when measured in terms of company software revenue. This means that users

Figure 4
1996 Worldwide Mechanical CAD/CAM/CAE Software Product Revenue



Source: Dataquest (October 1997)

Table 5
1996 Worldwide Mechanical CAD/CAM/CAE End-User Software Spending

Vendor	Indirect Software Revenue ($M)	Dealer Software Revenue ($M)	User Software Revenue ($M)	Market Share (%)
IBM	0	0	580	13
Parametric Technology	50	111	556	12
Autodesk	156	346	366	8
Computervision	57	126	243	5
Structural Dynamics Research	68	153	238	5
Dassault Systemes	0	0	229	5
MICROCADAM	144	213	220	5
EDS Unigraphics	28	55	219	5
MacNeal-Schwendler	30	60	155	3
Matra Datavision	27	67	131	3
All Companies	**1037**	**2159**	**4466**	**100**

Source: Dataquest (October 1997)

worldwide spent about U.S.$4.4661 billion worldwide in 1996. IBM has retained its position from last year, but Autodesk has slipped to No. 3, with second place going to Parametric Technology. Computervision has gone down to No. 5 from No. 4, having been overtaken by EDS Unigraphics.

Market Ranking by Software and Software Service Revenue

The following section looks at the market ranking by software and software service revenue. As explained earlier, the software service component includes customization and maintenance. Table 6 shows the ranking.

Dataquest's final look at the market takes into consideration software service. Service is a large component of the mechanical CAD market and in 1996 was U.S$2.205 billion, of which U.S.$957 million was software service revenue.

Table 6
1996 Worldwide Mechanical CAD/CAM/CAE Software and Software Service Revenue

Vendor	1995 Service Revenue ($M)	1995 Software + Service Revenue ($M)	1996 Service Revenue ($M)	1996 Software + Service Revenue ($M)	1995-1996 Growth (%)	1996 Market Share (%)
IBM	199	632	239	725	15	16
Parametric Technology	119	440	165	660	50	14
Structural Dynamics Research	99	244	132	285	17	6
EDS Unigraphics	17	172	34	225	31	5
Fujitsu	79	148	87	164	11	4
MacNeal-Schwendler	13	127	9	133	5	3
CoCreate	25	104	34	124	19	3
Matra Datavision	14	102	9	100	-1	2
Hitachi	17	88	18	98	12	2
Nihon Unisys	39	92	38	92	0	2
Others	337	1,774	493	1,995	-	43
All Companies	958	3,922	1,258	4,603	17	100

Source: Dataquest (October 1997)

Dataquest Perspective

There are many different ways of looking at a market. The metric used can make all of the difference in a market ranking. Each of these metrics is an equally valid representation of the market, and Dataquest has been careful not to double-count the market opportunity of U.S.$3.3445 billion worldwide mechanical software revenue for 1996. Evaluation by different metrics gives readers a chance to see a company's revenue distribution model and brings some companies into the top 10 list—companies that would not have been there otherwise, merely because of the difference in their revenue distribution models.

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Perspective

Mechanical CAD/CAM/CAE Worldwide
End-User Analysis

Friction-Free Supply Chains—1997's Focus for the European Manufacturing Industry

Abstract: *This Perspective presents findings from research among major European manufacturing organizations and analyzes their current and planned information technology (IT) intentions. Reducing cost in both business processes and IT is the number-one priority for the European manufacturing industry in 1997. The relentless search for efficiency in the face of global competition is leading manufacturers to not only rationalize and consolidate their existing IT infrastructures, but also to seek cost savings in their links with suppliers and customers. As a result, manufacturers need to create both more efficient internal IT systems and IT-based connections with the outside world.*
By Ben Pring and Petra Gartzen

Introduction

This Perspective is based on a previously published Dataquest document, "'Friction-Free' Supply Chains—1997's Focus for the European Manufacturing Industry" (PSVM-EU-DP-9704), June 13, 1997. Dataquest's aim in printing portions of that document here is to give its Mechanical CAD/CAM/CAE Worldwide clients a better understanding of European manufacturers' information technology (IT) plans as well as the IT developments into which future CAD/CAM/CAE systems must fit.

Infrastructure Consolidation Aims at Faster, Cheaper, and Better

Dataquest's recent research into the information technology (IT) plans and intentions of senior IT executives within the European manufacturing industry highlights their concentration on consolidating and rationalizing their organizations' IT infrastructures and focus on managing increasingly

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distributed IT architectures. Dataquest's research also suggests, however, that though the search for continued operational excellence in organizations' own internal IT environments will not stop, the next step in the evolution of this never-ending process will be to seek efficiencies and cost reductions in organizations' links with their suppliers and customers.

Friction-free supply chains are fast becoming the new competitive battleground for the European manufacturing industry, and subsequently their IT suppliers. Facing ever-increasing levels of global competition from low-cost centers of production in the emerging markets of the Far East, Latin America, and South Africa, the European manufacturing industry has focused relentlessly on the reduction of cost in all aspects of day-to-day operations.

Now this focus is extending outside of the walls of the enterprise into the ways that companies relate to and work with other organizations with whom they share a mutually dependent relationship. IT departments, as a consequence, are continuing to focus on standardizing IT platforms and attempting to streamline the very many different custom-developed systems and packages implemented over, in many cases, decades, and which as they age are both increasingly unsuitable for modern competitive conditions and expensive to run and maintain.

Beyond this imperative, manufacturing companies are examining the application of technology to connections to external organizations. Dataquest's research provides evidence that workgroup applications, Internet technology, and electronic commerce are all being pursued aggressively by European manufacturing organizations in the face of the new maxim, "Single organizations can no longer compete; only supply chains can."

This Perspective presents findings from research among more than 125 major manufacturing organizations that have their headquarters in Europe. In particular, this document focuses on manufacturing companies initiatives in the following:

- Enterprise Resource Planning (ERP)—European manufacturers are cementing ERP software's role across the enterprise
- Electronic Commerce—Manufacturers are looking for electronic commerce to deliver the long-heralded benefits of electronic data interchange (EDI)
- Windows NT—Discrete manufacturers lead Europe's march toward Microsoft's enterprise operating system
- Distributed Systems Management (DSM)—Forty percent of manufacturing organizations utilize DSM methodologies. DSM is becoming the framework for all other technologies and services

MRP Evolves into ERP; Extended ERP (EERP) Software Next

Dataquest conducted research among 126 European manufacturing organizations as part of a broader primary research project in the first quarter of 1997 regarding their intentions on the utilization of a range of key technologies. The research also addressed attitudes toward a number of pressing business issues, such as the Year 2000 date change and the impending movement toward a common European currency. These manufacturing organizations were operational within the four major economies of Europe: France, Germany, Italy, and the United Kingdom. The sample was further split into organizations categorized as either "process" or "discrete" manufacturers. Table 1 sets out definitions of activities that comprise process and discrete manufacturing. Dataquest interviewed 62 process and 64 discrete manufacturing organizations.

Dataquest's research suggests that time-based competition based on shorter production cycles, manufacturing to order, and mass customization are the most significant driving business forces in play in the European manufacturing industry today. IT executives are, as a consequence, heavily involved in installing open, interoperable systems, establishing common data strategies, and integrating information between suppliers and customers.

Dataquest's research finds that organizations characterized as discrete and process manufacturers display very similar attitudes toward key IT issues and exhibit similar adoption rates and time lines. Examining respondents from these different categories' responses to questions regarding the way in which they are implementing technology highlights very common approaches to technology management.

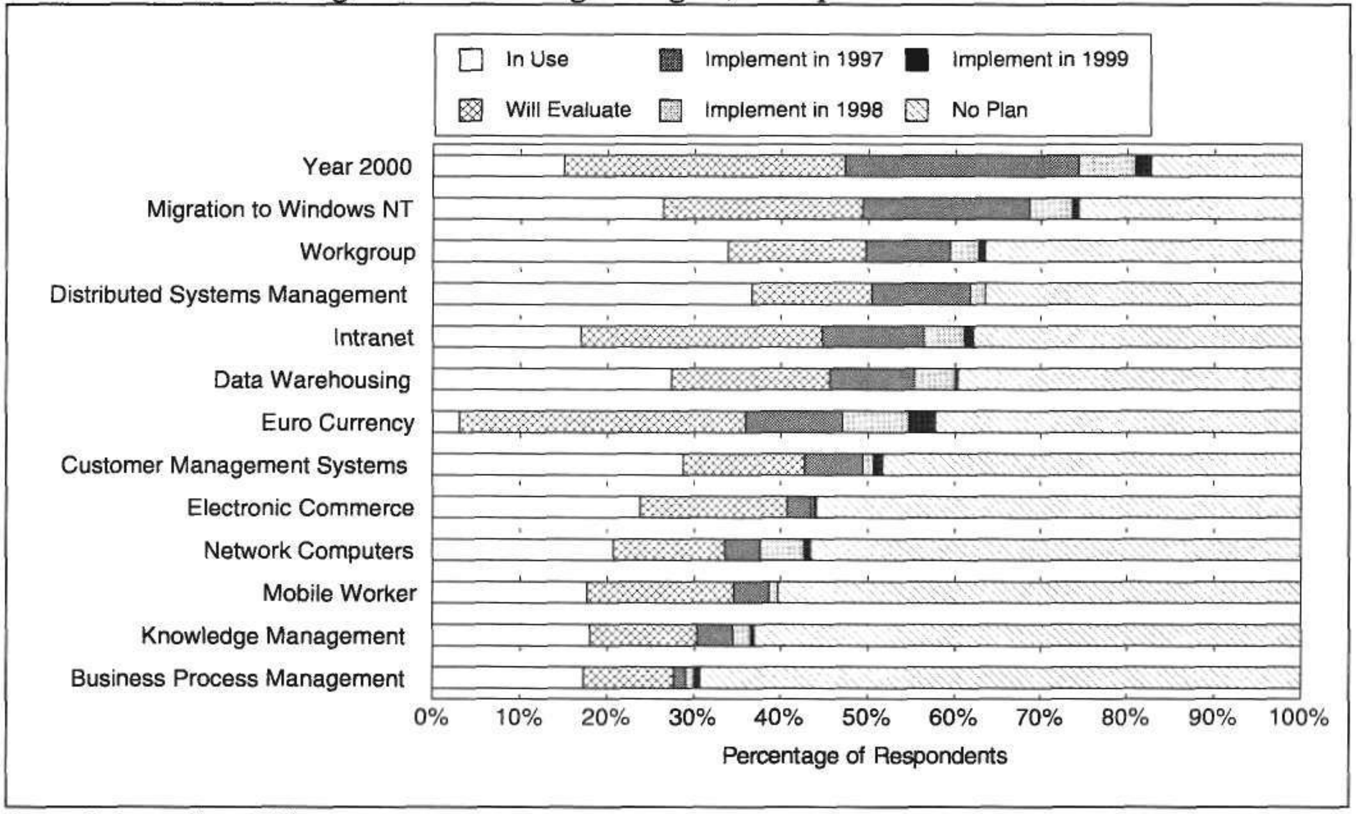
Figures 1 and 2 show, respectively, process and discrete manufacturers' implementation intentions toward 13 key business and technology issues. The pattern of responses is, with a certain number of exceptions, almost identical. Both process and discrete manufacturers display the same focus on cost and efficiency through the rationalization of existing IT infrastructures.

Table 1
Industry Sector Definitions

Industry Sector	Activities
Process Manufacturing	Food, tobacco, textile production, paper and pulp, chemicals, petroleum, rubber, stone, glass, and primary metals
Discrete Manufacturing	Apparel, lumber furniture, printing and publishing, leather production, fabricated metals, computers, transportation, and industrial equipment

Source: Standard SIC Codes and Dataquest (June 1997)

Figure 1
Process Manufacturing, Intentions Regarding IT, Europe 1997-1999



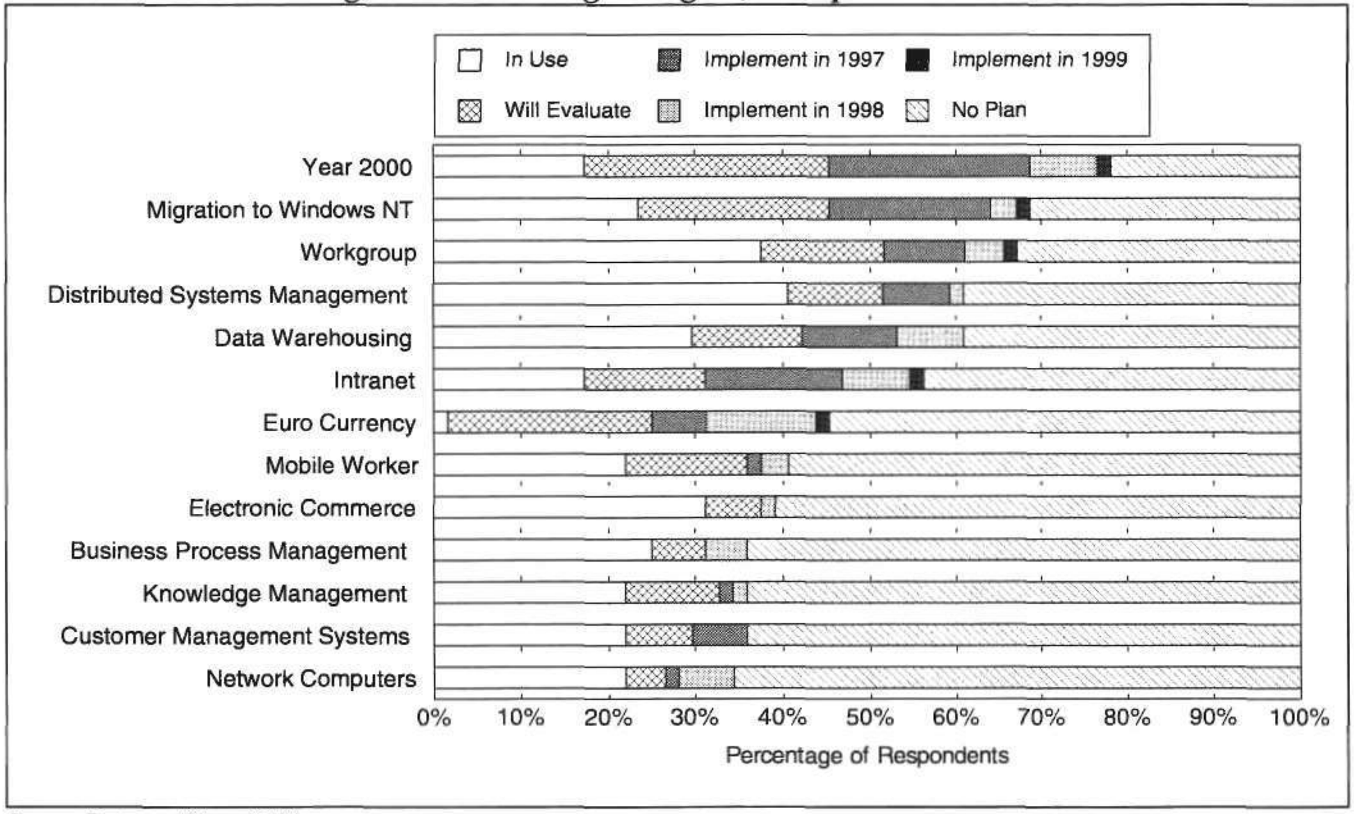
Source: Dataquest (June 1997)

One of the key building blocks in this process has been centered around the evolution of Manufacturing Resource Planning (MRP) systems into Enterprise Resource Planning (ERP) systems. MRP technology, with its mainframe background, is now heavily installed across the broad majority of manufacturing industry and has produced significant benefits in user organizations, but is now being superseded by the widespread adoption of client/server based ERP technology.

The spectacular success the leading ERP software vendor, SAP, has enjoyed over the last three years is testament to the impact ERP software has had in the European manufacturing sector. SAP's overall revenue grew at almost 40 percent in 1996 reaching $1,133 million in Europe. Much of SAP's success has been predicated on the enterprisewide integration of different business processes that ERP technology facilitates and that are increasingly key to manufacturers' continued competitiveness in global markets.

The trend toward greater and greater levels of consolidation and integration is having a number of consequences for software and services vendors, most noticeably the continued movement in certain industries toward a common IT infrastructure, which all participants in a supply chain are adopting as a way of remaining competitive within a specific marketplace.

Figure 2
Discrete Manufacturing, Intentions Regarding IT, Europe 1997-1999



Source: Dataquest (June 1997)

The advent of ERP-based systems is, as both a cause and effect, altering the way in which manufacturing organizations operate. MRP systems historically have essentially operated within a supply push business model, where goods are produced and then sales and marketing teams are required to sell them. ERP is increasingly moving operations toward a demand-side pull business model where information from the marketplace is instrumental in decisions about what and where good are manufactured.

This demand-driven paradigm is affecting all aspects of the manufacturing industry, including forecasting, distribution, plant planning, inventory, procurement and sourcing. Because of this complexity there is increasing demand for technology that can assist organizations to connect with other elements of the supply chain in which they operate. Consistency of underlying IT architectures and platforms is a key element of this requirement. ERP software is now being seen as one way of creating this consistency.

Extended Enterprise Resource Planning Software (EERP) is the next logical step in this dynamic. Much of SAP's development focus is in utilizing Internet technology to increase cross-organization cooperation.

Forty Percent of Manufacturing Organizations Trade Electronically

Dataquest's research provides further evidence of manufacturers' focus on more than just their own internal operations; they are looking externally and attempting to reduce cost in their supply and distribution networks.

Business school-developed arguments that single companies will not be able to compete in future markets against companies in interlinked supply chains is forcing organizations to pay great attention to the entire supply chain in which they operate. Though the continuing search for efficiency and faster/cheaper versions of the installed base will remain a high priority, the next generation of savings and efficacy will occur beyond the internal walls of the industry and within an organization's broader, holistic operations.

As a result, organizations are focusing on supply chain development and support, adopting enabling technologies ranging from Internet browsers to high-bandwidth networks.

Achieving these objectives requires close integration among all players in a particular supply chain, which itself requires the facilitation of information flows passing consumer and production information. The resulting demand is for technology integration, real-time information collection, and distribution and collaborative workgroup tolls and technologies.

Underpinning these moves has been the continuing development of EDI. EDI has been a common technology in the manufacturing industry since the 1970s, but it has never become as prevalent as its champions would have wished. EDI has long faced issues of cost and complexity and its propriety nature. (Different suppliers have propagated differing flavors of EDI.) The promise of EDI is set, however, to be delivered by the second generation of electronic information exchange: electronic commerce. The possibility of EDI over the Internet and the emergence of extranets (Internet technology linking organizations together) is quickly becoming a reality for a whole host of European and American manufacturing businesses.

Almost 25 percent of manufacturing organizations are currently using forms of electronic commerce, while another 15 percent are evaluating it over the course of 1997.

The giant U.S. organization, General Electric (GE), is at the forefront of utilizing Internet technology to facilitate broad and simple EDI with its suppliers and its onward-facing customers. GE now places information outlining its requirements of its suppliers in HTML form on its "TradeWeb" system for any and all of its suppliers to interrogate, allowing these suppliers to connect directly with it through Internet technology. Cost savings are already being spoken of in terms of billions of dollars, and this approach is sweeping throughout the whole of GE's business.

Another element of developments in the Internet and electronic commerce is the emergence of the network computer (NC), which promises cost-effective IT tailored for tasks for which PCs are unnecessary. The manufacturing industry has become a key target marketplace for manufacturers of the NC.

The combination of the high cost of PCs and manufacturers' low need of a PC's functionality has kept PC penetration rates low on factory floors. However, the NC as a (potentially) cheaper technology allied to a specifically tailored functionality set promises both the replacement of "green screens" and the penetration of entirely new areas. Of manufacturing organizations, 20 percent state that they will implement or evaluate the utilization of NCs over the course of the next two years.

Windows NT Penetration Rates Set to Increase Substantially

Another aspect of the consolidation and rationalization of IT infrastructures that is prevalent within the manufacturing industry at present is the moves manufacturers are making toward Windows NT. Dataquest's research provides evidence of the explosion that is happening in the uptake of Microsoft's enterprise operating system, Windows NT. By the end of 1997 almost half of European process manufacturing organizations will have implemented Windows NT while another 20 percent will be at some stage of evaluating it.

Discrete manufacturing organizations display slightly lower levels of migration toward Windows NT—42 percent of user organizations will be utilizing Windows NT by the end of the year, but clearly also appear to be significantly engaged in what is becoming an industrywide decision to endorse Microsoft's movement into "big iron" computing.

Only about one-fourth of the respondents in each of the two industry sectors, appeared in early 1997 to have no plan to make any investment in Windows NT. As is common with Dataquest's recent European user research, user organizations provided inconclusive evidence toward Windows NT (as indeed they did with all the other issues they were queried on) in the medium term. Organizations' planning cycles appear to be such that issues are either being acted on presently or are nothing more than of peripheral interest. Only small numbers of both process and discrete manufacturing organizations state that they will implement Windows NT technology in 1998 or 1999.

The utilization of NT is clearly seen as a strategic decision and one subsequently handled as a core part of an IT department's activities.

Manufacturing Organizations Focus on Distributed Systems Management

DSM, a consequence of organizations' move to distributed, decentralized computing platforms, is an area of major concern for the European manufacturers surveyed by Dataquest in January.

Slightly less than 40 percent of discrete manufacturing organizations and slightly more than one-third of process manufacturers already employ some from of DSM. The high incidence of DSM suggests that manufacturing organizations are further advanced in deploying client/server technology than organizations in other vertical markets and industry sectors. The "compete or die" imperative of competition with other parts of the world has become an overriding issue for the European manufacturing industry, and its impact on IT has meant a focus on efficiency and cost reduction.

Dealing with the complexity of heterogeneous, client/server-based environments is perhaps the top challenge that IT managers face today and the manufacturing companies surveyed in Dataquest's survey reflect the true nature of the problems they face on a day-to-day basis. New networking technologies, including the Internet, are only adding to these challenges, but they are additive rather than replacement problems.

DSM is a core part of the operational requirement in European manufacturing industry as focus on issues such as total cost of ownership (TCO) become increasingly high profile.

Dataquest Perspective

Senior IT executives within both process and discrete manufacturing organizations are struggling to deal with an unprecedented set of challenges caused by change in the businesses conditions they operate within and the technology available to them to support their business operations. Amid an accelerating rate of change, IT managers must juggle the conflicting demands of managing today's IT while creating the infrastructure to manage rapidly emerging new technologies that threaten to invalidate many accepted orthodoxies.

Whole new classes of technology are becoming available, while IT managers are still attempting to deal with problems caused by previous generations of technologies. While the IT hype bandwagon moves on, IT managers are left behind, trying to perfect ways of dealing with the realities of yesterday's promises.

As technology creates new business possibilities, for example the emergence of electronic commerce, conservative IT managers are having to manage their already-installed base technology—witness industry interest in TCO.

Users surveyed for this End-User Analysis study reflect these dichotomies of dealing with promise and reality; while the brave ones express interest in electronic commerce and are investing in intranet applications, large mainstream European IT users are focused on managing their existing infrastructures, solving the year 2000 problem while trying to ignore the awful truths that EMU promises to raise.

IT managers are spending on IT projects within two identifiable parameters: firstly, projects aimed at developing systems that facilitate value creation; secondly, projects required as necessary to maintain an organization's infrastructure but that are regarded as costs with no positive business return. Dataquest's research suggests that European organizations will focus increasingly on these second, "defensive," initiatives over the next two years rather than on the first more "offensive" type of project.

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Perspective

Mechanical CAD/CAM/CAE Worldwide

Market Analysis

Automotive Manufacturing Industry

Abstract: *Automakers and suppliers are facing numerous challenges for which IT solutions offer a means to counter the negative business impact and optimize the business opportunities created by trends in globalization, consolidation, and environmental and safety regulations. This market analysis links the key business issues and trends that are driving IT opportunity within the automotive manufacturing industry for technologies and related IT services. Emphasis is placed on vehicle and related parts manufacturing.*
By Cynthia Moore

Introduction

This Perspective was originally published for Dataquest's Vertical Market Opportunities North America service (PSVM-NA-DP-9704). While the document addresses IT opportunities in the U.S. automotive industry and does not focus specifically on mechanical CAD/CAM/CAE, Dataquest believes that the information presented here will help Mechanical CAD/CAM/CAE Worldwide clients understand basic dynamics of the U.S. automotive industry, one of the larger consumers of CAD/CAM/CAE software today.

Industry Overview

The U.S. automotive industry is a 15.1 million-unit-per-year business, generating one-sixth of all U.S. manufacturers' shipments of durable goods and consuming 30 percent of the iron, 15 percent of the steel, 25 percent of the aluminum, and 75 percent of the natural rubber purchased by all industries in the United States, according to U.S. Department of Commerce figures. Sales of motor vehicles for 1996 exceeded $260 billion, about the same as sales levels for 1995.

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The Commerce Department's Bureau of Economic Analysis (BEA) reports that in 1995, the automotive industry (Standard Industrial Classification 371 "Motor Vehicles and Equipment") accounted for 9 percent of the private industrial employment provided by manufacturers of durable goods in the United States. BEA data shows that industry firms as defined by SIC 371 directly employed 899,000 U.S. workers in 1995, almost 79,000 more than in 1992, and the highest level since 1979. Its employees earned compensation totaling $60 billion, a 33 percent increase over 1992 and equal to 12 percent of the total paid by durable goods manufacturers.

The U.S. automotive industry has made substantial investments in its U.S. facilities. According to the latest Bureau of the Census data, expenditure by motor vehicle and equipment manufacturers for new plant and equipment totaled an estimated $16 billion in 1994--more than 8 percent of total plant and equipment investments by manufacturers in the United States. Between 1992 and 1994, the industry's total plant and equipment investment amounted to $36.8 billion. The U.S. motor vehicle manufacturing industry consists of three American, two German-affiliated, and seven Japanese-affiliated manufacturers of light vehicles (LV) plus five large and about 100 medium and smaller assemblers of commercial vehicles. Collectively, the industry produced 11.8 million vehicles in 1996, and slightly more in 1995.

The U.S. automotive parts industry comprises some 5,000 companies--including about 500 Japanese, European, and Canadian manufacturers that supply either the original equipment (OE) market, the replacement parts market, or both. For 1995, automotive parts production reached $131 billion, according to the latest commerce figures. The U.S. parts industry is dominated by 50 large manufacturers that account for the large majority of sales. From 1992 to 1995, North American sales by these top 50 suppliers increased by almost 50 percent, growing from $68 billion to $101 billion. The U.S. has the world's sales leader, GM's Delphi Automotive Systems, with 1995 global sales of over $26 billion—$10 billion more than its nearest foreign competitor. In 1995, U.S. automotive parts industry employment reached 711,000, its highest level since 1979, according to BEA statistics. Employment has grown at an average of 5 percent annually since 1992, when it totaled 610,000.

For 1997, the consensus of many industry experts is that new U.S. light vehicle sales will stay at about 15 million units. Many analysts believe that the automotive market will remain relatively unchanged for several years. With no overall market growth expected by analysts over the next few years, local competition among existing players is expected to intensify. The anticipated entry of several new foreign suppliers beginning with Korea's Daewoo in late 1997 is likely to make their effort even more difficult.

U.S. motor vehicle production is expected to remain fairly constant for the next several years at about 12 million units per year. Table 1 summarizes key business trends and issues shaping IT opportunity in the automotive manufacturing industry (automakers and component suppliers) during this time frame.

Table 1
Key Trends and Issues—Automotive Manufacturing

SIC Code	Automotive Manufacturing Industry Subsegment	Business Challenge	IT Trends
3711/ 3713/ 3715/ 3716	Motor vehicles and car bodies; truck and bus bodies; truck trailers; motor homes	■ Globalization ■ Intelligent transportation systems (ITS) development/product liability ■ Regulatory compliance (environmental/safety) ■ Cost reduction (development and manufacturing) ■ Decrease time-to-market ■ Market expansion ■ Improved customer service	■ JIT production methods ■ Radar/sensor systems/CCTV ■ Antitampering protection/on-board diagnostics/smart systems ■ Intranet development/electronic commerce ■ Digitization of the development process CAD/CAM/CAE and VR technology investment related to design process and clinic/research work
3714	Motor vehicle parts and accessories	■ Consolidation and restructuring ■ Logistics management ■ Globalization ■ Link with automakers ■ Cost reduction, design improvements, and raising quality levels	■ Standardization ■ Supply chain management/integration ■ Regional factory and design center linkage (data/voice/video networks) ■ Investments in CAD/CAM/CAE, cost control systems, quality-based processes (QS/9000)

Source: Dataquest (March 1997)

Automakers

Leading U.S. automakers include General Motors Corporation, Chrysler Corporation, Ford Company, and Toyota Motor Manufacturing USA. The most pressing issues for automakers are in the areas of globalization, lead time and cost reduction, and improvements in quality and supplier linkages as follows:

- Globalize business—By maximizing the use of design, engineering, and manufacturing resources, automakers can increase economies of scale and take advantage of newly opened markets. To this end, automakers are colocating workers either physically or electronically. Global telephone, video, and satellite networks are being sought to offer real-time access to colleagues and data that are resident elsewhere.
- Lead time and cost reduction—Slashing time-to-market allows manufacturers to better respond to market trends and dynamics while reducing underlying costs. Consequently, virtually every aspect of the automotive development process is being moved from paper, clay, and sheet metal to digital form, requiring extensive investment in advanced

Computer-Aided Design/Computer-Aided Manufacturing/Computer-Aided Engineering (CAD/CAM/CAE) technology. Similarly, extensive use of processing power to improve market research and analysis is also required, as is increased investment in VR applications for both the design process and clinic/research work. Such significant investments in technology can reduce time-to-market from five years or longer to as little as 18 months. Lastly, the development of internal intranets fulfill a critical business role while lowering design and engineering costs, and by ensuring that all relevant parties are advised of project modifications, such as notifying a suspension engineer when changes are made to tire size, which can alter handling performance.

- Improvements in quality and supplier linkages—Quality is now the cost of doing business; the results of increased quality are higher levels of customer satisfaction and retention while lowering warranty costs. Required technology includes extensive use of quality-oriented tools, such as QS 9000, a process that is designed to prevent the initial occurrence of defects. Supplier linkages are also a key factor in achieving cost reduction and shortened lead times. Manufacturers are reducing the number of suppliers, but those that remain in Tier I must assume additional design and engineering responsibilities from automotive partners. Consequently, suppliers must be well-integrated with the automaker's internal IT systems to facilitate a more active role beginning with concept development and engineering.

Component Suppliers

Leading U.S. automotive component suppliers include Delphi Automotive Systems (GM subsidiary), Goodyear Tire & Rubber Company, Tenneco Automotive, and Federal-Mogul Corporation. The most pressing issues for component suppliers are similar to the automakers they serve in terms of the need to globalize business operations; reduce costs, improve designs, raise quality; and establish better links. These issues are detailed as follows:

- Globalize business—Similar to the auto manufacturers, suppliers must globalize operations and maximize economies of scale in the process. To this end, regional factories and design centers must be linked by data, voice, and video networks
- Reduce costs, improve designs, and raise quality—Suppliers must meet the same basic set of market demands facing customers and the automakers. Consequently, suppliers are also increasingly being held responsible for compliance failures by sharing costs of recalls and warranty repairs. The pressure on margins continues to grow as automakers demand annual price cuts on existing contracts, resulting in the implementation of CAD/CAM/CAE technologies, improved cost control systems, and the application of quality-based processes, such as QS9000.
- Link with automakers—Suppliers are being brought into the design and development process, resulting in increased linkage between factories and design centers as well as improved access to internal manufacturers' systems. Depending on supplier and manufacturer, integration may

represent a significant challenge to the supplier if unique hardware and software systems are involved for each OEM customer.

The Massachusetts Institute of Technology and the U.S. Department of Commerce recently identified the following "dynamic changes" at work in the U.S. automotive vehicle and parts industry:

- The automotive business is played out on a worldwide stage. Supply chains are long and complex, and there are many important players both upstream and downstream of the major manufacturers. Speed and flexibility in detecting shifts in market opportunities and reconfiguring the supply chains to respond to the opportunities will be the important assets.
- Although private sector companies dominate many aspects of the industry in the developed world, governments have historically played, and will likely continue to play, major roles in shaping the industry.
- Dramatic changes in product and market leadership, technology, distribution channels, and geography of production have occurred in the past two decades.
- Sales volume is likely to continue its exponential growth in developing countries, and comparatively flat demand will continue in the developed world.
- Severe competition is likely in every segment of the supply chain, driving innovation in business models and causing continued turbulence in the standings of different players.
- Especially in the developed world, public pressures to make vehicles safer and more environment-friendly are unlikely to abate.
- Cost competition will continue to encourage "world car" concepts that spread development efforts over more production units.
- The economics of development and manufacturing support predictions of industry concentration, but the splintering of the distribution chain, the geographic dispersion of market demand, and the possible radical shifts in technology may encourage disaggregation.
- The industry will continue as a knowledge-intensive industry, as opposed to the more limited activities of cutting, forming, and joining metal.
- Electronics will continue to be an important part of the product.

Dataquest notes that there are several other dynamics under way in the automotive market that can be added to this list in relation to overcapacity, and they are as follows:

- Currently, global capacity is in place to produce about 45 million units annually (according to Detroit-based Harbour & Associates). By 2002, production could reach 65 million units, and although demand is expected to increase during that time frame, it is not likely to expand at the same pace.

- Due to increased overcapacity and cost realities, OEMs will continue to seek partnerships and joint ventures around the globe. Recent examples of these initiatives include collaboration in minivan production at the Ford/VW plant in Portugal and the BMW/Chrysler plan to produce a new generation of small engines in Brazil. Key Business and Technology Trends

Dataquest believes the following key trends will significantly impact the use of information technology and the composition of IT solutions for providers of technology and related external IT services to the automotive manufacturing industry.

Competition

Business Trends—Consolidation and Restructuring

Automakers increasingly expect automotive suppliers to provide integrated automotive systems rather than individual parts. This has led to individual component suppliers to merge or for one large company to acquire a number of smaller companies in order to offer complete automotive systems to the market. There is a growing risk for suppliers that if they do not offer vertically integrated systems, they will be eliminated as top-tier suppliers to the automakers. There are currently three tiers to the automotive supply chain: the first tier supplies integrated automotive systems directly to the automakers; the second tier supply the intermediate components to the first-tier suppliers; and the third tier supplies basic components and materials to the second tier.

In a speech given by Chrysler vice president of procurement and supply, Thomas T. Stallkamp, to the Automotive Supplier Conference & Exhibition delivered late last year in Detroit, Mr. Stallkamp cited that during 1996, the total price tag for mergers among automotive suppliers was estimated at $10 billion by industry executives, with the potential of reaching $15 billion in 1997. Many within the industry also believe that "merger-mania" is only starting to gain momentum in the automotive supplier community. This merger momentum could create a number of problems for suppliers. First, an automotive supplier could buy the wrong company and find itself with plants, product lines, and extra baggage that do not match its objectives. Second, a supplier might buy a company for its specialized technology, only to watch the technology change or disappear. Finally, a supplier could buy a company that is too large and find itself strapped with larger debts and fewer options for growth.

Technology Impact—Standardization of Information Systems

This trend toward consolidation and the attendant business issues create an opportunity for information technology systems to assist in integrating the larger automotive supply companies and to integrate the supply chain as a whole. Certainly, elimination of redundant technology and coordination of existing technology is a priority for these companies.

Also the entire supply chain, in order to operate more efficiency, requires better coordination and elimination of redundancies and outdated information technology. The Automotive Industry Action Group (AIAG), a joint business-government body, has estimated that the North American automotive industry could save billions of dollars annually and increase its competitiveness through cooperative efforts in IT standardization and coordination. AIAG noted that communication and interaction throughout the supply chain is critical. The group estimated that more than 60 percent of the cost of a new vehicle comes from the supply chain.

Global Supply Chains

Business Trends—Globalization

U.S. automakers are expanding rapidly overseas, with increasing emphasis on emerging markets such as Asia, Eastern Europe, and Latin America. Automakers are expanding overseas in order to take advantage of lower costs in labor, raw materials and finished products, and to have a physical presence in growing overseas markets for automobiles. First-tier suppliers are following the automakers to provide integrated components in a timely manner to the automakers' manufacturing plants. Automakers are delegating much of the responsibility for meeting fuel efficiency and emissions control laws in various countries to the suppliers who manufacture those related systems. Vehicle sales and production in the United States, Europe, and Japan are expected to be stagnant, while annual growth rates in Asia, Eastern Europe, and Latin America are expected to increase by double digits, according to findings by the Commerce Department's Office of Automotive Affairs in a paper published in February of this year on future trends in the auto industry. In China, light vehicle production is expected to increase by 25 percent annually through the turn of the century. The number of cars and trucks on the road in China will more than double over that period—from 3 million to at least 7 million. India is another country with tremendous potential. Vehicle production in India is expected to grow more than 10 percent annually.

Technology Impact—Just-in-Time Production

The automotive industry continues to move toward just-in-time (JIT) production methods, where component suppliers establish manufacturing facilities close to the vehicle assembly plant and provide components to meet the production schedules of the automakers. The business impact is lower transportation, logistics, and warehousing costs. However, with a global supply chain, JIT production becomes an increasingly complex operation. While first-tier suppliers are following automakers overseas and setting up manufacturing facilities close by, the second- and third-tier suppliers, with less capital and greater diversity of customers, are not rushing overseas. This disparity is creating logistical problems for the first-tier suppliers, requiring a global data and communications network to coordinate production schedules and supply lines. The IT industry can assist these suppliers in providing greater integration of communications networks among the various tiers of the supply chain and over wider geographic areas. Improved inventory management practices and technology would also benefit these suppliers, so that the lower-tier suppliers are able to contribute to, rather than become obstacles for, the JIT production method of the first-tier suppliers and automakers.

Component suppliers are already operating at razor-thin margins, while facing pressure to trim costs and margins even further. At the same time, suppliers are being told to adopt IT-style production and delivery systems, forcing an increasing number of suppliers to build satellite plants adjacent to their customers' assembly lines. But as these lines slow down or idle, suppliers could be seriously hurt.

Spurred in part by the issue of overcapacity, manufacturers are looking for ways to rationalize capacity, leverage assets, and minimize fixed and other costs. They may also see this as a way to reduce competition or enter new market segments. In some cases, this approach may result in outright acquisition, such as Ford Motor Company's takeover of Jaguar cars. More often it results in strategic partnerships and joint ventures. Ford, for example, has assumed a near-controlling role in the operation of its Japanese affiliate, Mazda Motors, which also suggests that it will cooperate on the design, development, manufacturing, and timing of future products. Ford also has a much more limited partnership with Volkswagen to produce minivans at a plant in Portugal.

The joint-venture approach is particularly useful to gain entrance to emerging markets, such as China or India. In many cases, outside companies are not permitted to own a controlling interest. In others, the local partner serves to facilitate government relationships, among others. These situations create a variety of problems and IT issues that include the need to colocate worker knowledge and the challenge of breaking down cultural, technical, and time barriers.

Transportation

Business Trend—Intelligent Transportation Systems

There is a growing trend to have more elaborate information technology systems in automobiles and to have the systems connected to outside IT systems, such as traffic information systems or global positioning systems that allow a satellite to traffic a vehicle and give travel directions. Intelligent transportation systems (ITS) are new technologies that provide answers to the problems of daily commuting. ITS could use existing roads while increasing their capacity, reducing toxic emissions and fuel consumption. The following are some of the automotive components and systems that could be used in the developing ITS area: automatic 911 dialing in the event of an accident, reporting vehicle location to police and emergency crews; computer screen displays to aid driver when visibility is poor; sensors that would keep driver from losing control; sensors to indicate if there was a danger of hitting another vehicle or person, with an automatic application of brakes as a potential response; remote button to start vehicle from distance; automatic pilot; voice activation to operate car; and travel navigation system using satellites to find vehicle location and plot the best route. Industry estimates suggest that the market for ITS-related automotive systems could reach $656 million by the year 2001, averaging a 31 percent annual growth rate.

The world's first automated public highway will go into prototype operation this August at a 7.6-mile portion of I-15 north of San Diego. A fleet of specially equipped vehicles will be able to use the highway's express lanes for hands-free driving. This operation is part of a seven-year, $250 million project dubbed the NAHSC, or National Automated Highway System Consortium. The consortium is a public/private partnership linking a number of government agencies, research labs, and universities with numerous IT companies, hardware manufacturers, and automakers, including GM (a prime partner), Honda, and Toyota. A second-phase effort will begin in 2002, and the goal is to begin operation of true public automated highways shortly after 2020.

While this program is under way, additional public and public/private programs are in process. Last year the federal government authorized a program that will eventually create regional traffic centers in as many as 75 major American urban markets. These centers will be linked by digital radio or other means to in-car navigation systems. The concept is to allow motorists to use on-board navigation systems for real-time routing and traffic advisories, including the posting of detours and alternate routes in the event of traffic tie-ups.

Technology Impact—Better IT Components and Coordination with Other IT Sources

The U.S. government has identified five ITS segments that would reduce traffic congestion: advanced public transportation systems (APTS), advanced traffic management systems (ATMS), advanced traveler information systems (ATIS), advanced vehicle control systems (AVCS), and commercial vehicle operations (CVO).

In the more consumer-oriented ITS segments, IT companies could focus on improving system capabilities and user-friendliness. One area of concern for manufacturers is product liability. For example, in the ATIS market, a map display located on the dashboard could distract the driver and cause an accident. Voice-prompted systems would be a safer alternative because there are no buttons to push and the driver's eyes will not be averted from the road. In the AVCS market, radar and sensor systems can detect pedestrians around vehicles and buses. Car companies like BMW have a system that aids drivers in parking their car by using a sensor and sound system. Night vision and cooperative cruise control are still in the testing stages and liability possibilities are still being examined. ATMS collects data on the flow of vehicle traffic through sensors and closed circuit television (CCTV). This system is used to keep commuters informed of traffic problems and to distribute information to set the metering lights during peak traffic flow periods. All of these segments have a potential demand for IT product applications and innovations.

The ITS concept is evolving via efforts to develop fully integrated "smart" cars and "smart" in-car hardware. For example, next year Mercedes will unveil an Adaptive Cruise Control system, which will use radar to monitor the position of the car immediately ahead. Speed will be set, as with normal cruise, but will automatically adjust to the forward car's speed pattern. Several systems have already been developed that are able to initiate calls for assistance, including the automatic dialing of 911 in an accident severe enough to set off an air bag—GM's OnStar system. OnStar is evolving its "smart" capabilities further in the creation of a "concierge" service by which motorists/subscribers may call for routing information, flight scheduling, or to order floral arrangements.

Regulatory Requirements

Business Trend—Environmental Protection and Safety Standards

Two regulatory areas that greatly affect the automotive industry are environmental protection, particularly the Clean Air Act, and various vehicle safety standards. The Clean Air Act requires gradual emissions reductions for vehicles into the next century. At the end of last year, the Environmental Protection Agency (EPA) proposed stricter ozone and particulate matter standards, which are expected to require additional expenditure by automakers and parts suppliers to meet. These requirements have led to technological developments within the automobile to reduce emissions using electronic systems and components. Also each state has the responsibility of meeting the federal emissions requirements in its own way. California has adopted stricter emissions standards than the federal law requires. This has led to additional costs and complexity for automakers and suppliers.

Many safety regulations impact vehicle makers and suppliers, from crash standards to brake testing to air bag deployment rates. In March of this year, the National Highway Traffic Safety Administration (NHTSA) issued a final rule allowing automakers to reduce the speed at which air bags deploy. The ruling came in response to instances where children where killed or seriously injured by deploying air bags. The NHTSA proposed a number of possible additional changes to address this problem, including allowing current owners to have mechanics or dealers disconnect air bags and allowing automakers to include air bag cut-off switches to turn off the air bag if small children are present.

Technology Impact—IT Solution Needed to Regulatory Problems

In the emissions control area, on-board computers allow a significant reduction in emissions through adjusting the performance of the vehicle's systems and monitoring the emissions output. The on-board diagnostics systems allow for greater efficiency in vehicle operations and lower emissions levels, but the diagnostics systems have created problems for replacement parts makers and mechanics. The regulations require that the computer systems have antitampering protection to prevent it from being circumvented and to protect proprietary information of the automaker.

However, the replacement parts makers and repair mechanics complain that they are unable to manufacture and service vehicles because they cannot access the computer system to build replacement parts that will work properly and to repair the vehicles. One area where IT companies could offer a solution to this problem would be to design a computer system that prevents tampering, yet allows replacement parts makers and mechanics to gain appropriate access. Also the recent proposal of stricter EPA air standards has generated opposition among automakers and suppliers because of the additional costs that may result for these companies. A more sensitive computer system on-board the vehicle may be able to meet the stricter standards without a significant cost increase for the automotive industry.

On the air bag deployment problem, one solution being discussed by automakers and government regulators is the development of "smart air bags." These would have sensors that could determine the speed of the accident and the location and size of the passengers and adjust deployment speed accordingly. U.S. automakers announced at the beginning of this year that they are speeding up their research into "smart air bags" through the U.S. Council for Automotive Research. The smart air bags could also deactivate if a child is detected in the front passenger seat. NHTSA has proposed setting a phase-in schedule for production of "smart air bags" to begin in the fall 1998 for 1999 model year automobiles.

Internet, Intranet, and Electronic Commerce

Business Trend—Cutting Costs through Electronic Commerce

Automotive companies are trying to cut costs, improve customer service and expand their market through the use of a variety of on-line applications. Automaker Chrysler estimates that it is reducing operating costs by more than a billion dollars a year using online applications, such as Lotus Notes and dial-up links. By extending its electronic commerce efforts over an industrywide network, Chrysler expects to double savings over the next three years. Earlier efforts to reduce costs by the automaker led to the launch of Supplier Cost Reduction Effort (SCORE) 1989 when Chrysler offered its suppliers a cut of whatever cost savings they could achieve. SCORE went online three years ago; with the second phase of this electronic-commerce application, the automaker expects cost savings of $2 billion annually by the year 2000. Similar electronic commerce efforts are also under way at GM and Ford, as well as major automotive suppliers.

Technology Impact—Intranets and Electronic Commerce

All automakers and many major parts suppliers have already set up Web sites and are actively integrating their information technology systems with the Internet. This capability allows automakers to interact with their dealers, car buyers, and parts suppliers on a more efficient basis. Also parts suppliers are better able to coordinate their order of parts from lower level suppliers with the production schedules of their automaker customers. Also, a growing number of consumers are researching and purchasing their vehicles through the Internet. This type of purchasing will only increase in the future, creating a medium/tool for automakers to expand their market presence in both domestic and global economies. However, the parts aftermarket area of the automotive industry is lagging in electronic commerce development. In this area, electronic commerce applications are only now taking hold.

Market Size and Forecast

Significant business trends and related issues challenging industry executives are driving IT opportunity in automotive manufacturing. To position the relative size of this opportunity, Table 2 offers a top-level U.S.

market size and forecast for transportation equipment. This size and forecast for total IT is extracted from Dataquest's 1996 IT market sizing for all discrete manufacturing industries. (Note: This market sizing represents Dataquest's preliminary assessment of IT opportunity, as defined by Dataquest, in the manufacture of transportation-related equipment.)

Dataquest's market size and forecast for transportation equipment manufacturing includes all industry subsegments within SIC 37: motor vehicles and car bodies; truck and bus bodies; motor vehicle parts and accessories; truck trailers; motor homes; aircraft; shipbuilding; boatbuilding; railroad equipment; motorcycles; guided missiles and space vehicles; tanks; and travel trailers. Dataquest estimates that all motor vehicle components of SIC 37, including motor vehicles and car bodies, truck and bus bodies, motor vehicle parts and accessories, truck trailers, and motor homes) represent about 67 percent of total IT opportunity associated with transportation equipment manufacturing (SIC 37).

Although this Perspective targets assessment of market opportunity specific to automotive manufacturing, additional insights regarding other components of the automotive value chain are discussed in terms of IT provider capabilities. These components include distribution (dealers) and business services (repair, rental, and leasing services).

The IT market associated with the transportation equipment manufacturing industry represents about 22 percent of the total IT market for all discrete manufacturing industries and has a five-year total IT CAGR of slightly over 9 percent. Across all IT categories, IT Services and IT Telecom reflect the most rapid year-to-year growth. These higher-growth areas are driven by key business needs rooted in globalization and a strong emphasis on supply-chain management and integration requiring significant process and systems integration, translating at a top level into communications and services investments. For comparative purposes, the market sizing for total discrete manufacturing and other comparative data is published in Dataquest's report, *Vertical Market Opportunities: State of the Industries—1996* (PSVM-NA-MT-9601) (Note: This document is an annual publication of the syndicated Vertical Market Opportunities program; *Vertical Market Opportunities: State of the Industries—1997* is scheduled for release in the fall of 1997.)

Table 2
Total U.S. IT Market Size and Forecast 1995 to 2000: Transportation Equipment Manufacturing (SIC 37) (Millions of U.S. Dollars)

	1995	1996	1997	1998	1999	2000	5-Year CAGR (%) 1995-2000)
IT Hardware	2,494	2,722	2,916	3,143	3,371	3,646	7.89
IT Software	638	682	720	773	798	824	5.27
IT Telecom	763	896	1,003	1,066	1,159	1,242	10.25
IT Services	2,789	3,083	3,458	3,866	4,284	4,740	11.19
Total IT	6,684	7,383	8,097	8,847	9,612	10,452	9.35

Source: Dataquest (May 1997)

IT Providers—A Comparative Overview of Key Players

Information technology continues to play a strategic role in all segments of the automotive industry. Historically, technology has moved North American automakers toward standardized computing environments in support of integrating functionality across large enterprises, as well as global initiatives in product and manufacturing operations. The advancement of Internet technologies is a key component of current solutions being offered to the automotive industry as automakers seek to establish brand loyalty and deepen relationships with consumers (as well as gauge service expectations) through the marketing, research, and commerce potential of Web sites. Similarly, call center and customer service technologies have become a key means of entry into emerging related fields such as roadside assistance. IBM's joint development project with Daimler-Benz Research in development of a network computing architecture for Mercedes-Benz' next-generation cars is one example of current IT solution provider activity. All major systems (such as engine, lights, climate control, security, navigation, and communication) will be able to "talk" to each other via an in-car network. Follow-on development work will seek to pull information from the Internet and other communications networks.

EDS has targeted value creation for automotive clients with an emphasis on market agility and innovation (for example, the navigation and communication option for '97 Cadillacs called OnStar) and the benefits of integrated computing and communications infrastructures through higher levels of customer loyalty via offerings, such as GM Card and customer and roadside assistance. Outsourced business processes and supply-chain integration/logistics management associated with the automotive industry are strong focal areas for the largest IT solution providers and management consultancies, but are a key component in the development of new technology-based offerings among smaller players. Partnerships with leading (as well as niche) software players, such as Baan, are supporting a growing market opportunity linked to application architecture for virtual enterprise management. Brief demographics and portfolios of IT providers offering solutions to the automotive manufacturing industry are provided in Table 3 through Table 6.

Table 3
Automotive Industry—IT Solution Provider Statistics

Vendor	1996 Worldwide Automotive Revenue (Millions of U.S. Dollars)	Automotive Headquarters	Automotive Headcount
Baan	NA	Troy, MI	NA
EDS	NA	Plano, TX	NA
HP	$2 billion+	Novi, WI	300+
IBM	NA	Southfield, MI	NA
KPMG	100	North America—Detroit, MI Europe—United Kingdom Asia/Pacific—Melbourne, Australia	300
Silicon Graphics	700	Detroit, MI	75

NA = Not available
Source: Dataquest (May 1997)

Table 4
Automotive Industry—IT Solution Provider Subsegments

Industry Subsegment	Baan	EDS	HP	IBM	KPMG	Silicon Graphics
Light Vehicle (Manufacturing)	E	E	E	E	E	E
Assemblers (Manufacturing)	E	E	E	E	E	EM
Original Equipment Parts (Manufacturing)	E	E	E	E	E	E
Replacement Parts (Manufacturing)	E	E	E	E	E	E
Dealers (Distribution)	EM	E	E	E	E	EM
Repair/Rentals/Leasing (Services)	EM	E	EM	E	E	EM

Note: E = Established focus; EM = Emerging market
Source: Dataquest (May 1997)

Table 5
Automotive Industry—Geographic Coverage

Vendor	North America	Europe	Asia/Pacific	Latin America	Middle East	Africa
Baan	S	S	LS	LS	LS	LS
EDS	S	LS	LS	NA	NA	NA
Hewlett Packard	S	S	LS	LS	NA	NA
IBM	S	Western: S Eastern: LS	S	LS	LS	LS
KPMG	S	S	S	LS	LS	NA
Silicon Graphics	S	S	S	LS	NA	NA

NA = No presence or participation in this industry segment within this geography
Note: S (Strong) = Local presence in the automotive industry with over 20 percent of revenue for company in this industry associated with the specific geography (Can include predominant use of partners; must be a major geographic target for this industry); LS (Less strong) = Local presence representing under 20 percent of revenue in this industry (May be strategic for future or in high growth phase, but not a leading revenue generator)
Source: Dataquest (May 1997)

Table 6
Automotive Industry—Technologies, Business Applications, and Related Partnerships

Vendor	Key Technologies	Software Products/ Application Category	Alliance Partners
Baan	EDI	Manta (PDM)	BDM, Bain
	Orgware (automotive-specific models)	EDI products from Premenos and Sterling	KPMG
			Ernst & Young
			IBM
			Perot Systems

Table 6 (Continued)
Automotive Industry—Technologies, Business Applications, and Related Partnerships

Vendor	Key Technologies	Software Products/ Application Category	Alliance Partners
EDS	Internet/new media Client/server architecture Object technology Wireless data exchange Human computer interface Data warehousing/data mining Messaging Optical storage 3-D computer graphics and simulation Modeling software Interprocess communication middleware Collaborative software	File services Message services Data management Transaction processing Midrange transaction processing Multimedia Automated language and currency conversion	None identified
Hewlett-Packard	UNIX servers and workstations NT servers and clients Printers	OpenView (Network management) OpenMail (Messaging) HP Domain (Internet middleware)	SAP Baan SDRC Unigraphics QAD
IBM	Network computing Smart cards Embedded systems (architecture design for subsystems) Internet technologies Virtual product modeling Concurrent engineering	RISC technology (CATIA CADAM) Lotus Notes and Domino (Lotus technology software server allowing use of Internet technology) Middleware (dealer systems)	ERP vendors
KPMG	ERP Electronic commerce (Internet/intranet) Industrial CAD	SAP, Baan, Peoplesoft, Oracle, and Lawson software products Strategic cost management (target costing) Electronic commerce; knowledge management; year 2000: Red Pepper, I2, Manugistics	ERP: SAP, Baan, PeopleSoft, Oracle Strategic cost management: Decision Architects Industrial CAD: Concentra Corp.
Silicon Graphics	Graphics workstations (1); Web technology/VRML (2); Workstations/computer servers Supercomputers (3); Graphic supercomputers (4)	CAD: ProE/M.Series/Euclid/ Catia/UG/CADDS (1) CAID: 3-D Studio/Paint/CDRS; Styling SW (1) Cosmo Suite/Netscape Nav. (2); CAE: Ansys/Hypermesh/ Adams (3) Large Model Review/Render/ Visual Simulation (4)	PTC/SDRC/Matra Dassault/EDS/ CV (1); Alias/Wavefront/PTC (1); Cosmo/Netscape (2); MSC/Patran/ LSDyna/MDI (3); ProSolvia/EAI/CAD Centre/Dassault (4)

Source: Dataquest (May 1997)

Dataquest Perspective

Key areas that impact the success or failure of IT solution providers targeting the automotive manufacturing industry include the following:

- Supply chain management: With the increasing movement of U.S. automakers overseas, managing the supply chain will become an increasingly complex and global operation. Automakers are requiring first-tier suppliers to provide complete automotive systems and to build manufacturing facilities close to the automakers' assembly plants overseas. Yet, second- and third-tier suppliers are remaining in the domestic market, creating supply-chain management challenges. These suppliers will need assistance from IT providers in coordinating and standardizing the various information technology systems they use, and in developing databases that link and coordinate various suppliers in the chain with each other and with the automakers themselves.

- Regulatory compliance: Automakers and suppliers face regulatory requirements for both environmental and vehicle safety. Implementation of existing vehicle emissions standards and possible imposition of further requirements will necessitate the automotive industry increasingly to use on-board computer systems in vehicles to improve engine performance and reduce emissions. These computer systems will need to be designed to provide security from tampering while allowing access by replacement parts makers and auto mechanics. IT providers can assist in computer design and coordination with other systems. Information databases will also be helpful. To meet evolving safety regulations, IT providers can help in designing systems, such as "smart air bags" with sensors, to provide safety while avoiding unintended injury. Similar IT solutions could enhance safety and enable automotive companies to strengthen crash-worthiness of frames and components, while not impeding vehicle performance and appearance, and to enhance antilock brake performance and other safety-related components.

- Consolidation and globalization: "Merger-mania" has been sweeping through the automotive supply industry, as companies consolidate and restructure to meet automakers demands for integrated component systems. This pressure is increasing competition and creating a number of problems that require IT solutions. This restructuring, combined with the overseas expansion of the larger automotive companies, has created a need for these companies to balance the advantages of a centralized database and network control with the need to delegate decision-making to local subsidiaries through global networking and electronic data interchange systems.

- New versus upgraded systems/packaged off-the-shelf versus custom developed applications: Whether automotive firms need new IT systems versus upgraded systems, or need off-the-shelf versus custom-developed applications depends upon the individual company and where it is located on the automotive chain. The major automakers and first-tier suppliers already have complex IT systems operating and will most likely require mostly upgrades, unless they need a customized IT solution to a new problem. On the other hand, second- and third-tier suppliers and much of the aftermarket lags behind in terms of existing IT systems. These companies will need new systems, and in the near term will need off-the-shelf applications. However, as companies integrate these systems into normal operations, customized IT solutions will increasingly be needed.

- Interoperability: Automotive companies need to integrate their various IT systems, both within each company and between companies throughout the supply chain. These companies will use different software and information networks to accomplish the complex task of ordering components, coordinating production schedules, and bringing vehicles to market. Also aftermarket companies will need to have software and databases that track parts inventories and access the needed part on demand. These systems will need to be compatible with systems at other outlets of the same company as well as with other levels of the distribution chain. Finally, IT systems within the vehicle will need to operate with other systems within the vehicle as well as other IT systems and networks outside the vehicle, such as mobile communication networks.
- Flexibility and customization: Both the original equipment and aftermarket sectors of the automotive market require software and IT hardware that are user-friendly and not prohibitively complex. At the same time, the IT systems will be required to meet a range of needs, from huge multinational corporations, like General Motors, to small and medium-size parts suppliers to dealers, aftermarket parts distributors and retailers, and local repair shops. This will require customized IT solutions and long-term partnerships between the IT providers and the various companies in the automotive market, including postsale service and troubleshooting.
- Retraining technical workforce: There are distinct training needs for the automotive workforce, depending on whether the employees work in the original equipment market or the aftermarket. For the original equipment companies, which include automakers and suppliers, IT providers will need to work with these companies to enable employees to integrate complex data management systems, Internet and intranet systems, and other IT solutions into production, ordering, and design schedules. For the aftermarket, employees who may be unfamiliar with many IT systems will need to be trained on increasingly complex data management systems, particularly for the warehousing and distribution of aftermarket parts. Automotive mechanics who use these parts to repair vehicles will need to be trained in more complex automotive systems, such as on-board computer systems and interaction of information systems with satellites and other outside sources.

Glossary of Automotive Industry Terms

The following list defines automotive industry terms referenced in this report:

- Automotive Industry Action Group—AIAG is a nonprofit trade association of North American vehicle manufacturers and suppliers, whose mission is to improve the productivity of the automotive industry by providing a forum to foster cooperation and communication between trading partners and their suppliers and to improve and reduce variation in business processes and practices; address existing and emerging common issues and apply new and current technology to increase the efficiency of the industry; cooperate and communicate with other industry, government, educational, and technical organizations.
- CAD/CAM/CAE—IT systems that allow design, manufacturing, and engineering work to be done on-screen, rather than on paper.
- Clean Air Act—This 1990 act, amending previous Clean Air legislation, imposes much wider restrictions on vehicle emission levels, requires tougher inspection procedures in highly polluted areas, and mandates the use of gasoline and diesel fuel with pollution reducing additives, among many other provisions.
- Colocate—Manufacturers are physically or electronically colocating employees to break down "chimneys" or "silos" separating disciplines such as design, engineering, and marketing.
- National Automated Highway System Consortium (NAHSC)—A public/private partnership designed to test the concept of hands-free driving, and develop infrastructural, hardware, and software standards. The seven-year, $250 million program's first major test is in August 1997.
- National Highway Traffic Safety Agency—Part of the U.S. Department of Transportation, NHTSA was established by the Highway Safety Act of 1970 to carry out safety programs under the National Traffic and Motor Vehicle Safety Act of 1966 and the Highway Safety Act of 1966. NHTSA sets and enforces safety performance standards for motor vehicle equipment; investigates safety defects in motor vehicles; sets and enforces fuel economy standards; promotes the use of safety belts, child safety seats, and air bags; investigates odometer fraud; establishes and enforces vehicle antitheft regulations; and provides consumer information on motor vehicle safety topics.
- Original Equipment Manufacturer (OEM)—Automaker
- U.S. Council for Automotive Research (USCAR)—USCAR was formed in 1992 by the three U.S. automakers General Motors, Ford, and Chrysler. The council's main objectives are to monitor current research projects on automotive technology and consider new opportunities; coordinate the industry's interaction with government researchers in the government-business joint effort, a Partnership for a New Generation of Vehicles; share results of joint projects with member companies; seek and

recommend funding from public and private sources for joint research and development; and provide facilities and administration for research consortia.

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Perspective

Mechanical CAD/CAM/CAE Worldwide

End-User Analysis

UNIX-Based Mechanical Designers

Abstract: *For mechanical CAD/CAM/CAE vendors to be successful, they must have a thorough understanding of their target customer base. This Perspective summarizes the results of a recent end-user study focusing on North American designers that use primarily UNIX-based mechanical CAD packages. Dataquest examined current user environments, spending plans, and user satisfaction with CAD software and vendors.*
By Sharon Tan

Introduction

Each year, Dataquest's Mechanical CAD/CAM/CAE Worldwide program performs an extensive survey of mechanical designers and reports on their shifting priorities, needs, and demands. Dataquest's research of mechanical engineers and designers provides an insightful look into their preferences, tool and vendor satisfaction, and spending plans. In particular, this Perspective highlights the results of a study of North American designers that use UNIX-based mechanical CAD packages. Dataquest's market statistics show that the mechanical market is driven primarily by UNIX-based purchases of mechanical CAD packages. In 1996 alone, UNIX-based mechanical CAD software revenue comprised nearly 75 percent of the market. This survey was designed to gain a keen understanding of this group of users who tend to spend more money on CAD systems. For more detailed analysis and findings, see Dataquest's document titled *UNIX-Based Users in Mechanical Design: An End-User Study* (CMEC-WW-UW-9701), dated June 23, 1997.

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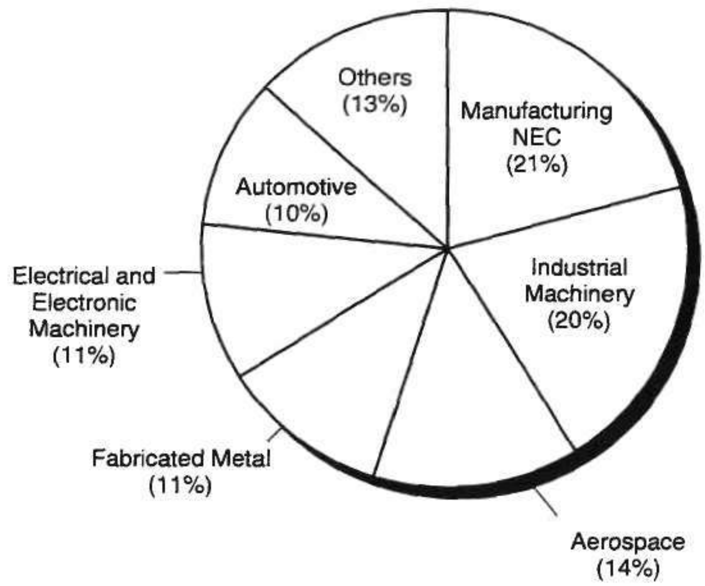
Survey Methodology and Respondent Demographics

This study is based on the results of a May 1997 telephone survey in North America of 198 managers and professionals deeply involved in the mechanical design process. In this survey, respondents needed to meet specific criteria (namely, having a UNIX-based mechanical CAD/CAM/CAE system in development or in place) to qualify for participation.

While reading this Perspective, it is important to keep in mind that the respondents to this survey identified a UNIX-based mechanical CAD system as their primary design system. While there are a number of PC-based users out there, this survey was specifically designed to understand the needs of the traditional high-end mechanical CAD users.

Figure 1 illustrates the respondent breakdown by industry. The data represents a wide cross section of prominent industries in North America. The category "Manufacturing NEC" consists of those respondents in discrete manufacturing that do not fit into one of the categories in Figure 1. (Most of the Manufacturing NEC respondents were in medical manufacturing, computers, or consumer electronics; NEC stands for "not elsewhere classified.") The category "Others" consists of those respondents in services, government, and telecommunications. Further analysis in this Perspective will be based on those industry classifications.

Figure 1
Respondents by Industry



Source: Dataquest (June 1997)

Designing in 3-D versus 2-D

For the most part, the UNIX-based mechanical designers in this survey design in 3-D. Details by industry are given in Table 1. Aerospace users report significantly higher use of 3-D design than other industries; in fact, 85 percent of these respondents consider 3-D their main form of design and tend to use more of the 3-D functionality that is available to them.

At the other end of the spectrum, slightly more than one-half of those designers in fabricated metals consider 3-D their primary design method, and this group of users only uses 55 percent of the 3-D functionality available in their systems. Surprisingly, only 55 percent of automotive respondents stated that their main design method is 3-D. This figure is much lower than results from previous end-user surveys. However, as expected, the amount of 3-D functionality they use is above the average for all respondents.

Reasons for Staying with 2-D

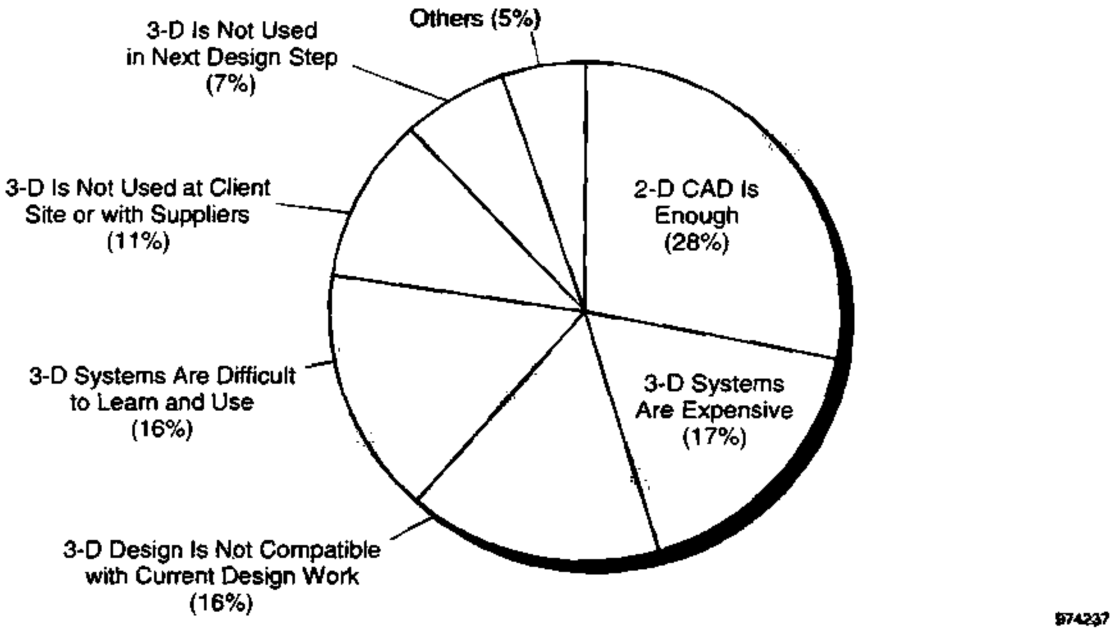
Of those UNIX-based users who do not consider 3-D to be their main form of design, Dataquest asked if it would become the main form by 1999. Fifty-seven percent of these respondents said yes, 37 percent said no, and the remainder did not know. Users cited many reasons for not planning to change to 3-D CAD by 1999. By far, the most commonly cited reason was that 2-D CAD is enough to meet their needs. All reasons are summarized in Figure 2. Interestingly, despite the proliferation of relatively inexpensive (compared to UNIX-based packages) 3-D CAD packages with graphical user interfaces and multimedia-based learning tools, there is still the perception out there that 3-D CAD systems are expensive and difficult to learn and use.

Table 1
Is 3-D Design the Main Method of Design?

	Yes (%)	No (%)	Percentage of 3-D Functions Used
Aerospace	85	15	73
Automotive	55	45	71
Electrical and Electronic Machinery	71	29	60
Fabricated Metal	55	45	55
Industrial Machinery	65	35	62
Manufacturing NEC	76	24	66
Others	77	23	70
All Respondents	70	30	66

Source: Dataquest (June 1997)

Figure 2
Reasons for Not Moving to 3-D Design Methods



Note: Multiple responses allowed
Source: Dataquest (June 1997)

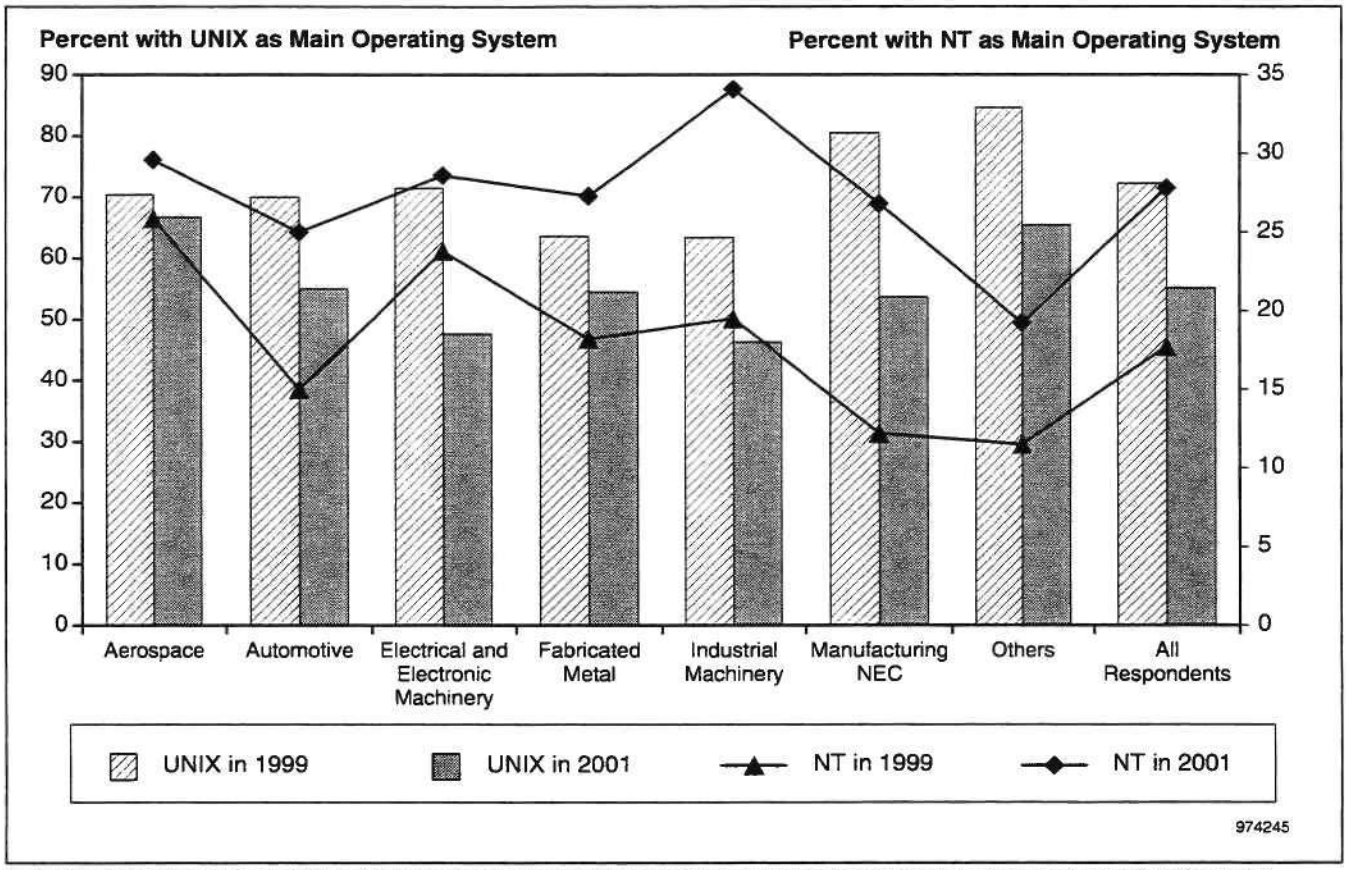
UNIX-Based Users: Will They Migrate to Windows NT?

Nearly every person associated with the mechanical CAD/CAM/CAE market has spent hours trying to find, predict, or invent the answer to this question: When will the high-end, UNIX-based mechanical designers move to NT? At last, Dataquest has some North American end-user data supporting the statement that actual movement of UNIX-based CAD users to NT-based CAD systems will occur, but not overnight. Instead, it will happen in a slower, more predictable fashion.

Dataquest asked users what their main CAD operating system will be in 1999 and in 2001. UNIX will indeed cede some CAD ground to Windows NT. Over the next two years, 18 percent of UNIX-based users plan to move to the Windows NT operating system, and by the end of 2001, 28 percent expect NT to be their primary CAD operating system. Further, 6 percent of respondents are unsure what their main CAD operating system will be in 1999, with that number growing to 12 percent in 2001. Previous end-user surveys have shown that users tend to be more optimistic about change than what is born out in reality. Dataquest expects the actual movement to NT to be slower than the numbers cited above.

The overall numbers do not portray the whole picture. It appears as though each industry will adopt the NT operating system at very different rates. Figure 3 illustrates some of these industry-level differences.

Figure 3
Adoption of NT by Industry



Note: Numbers will not add to 100 percent because responses to operating systems other than UNIX and Windows NT are not depicted.
Source: Dataquest (June 1997)

If the user community has its wishes, NT will make its greatest gains in electrical and electronic machinery and aerospace, but UNIX will also lose the least amount of ground in aerospace and in the "Others" category. These results are a change from previous surveys, where aerospace respondents were expecting to see less adoption of NT than seen here. This comes as a surprise, as aerospace sites tend to be larger sites that are well-entrenched in UNIX and have the expertise and resources to maintain a UNIX-based system. Also, the aerospace industry relies heavily on applications for which vendors have not yet announced a full-fledged NT solution. Automotive users appear more guarded about their transition to NT. The automotive industry also relies heavily on applications for which their "choice" vendors have not yet announced complete NT-based CAD/CAM/CAE solutions.

What Is Driving the NT Decision?

Dataquest asked respondents about their reasons for and against moving to the NT operating system for their mechanical design work. The two top reasons to move to NT were NT-based CAD software functionality and the prospect of reduced hardware costs. Indeed, NT-based CAD functionality has come a long way in the past few years. Just last year, UNIX-based users did not cite NT CAD functionality as a reason motivating their switch to NT.

Also, hardware vendors should take note: A previous survey also found the prospect of reduced hardware costs to be a top reason to move to NT-based CAD among current UNIX users.

Dataquest also investigated the reasons users did *not* expect to adopt NT as their primary operating system. Here, the top reasons were satisfaction with current UNIX operating system, followed by the functionality of NT-based applications—specifically, the ability of such applications to handle large or complex designs. The costs associated with purchasing new NT-compatible hardware or software were also top issues. Legacy data issues continue to rank low among the areas of concern against moving to NT. Mechanical CAD/CAM/CAE software vendors with a substantial installed base of UNIX licenses should look to maintaining a technological edge on NT-based CAD applications as well as keeping current users satisfied.

Is CAD/CAM/CAE Technology Helping to Meet Business Goals?

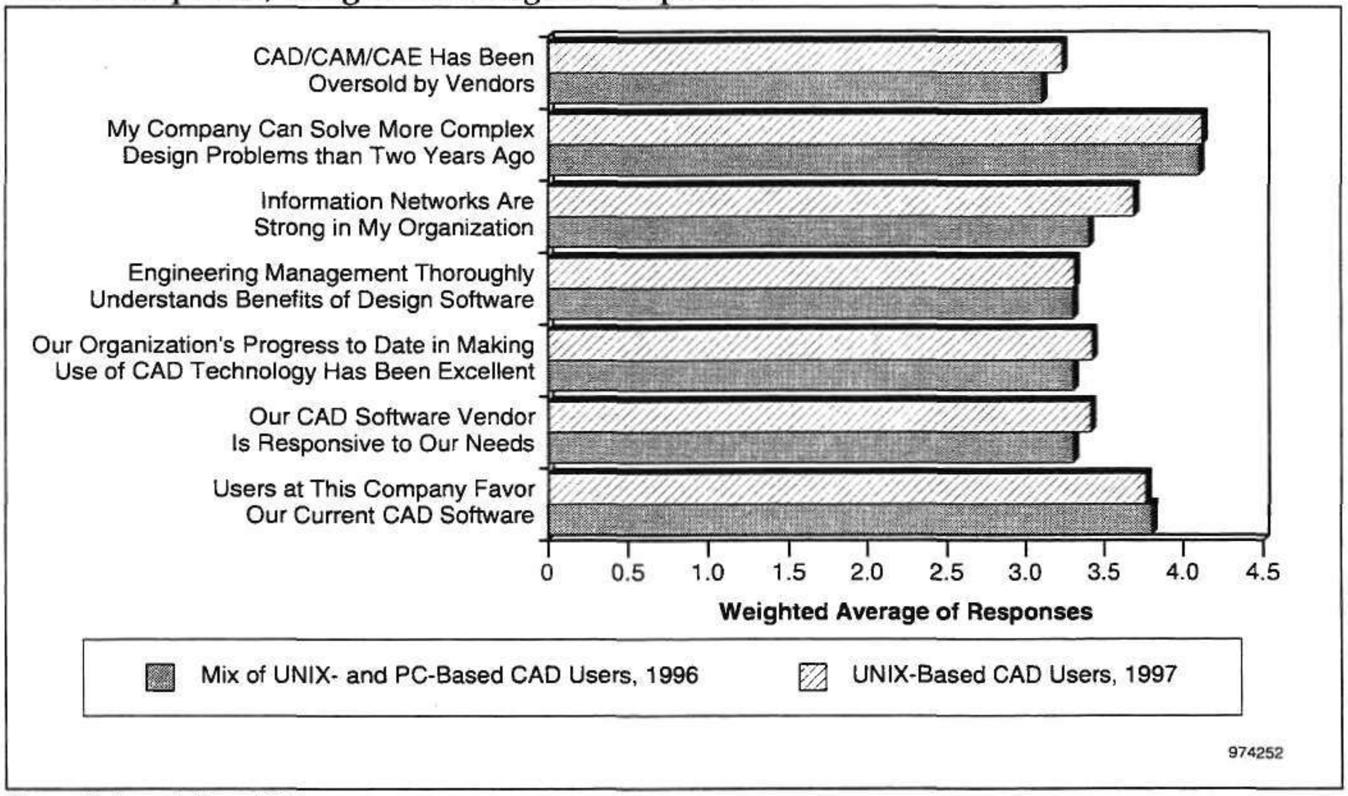
Many factors can affect whether a company or business in discrete manufacturing succeeds or fails, and CAD/CAM/CAE technology is just one of them. While CAD technology has promised many things to many people, Dataquest decided to investigate just what users think about how well CAD technology is deployed in a company. The idea is that those companies who have had more success in deploying CAD technology are better able to make the connection between CAD investment (dollars spent) and meeting business objectives (profits returned).

Dataquest asked respondents to what level they agree or disagree with a series of general statements concerning CAD/CAM/CAE, its role in the company, and its benefits—not just to engineering design, but to the company's overall business processes.

Overall, respondents in this survey are fairly happy with their CAD/CAM/CAE systems with respect to their company's business goals. In particular, Figure 4 shows results from this year's UNIX-based group of respondents in comparison to last year's mixed group (UNIX- and PC-based) survey respondents—the ratings are nearly identical. The one notable difference was that UNIX-based users felt less strongly about the statement that, "Information networks are strong in my organization." Dataquest has always felt that those companies with strong information networks are better able to adopt new technologies and respond to change.

Most respondents strongly agreed that CAD/CAM/CAE has helped their companies solve more complex design problems. The widest range of responses was seen when users responded to the statements "CAD/CAM/CAE has been oversold by vendors," and, "Engineering management thoroughly understands benefits of design software."

Figure 4
CAD Perceptions, Weighted Average of Responses



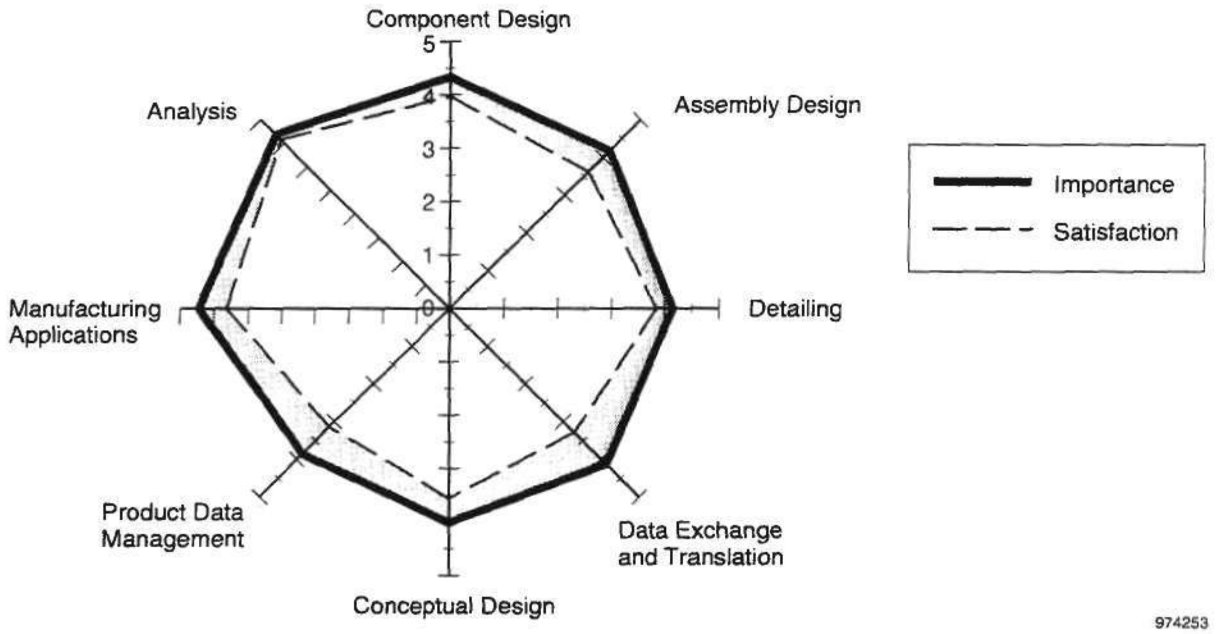
Source: Dataquest (June 1997)

Mechanical CAD/CAM/CAE Applications—What Users Think

Dataquest asked designers to rate their mechanical CAD/CAM/CAE applications with respect to importance and satisfaction on a scale of 1 (not important or not satisfied) to 5 (very important or very satisfied) on a range of functionality issues. Figure 5 provides a visual interpretation of these user importance and satisfaction ratings. The most important characteristic according to user rankings—component design—is plotted on a 1-to-5 scale at the top of the chart, and the other applications (for example, detailing and assembly design), are plotted in a counterclockwise manner about the axes in order of decreasing importance. The satisfaction rating for each application is mapped along the same axes as its corresponding importance rating. The gap, or difference, between the importance and satisfaction ratings for each application is indicated in Figure 5 by gray shading, exposing the areas that need vendor attention and improvements. In an ideal situation, importance and satisfaction ratings would be equal, and no gray area would appear in Figure 5 because the two circles would coincide. However, when the two circles do not coincide at every point, users are not as happy as they could be.

While most of the gaps in Figure 5 are not large, there are clearly some unmet needs out there. Once again, the importance of data translation software to designers and engineers becomes apparent. It was ranked high

Figure 5
Importance/Satisfaction Gap Analysis of Mechanical Applications



Note: Ratings on a scale of 1 to 5 (1 = not important/not satisfied, 5 = very important/very satisfied)
Source: Dataquest (June 1997)

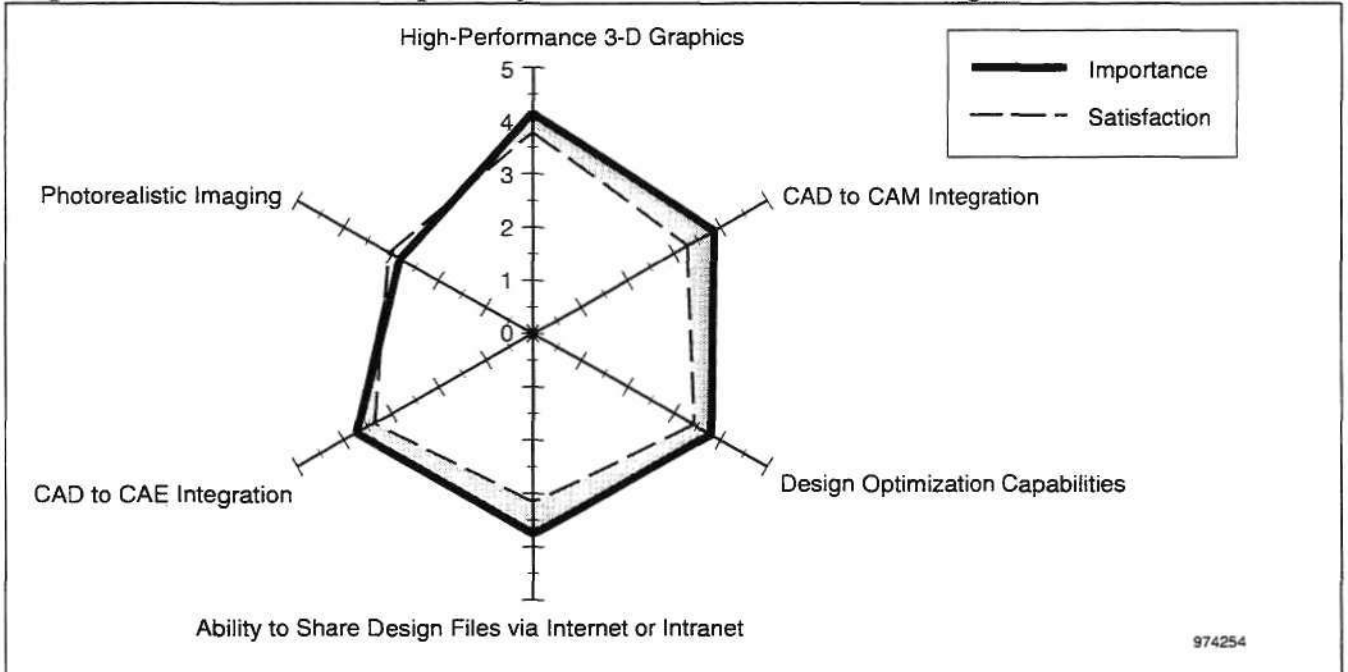
in importance by survey respondents, but this same group of people is very unsatisfied with the translation products they use. Data translation is one area that has always demanded attention from users, and these UNIX-based users are more unsatisfied with their translators than typically seen. The high importance ranking given to detailing underscores the importance in mechanical design of this very basic application. In comparison to other applications, the gap here is not large. Software vendors could better spend their efforts focusing on other user-perceived problems, as shown later in this Perspective.

Design-Related Tools and Technologies—What Users Want

Getting a product to market is not just about CAD software and design—it is also about how CAD and related technologies are used together. A host of tools and technologies are on the market today—such as photo-realistic imaging and 3-D graphics cards—that are targeted at making the lives of designers easier.

Dataquest asked users to rate several CAD-related tools and technologies with respect to importance and satisfaction on a scale of 1 (not important/not satisfied) to 5 (very important/very satisfied). The results are shown in Figure 6. Clearly, these UNIX-based designers and engineers want a lot of performance from their CAD solutions – tight integration among modules, good graphics, and design optimization capabilities.

Figure 6
Importance/Satisfaction Gap Analysis of CAD-Related Technologies



Note: Ratings on a scale of 1 to 5 (1 = not important/not satisfied, 5 = very important/very satisfied)
Source: Dataquest (June 1997)

Better 3-D graphics is one area that UNIX-based workstation vendors tout over their PC-based and NT-based competitors. And, as this survey shows, graphics is ranked high in importance to these UNIX-based designers and engineers. (Surprisingly, however, photo-realistic imaging is of less importance, and users are satisfied with their imaging solutions.) As companies take on more complex design problems and become more entrenched in 3-D design, it is natural that graphics become more of an important factor influencing purchasing decisions. The same is true for design optimization capabilities—as users begin to use more analysis and CAE tools in conjunction with CAD tools, the importance of optimization will rise.

To no one's surprise, integration of CAD with both CAM and CAE ranked high in importance and also showed large importance-satisfaction gaps. The user-perceived dissatisfaction with CAD to CAM and CAD to CAE integration is consistent with earlier data concerning exchange and translation.

Characterizing the Ideal Software Solution and CAD Vendor

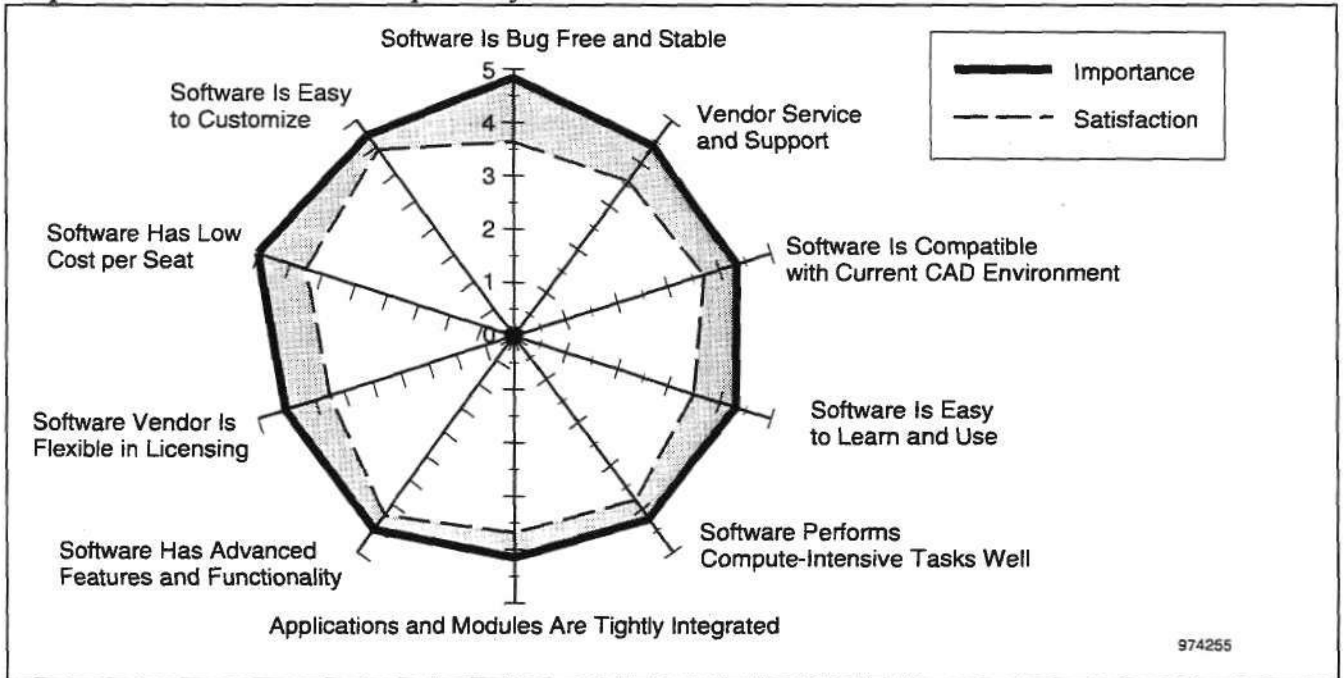
Dataquest created a "wish list" of items and asked users to rate the importance and satisfaction of the 10 characteristics centered around software performance and vendor satisfaction. It is with this wish list that the real dissatisfaction with CAD/CAM/CAE solutions among end users becomes apparent. Nearly every item on the list was ranked with an importance rating of 4.0 or higher (see Figure 7). All of the issues on the wish list factor into a company's decision to purchase mechanical CAD/CAM/CAE tools, and vendors could choose to address any one of these issues, as all of the gaps are large.

Topping the list in importance was the request for software that is bug free and stable. The gap here is quite large, and the importance rating is one of the highest in recent years of surveying CAD users. Software stability has always been an issue with the mechanical design community and can sometimes be an impediment to the adoption of new technologies and methodologies. It also comes as no surprise that the importance-satisfaction gap for vendor service and support is similarly large.

Software that is easy to learn and use is also important to the design community. Engineers are always facing time-to-market pressures, and they have little time to spend learning new tools or applications or going to training. Only recently have UNIX-based CAD vendors begun to concentrate on ease-of-use issues in earnest. These vendors should take their cues from some of the newer, midrange packages arriving on the market today with intuitive interfaces and robust learning tools.

Of all the items on the wish list, the ones with the smallest gaps are ease of customization and advanced features and functionality. While these technology-driven issues are important, there are clearly other areas in which a vendor can excel to become a commanding player in the mechanical design market.

Figure 7
Importance/Satisfaction Gap Analysis of an Ideal CAD Solution



Note: Ratings on a scale of 1 to 5 (1 = not important/not satisfied, 5 = very important/very satisfied)
Source: Dataquest (June 1997)

Opportunities for Vendors

This survey reveals that despite CAD/CAM/CAE technology's maturity, there are still unmet needs within the North American UNIX-based mechanical design community. Several opportunities exist for vendors to market a better solution addressing not just design issues, but solutions that enable users to solve more complex and broader problems than they can today. Issues for the vendor community to consider include:

- Mechanical CAD/CAM/CAE is a mature technology, with UNIX-based users having several years of experience. In some industries, mechanical CAD technology is now facing the prospect of saturation and growth by replacement seats instead of new sales.
- Unlike PC-based mechanical designers, use of both computer-aided manufacturing(CAM) and computer-aided analysis (CAE) tools is high among UNIX-based respondents, which points to a need for seamless integration among CAD, CAM, and CAE.
- According to respondents, UNIX will indeed cede some ground to Windows NT in CAD. Actual movement of UNIX-based CAD users to NT-based CAD systems will occur, but not at lightning speed. Instead, it will happen in a gradual, more predictable fashion.
- Despite the maturity of the technology, users are still not completely satisfied with their mechanical CAD/CAM/CAE solutions. Satisfaction ratings are still less than importance ratings for all basic CAD/CAM/CAE software functionality, such as detailing and assembly design capabilities.
- Similarly, mechanical designers are not completely satisfied with their CAD vendors' service and software performance. Software stability still ranks as a top concern for UNIX-based designers, as does vendor service and support.

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Dataquest
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Perspective

Mechanical CAD/CAM/CAE Worldwide

Dataquest Predicts

Windows NT and Mechanical CAD—The Field Is Wide Open

Abstract: *Windows NT-based mechanical CAD/CAM/CAE applications became more widely available in 1995. In this newsletter, we revisit the continuing NT versus UNIX versus DOS/Windows debate. We examine the status of Windows NT in the mechanical CAD/CAM/CAE market and predict how market forces will affect the adoption of the Windows NT operating system in the mechanical design world.*

By Sharon Tan

Dataquest Predicts

In 1994, Windows NT barely scratched the surface of the mechanical CAD/CAM/CAE market. The year 1995 marked the beginning of a number of NT-based CAD software products targeted at mechanical design. NT-based CAD solutions are beginning to make inroads into the mechanical design arena, and the field is still wide open for all vendors. Dataquest predicts that Windows NT will continue to lay down a strong foundation at the low end and the midrange mechanical CAD markets. Its impact on the high end will be seen, but it will not be significant until 1998.

NT CAD Market Today

The market for Windows NT-based mechanical CAD software solutions reached about $100 million in 1995, representing 3.3 percent of the $2,989 million worldwide mechanical CAD/CAM/CAE software market. The NT platform showed substantial growth, up about 125 percent from 1994 mechanical CAD software sales. Leading the pack on the NT platform was Parametric Technology, with about $51 million of revenue attributed to sales on the NT platform, with Hewlett-Packard and Matra Datavision rounding out the top three (see Figure 1).

Dataquest

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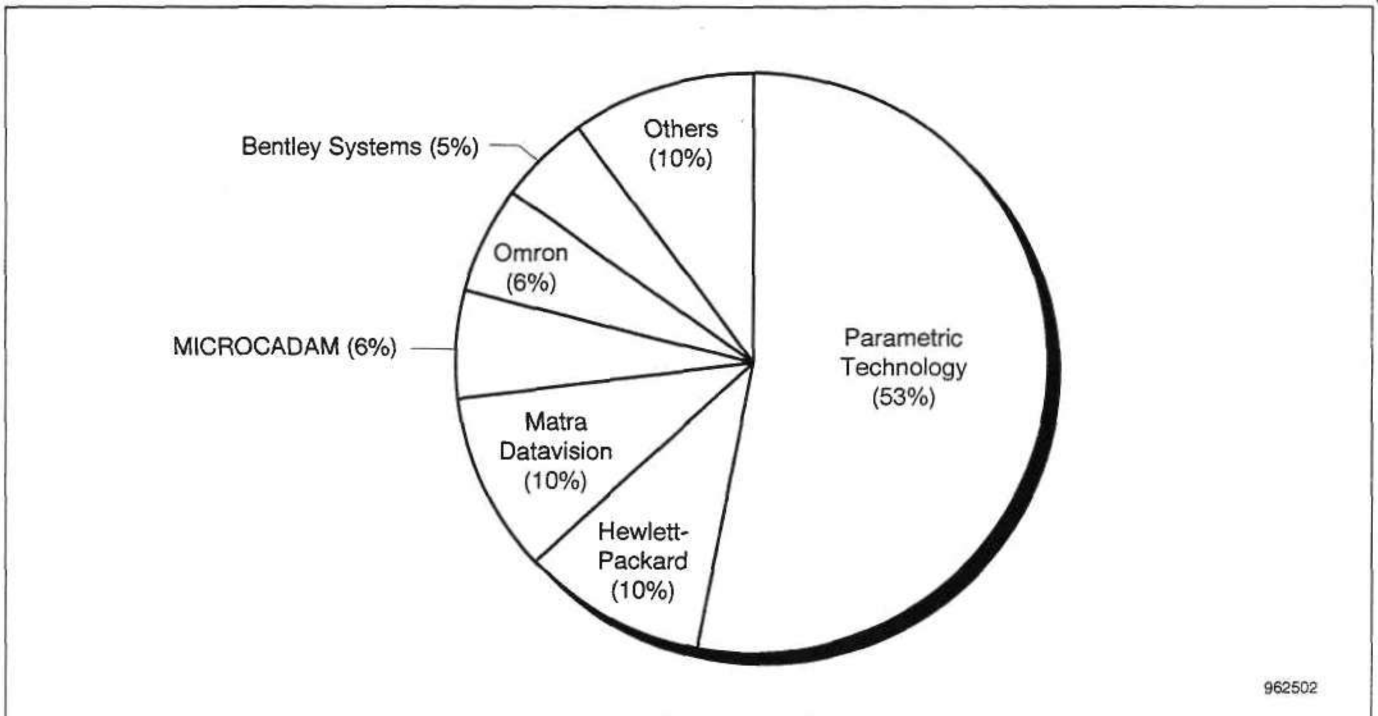
Figure 1
1995 Windows NT Market Share



Source: Dataquest (April 1996)

Outside of the mechanical CAD/CAM/CAE market, adoption of Windows NT-based CAD software appears to be varying greatly by application. Overall, NT-based software sales made up 5.6 percent of the worldwide CAD/CAM/CAE/AEC and GIS markets in 1995. Both the architecture/engineering/construction and geographic information systems had greater NT sales than any other CAD application that Dataquest tracks (see Table 1).

Table 1
Windows NT Sales in CAD/CAM/CAE/AEC and GIS for 1995

Application	Percentage of Windows NT-Based Software Sales in 1994	Percentage of Windows NT-Based Software Sales in 1995
Mechanical CAD/CAM/CAE	1.7	3.3
Architecture/Engineering/Construction	4.2	12.3
Electronic Design Automation	0.4	1.6
Geographic Information Systems	3.5	13.3
All Applications	2.1	5.6

Source: Dataquest (April 1996)

Vendor Offerings

NT-based offerings became available from the vendor community beginning in 1994. NT-based solutions run the gamut of mechanical CAD/CAM/CAE systems, developed from high-end, UNIX-based systems (for example, Pro/ENGINEER) to low-end, PC-based packages (for example, CADKEY), and everything in between. A number of analysis, numerical control, and product data management vendors have now ported their products to the NT platform. To date, the leading mechanical CAD vendors have offered their full CAD suite, a subset of it, or a future architecture on the NT platform (see Table 2). It is important to note that the entries in Table 2 are not meant to represent all of the available NT-based mechanical CAD solutions.

With a few exceptions, vendors have not changed pricing for NT-based applications. For instance, Parametric Technology's Pro/ENGINEER has the same list price for both the UNIX version and the NT version. Similarly, Autodesk's AutoCAD has the same list price for both the DOS/Windows versions and the NT version.

Because CAD applications on Windows 95 did not hit the market until late 1995, we have not listed any of these vendors or products in Table 2.

Table 2
Windows NT Offerings by Select Mechanical CAD Vendors

Vendor	Product
IBM	CATIA/CADAM Drafting
Parametric Technology	Pro/ENGINEER
Autodesk	AutoCAD, Mechanical Desktop
EDS Unigraphics	Unigraphics
Computervision	Pelorus
MICROCADAM	MICRO CADAM
SDRC	I-DEAS Master Series
MacNeal-Schwendler	NASTRAN
Matra Datavision	Prelude, CAS.CADE
Hewlett-Packard	ME10
Intergraph	Solid Edge
ANSYS	ANSYS
Cimatron	Cimatron 90
Adra	Cadra
Bentley	MicroStation

Note: The products and vendors shown do not represent all available NT-based applications for mechanical CAD/CAM/CAE.
Source: Dataquest (April 1996)

Where Is the Growth Coming From?

Much of the debate about the impact of Windows NT in the CAD world has centered around whether the growth of NT will occur at the expense of UNIX-based CAD applications or at the expense of Windows/DOS-based applications. The jury is still out on this issue. One thought that has drawn much vendor interest is the emerging "midrange" market, which is oblivious to the UNIX/Windows/DOS/NT debate. Both traditional UNIX vendors and Windows/DOS vendors are attacking this market. Midrange CAD is addressing the needs of users that go beyond drafting but do not extend into the traditional, high-end, fully functional, and completely integrated CAD/CAM/CAE suite. Considering the vendors and applications ported to NT today, it is this midrange market that is probably the most viable one for the NT platform, at least in the near term.

Again, it is too early to tell exactly where the impact of NT will be felt. One perspective is to look at how CAD revenue generated by various operating systems has grown or shrunk over the past five years (see Table 3). In 1995, while NT-based mechanical CAD/CAM/CAE sales grew 125 percent, UNIX-based sales remained fairly stable, and Windows/DOS-based sales dropped, albeit slightly, from 1994 levels.

From an industry perspective, sales of NT-based solutions are coming from industries other than aerospace and automotive. Dataquest does not expect this trend to change drastically over the next year, as these two industries comprise large, UNIX-entrenched users whose CAD requirements continue to be addressed by some of the larger market players such as IBM and Computervision, both of whom do not have a full suite of CAD/CAM/CAE software available on the NT platform today.

Table 3
Mechanical CAD/CAM/CAE Software Revenue by Operating System (Percentage)

	1991	1992	1993	1994	1995
UNIX	63.3	67.2	70.0	73.6	74.5
Windows/DOS	19.7	20.9	19.8	19.2	18.3
Windows NT	NA	NA	0.1	1.7	3.3
Host	17.0	11.9	10.1	5.5	3.9
All Operating Systems	100.0	100.0	100.0	100.0	100.0

NA = Not available
Source: Dataquest (April 1996)

Growth of NT in the UNIX Installed Base

For the next few years, the road for NT traveling down the UNIX path will not be smooth, simply because the mechanical design market is dominated by a handful of traditional UNIX-based vendors with large installed bases. The No. 1 mechanical CAD software vendor today is IBM, with nearly 13 percent market share. The full CATIA mechanical CAD/CAM/CAE suite has not been ported to NT; only the CADAM drafting package has been. Similarly, the No. 4 and No. 5 vendors are traditional UNIX players EDS Unigraphics, which has only just released its NT solution, and Computervision, which derives much of its revenue from software that is not (and probably will not be) ported to NT. These three players represented 25 percent of mechanical CAD/CAM/CAE sales in 1995. We do not expect these users to transition quickly over to NT-based solutions for CAD.

Different Regions, Different Adoption Rates

Dataquest forecasts that by the year 2000, NT-based sales will make up about 18 percent of the mechanical CAD/CAM/CAE market. We expect adoption rates of NT-based mechanical CAD solutions to vary around the world, as different market forces affect each region. Of particular interest are Europe and Japan.

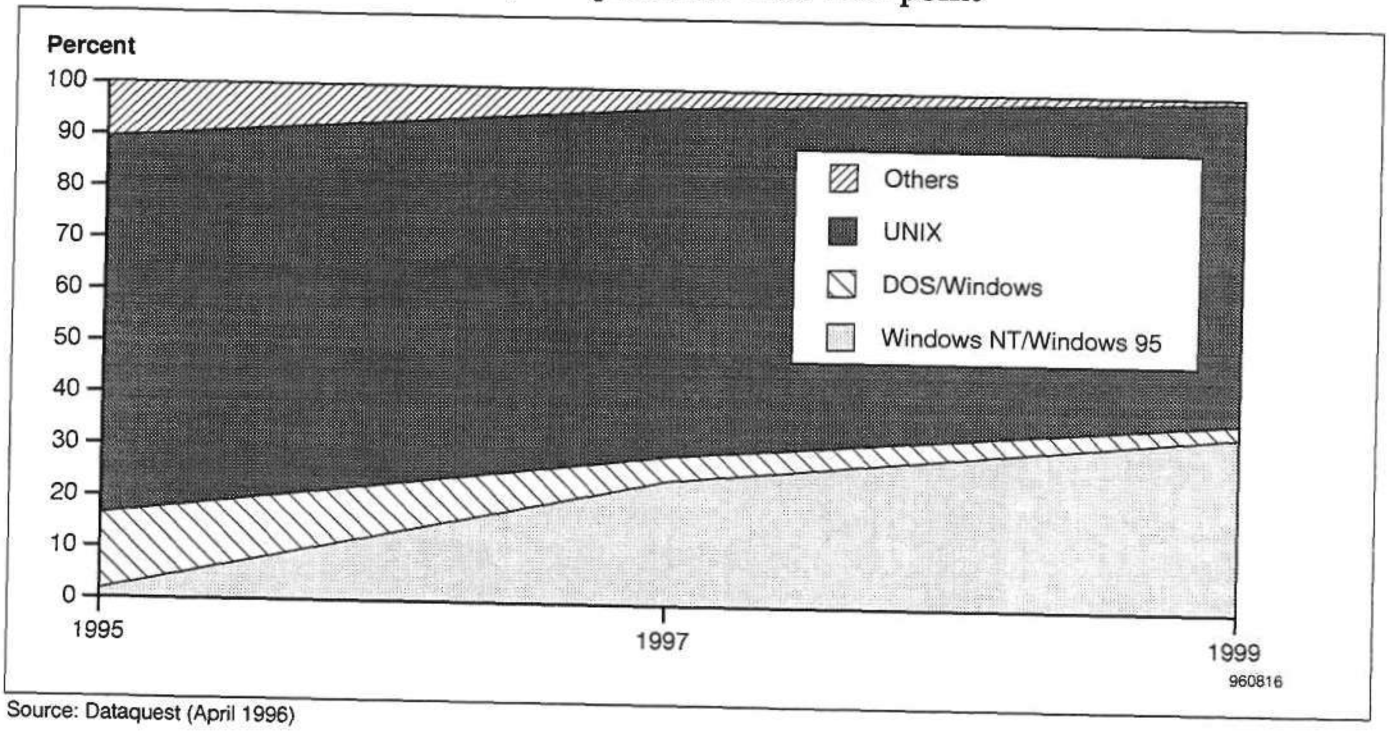
Europe

The prognosis for NT-based mechanical CAD solutions in Europe looks optimistic, particularly from the end-user viewpoint. In 1995, NT-based sales made up about 1.9 percent of the European mechanical CAD/CAM/CAE market. According to a recent Dataquest end-user survey, the European mechanical design community appears ready to embrace Windows NT, driven by the hope that CAD software running on NT will be cheaper, faster, and easier to use. In the study, we asked users which operating system they believe will be their dominant operating system in 1997 and in 1999. The results are shown in Figure 2. Full results of the survey are available in the Dataquest document, *CAD/CAM/CAE Technology Today and Tomorrow—A User's Perspective* (CMEC-WW-UW-9501, published February 5, 1996).

According to our survey results, end users are saying that DOS and Windows operating systems will shrink from 25 percent in 1995 to 3 percent by 1999. UNIX will lose some ground as well, going from 73 percent to 63 percent, and Windows NT/Windows 95 will gain a secure foothold in the mechanical CAD world, according to end users, growing from 2 percent to 34 percent by 1999.

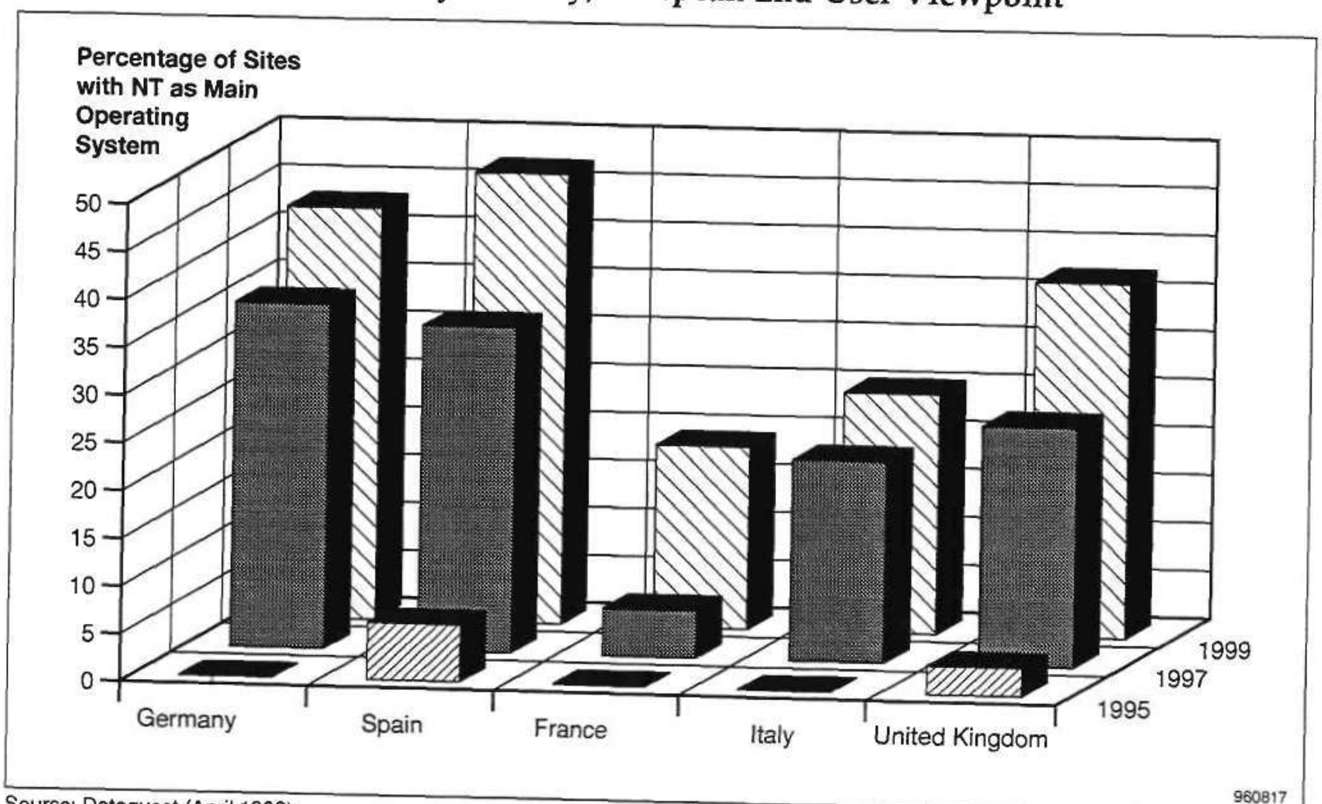
The overall numbers do not give the whole picture, however. From a country perspective, end users in France, Spain, and the United Kingdom all plan to move to NT at the expense of all current operating systems. However, in the cases of Germany and Italy, end users in these countries show that they will be holding onto their installed UNIX sites (see Figure 3).

Figure 2
Operating Systems of the Future, European End-User Viewpoint



Source: Dataquest (April 1996)

Figure 3
Adoption of Windows NT by Country, European End-User Viewpoint



Source: Dataquest (April 1996)

Japan

Particularly in Japan, the market for NT-based CAD sales is wide open. Of all mechanical CAD/CAM/CAE users, the Japanese market shows the most compelling reasons to move to NT the fastest:

- Economic concerns in Japan have forced some companies to reconsider the amount of money spent on CAD/CAM/CAE technology. End users at these companies are looking to turn away from the traditional proprietary CAD system to a commercially available one. Further compounding the situation is that many of their CAD systems are host-based. Over the next few years, Dataquest expects these users to be the main consumers of NT-based sales in Japan.
- The Japanese mechanical CAD/CAM/CAE market is heavily drafting-oriented. Many of the low-end or midrange NT packages are ideally suited to transition these 2-D users to solid modeling.
- There is no one single vendor with a significant lead in the NT market in Japan today. The top three contenders for NT-based mechanical CAD sales in Japan in 1995 were Parametric Technology, Omron, and MICROCADAM, with all companies reporting about the same amount of revenue.

The Prognosis for NT

The NT operating system has staked a claim in the mechanical CAD/CAM/CAE market, and we expect it to continue to grow at a rapid pace over the next five years as more applications become available that address the entire mechanical design process, from design to manufacturing. Its growth will be affected by a number of different variables, including application availability, CAD penetration in industries other than aerospace and automotive, cost-effective solutions (particularly for UNIX users who must switch both hardware and software), and development of a distribution channel to handle the midrange market.

Where Are the Opportunities for Vendors?

Many opportunities exist for software vendors looking to get a piece of the NT-based mechanical CAD/CAM/CAE market. Opportunities that vendors should consider include:

- Different regions of the world will adopt NT at different rates. Users in Japan are in a unique predicament of needing to move from proprietary systems to commercial ones, looking to reduce CAD costs, and ready to move from 2-D drafting to 3-D and solid modeling.
- Some industries will be easier to penetrate than others. The aerospace and automotive industries today consist of large UNIX-installed bases, and this is not expected to change in the near future.
- In order for NT solutions to be truly useful to the end user, they must cover the entire design and manufacturing processes, including analysis, design, drafting, and manufacturing. The end user today has a limited number of applications from which to choose.

The NT market is still in its infancy, and the field is wide open for any vendor who can address the needs of the end user with software that is inexpensive, bug-free, and easy to use.

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Perspective

Mechanical CAD/CAM/CAE Worldwide
Market Analysis

CAD Market Leadership: In the Wallet and at the Bank

Abstract: *The CAD market has evolved from a turnkey market sold by a direct salesforce to a rich collection of channel and packaging schemes worldwide, punctuated by Autodesk's gradual rise to the top, based solely on indirect sales through dealers. Comparing revenue between one company that sells primarily direct (at retail prices) with another that sells primarily through resellers (at wholesale prices) distorts the picture, both in terms of market share and in terms of assessing the true market opportunity. Dataquest's CAD group has recently solved this problem. This article explains the changes to our CAD reporting, and evaluates top players from our new perspective.*
By Kathryn Hale and Sharon Tan

New Market Views

Autodesk and IBM are widely recognized as leaders in the CAD market, and yet their positions are often contested, primarily caused by the different distribution channels used by the two companies, and their sources of revenue. We recently introduced expanded coverage by channel in CAD to help clarify the confusion caused by the extensive use of complex distribution channels throughout the world. We believe we have developed a data architecture that accurately reflects the revenue flow from the user's wallet, through resellers, and to the vendor's bank.

Understanding the New Definitions

Traditionally, Dataquest has reported factory revenue (that is, the money a vendor puts in the bank), and does not report end-user spending (the money that leaves the user's wallet). This approach works well in markets where

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either direct or indirect sales are the norm. However, it is not possible to fairly compare vendors using one metric in markets where both direct and indirect sales are used. For example, IBM primarily sells through a direct salesforce, while Autodesk typically sells through resellers in other countries. To accurately represent the market, it is necessary to be able to report software revenue as it accrues in the following ways:

- Directly through a company salesforce
- Indirectly from sales to dealers and other resellers
- As total software product revenue (the sum of direct and indirect sales for products the company owns)
- As revenue earned as a reseller of another company's products (for example, Intergraph's resale of Microstation product)
- As revenue earned supplying OEM software products that are sold under another name by a separate company (for example, AutoCAD's OEM version)
- As company software revenue, or revenue a vendor puts in the bank (the sum of direct, indirect, reseller, and OEM revenue)
- As dealer revenue (revenue earned by a vendor's dealers for selling the product)
- As user software spending—the total amount actually spent by end users (which is the sum of direct and dealer revenue)

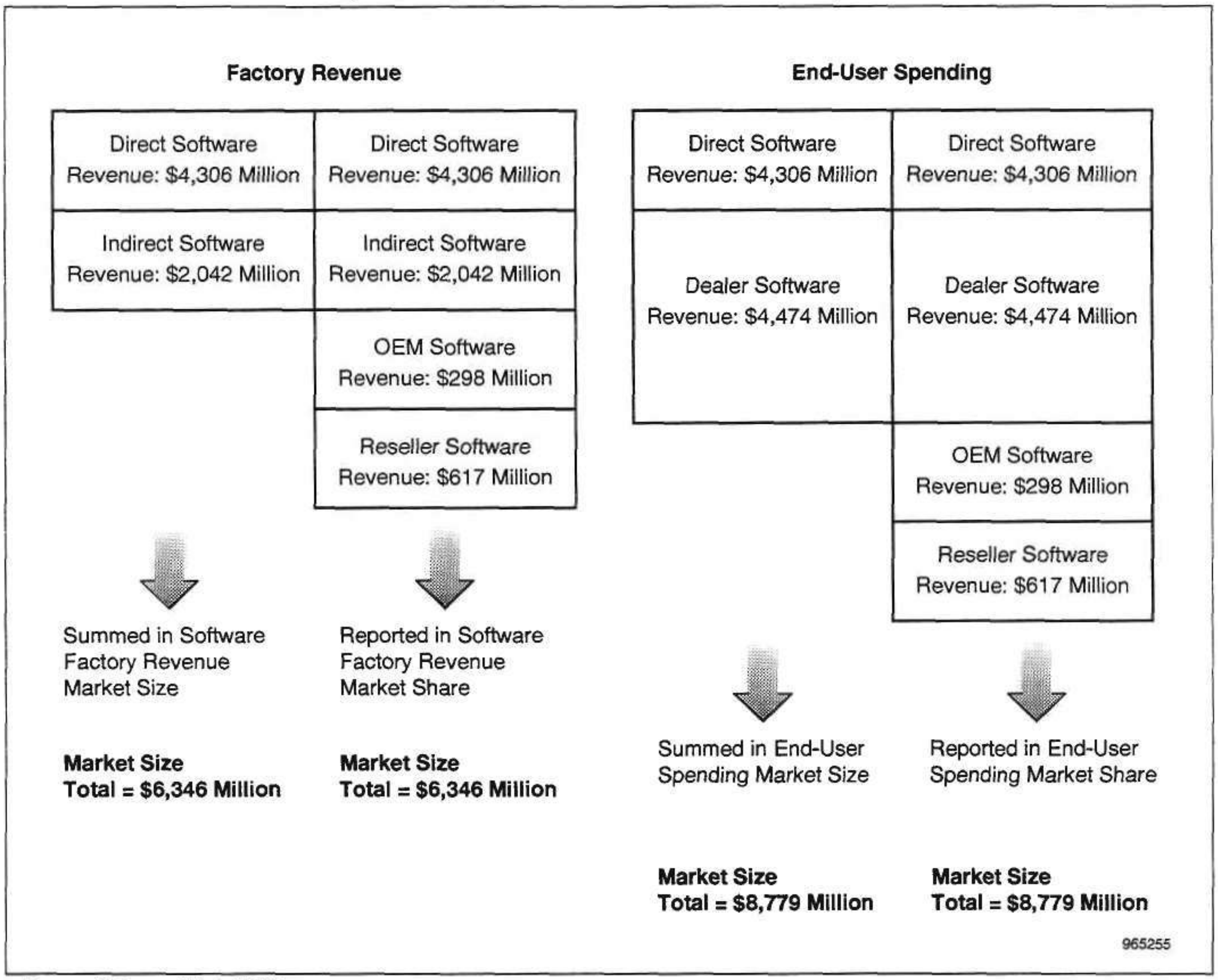
Figure 1 shows how we account for all these elements while not counting revenue twice. We will continue to report market size and market share based on company software revenue. However, total market size is the sum of direct and indirect revenue, and a company's individual market share is based on the sum of direct, indirect, OEM, and reseller revenue. This means that the sum of market shares will be somewhat more than 100 percent. We are also now able to report market share data based on any of the metrics listed in the previously listed bulleted items.

The same methodology is used to calculate end-user spending—the only difference is that, instead of using indirect revenue, we use dealer revenue. Dealer revenue is based on a multiplier of indirect revenue. Calculation of these multipliers will vary by vendor, by region, and by platform. Thus, market size from an end-user perspective is the sum of direct and dealer revenue. A company's individual end-user market share is based on the sum of direct, dealer, OEM, and reseller revenue. Again, the sum of the end-user market shares will be greater than 100 percent.

Advantages to this approach include the following:

- We do not double-count any total market opportunity, and we will continue to avoid overstating the actual revenue available, which will help our clients make the most reasonable investments.
- The high level of activity of vendors who are active in multiple channels will show up in market share tables, again without double-counting total

Figure 1
CAD Software Market by Channel, 1995 (Millions of Dollars)



Source: Dataquest (July 1996)

revenue. For example, it is now possible to understand the status of such complex issues as Dassault vis-à-vis IBM, and Bentley Systems vis-à-vis Intergraph. We can report Bentley's factory software revenue, Bentley's total end-user spending (some of which will be sold by Intergraph), Intergraph's sales from Intergraph products, Intergraph reseller sales from Bentley products, and sales made by Intergraph's own dealers. In general, this model will allow us to better detail market contributions by companies with complex business models, such as Fujitsu, IBM, and Intergraph.

- In Dataquest's ongoing tests of alternate reporting schemes, tables that report only vendor revenue (that is, tables where individual vendor revenue always sums to the total market) produce significantly misleading results in a number of important cases. On the other hand, tables that add all revenue reported into the market total produce results that mislead vendors about the actual revenue opportunity. We have found that tables which include all vendor activity while not double-counting the market actually produce the closest to what we believe is a true depiction of the market.

Who's the Market Leader?

Table 1 and Figure 2 outline the market position in software for top CAD companies according to Dataquest's new metrics. For 1995, Autodesk has the largest company revenue for its own products ($511.3 million software product revenue), while IBM has more revenue in the bank ($527.6 million company software revenue) for all CAD/CAM/CAE/GIS software revenue it sells, including its own products in EDA, AEC and GIS, CATIA software, which it sells exclusively ($467.6 million total), and MicroCADAM software, which it resells ($60 million). However, Autodesk sells almost entirely through the company's much-envied international reseller network.

So, in the end, users spend dramatically more for Autodesk CAD products than for any another company's offerings—$1,086.9 million (see Figure 2). Little wonder, then, that Autodesk so dominates user perception, yet IBM can claim to bank the most CAD revenue as a single company. Both companies are justified in claiming market leadership. It is, however, most fair to characterize Autodesk as clearly the No. 1 CAD vendor. Users speak with their wallets, and here Autodesk is the overwhelming favorite.

Equally important, IBM is primarily a packager of a variety of CAD solutions. As a special case in our database, IBM receives "direct revenue" credit for selling Dassault's CATIA (rather than reseller revenue) because, as the sole reseller, IBM essentially obscures the Dassault identity and effectively puts its own label on the product as the original equipment manufacturer. Also, in the case where IBM itself sells MicroCADAM software (a company 50 percent owned by IBM), it will receive "reseller" revenue—but IBM gets no revenue credit on software revenue tables for the MicroCADAM revenue sold by others.

Should the day ever come that Dassault elects to allow other companies to sell its products, IBM's position would dramatically change, partly because we would characterize IBM as a reseller, and credit Dassault as the primary vendor (instead of the OEM supplier). There is no corresponding single-stroke opportunity for a dramatic downward shift for Autodesk.

Tables 2, 3, and 4 also highlight the difference in market share accounting methods. Under our measurement of market share by company software revenue, IBM is the No. 1 player, closely followed by Autodesk, and with Intergraph, Parametric Technology, and Cadence rounding out the top five. In contrast, under our new measurement of market share by user software spending, Autodesk jumps up to 12.4 percent of the user software spending market, and IBM drops to 6.1 percent. Hewlett-Packard, Computervision, and ESRI move into the top 10, displacing Dassault, Synopsys, and Mentor Graphics.

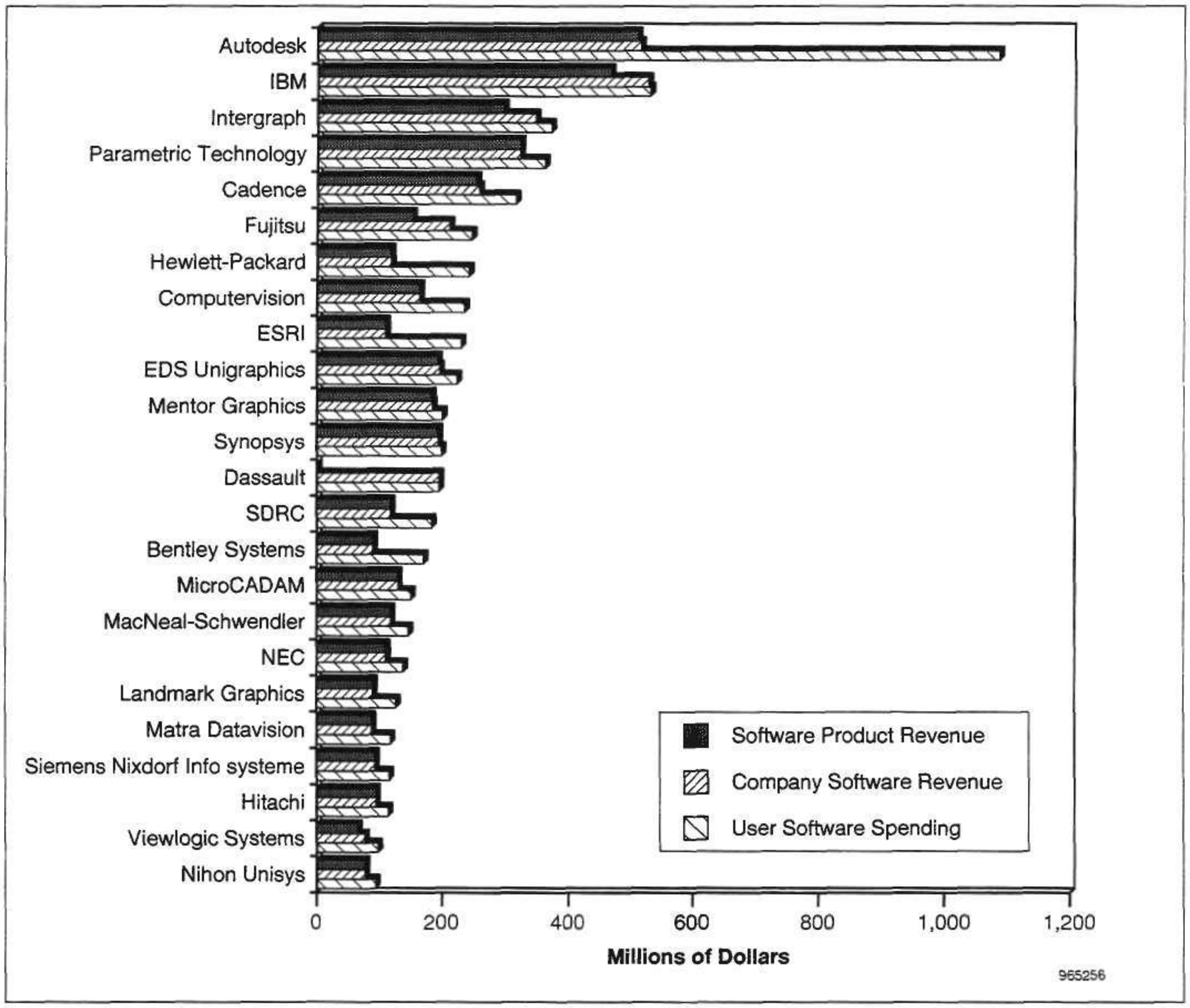
Table 1
CAD Software Market Leaders by Channel, 1995 (Revenue in Millions of Dollars)

	Direct Software	Indirect Software	Software Product	Reseller	OEM Software	Company Software	Dealer Software	User Software	Software Service
Autodesk	54.7	456.6	511.3	NA	5.1	516.4	1,027.0	1,086.9	3.0
IBM	465.0	2.7	467.6	60.0	NA	527.6	6.4	531.3	221.1
Intergraph	269.4	26.1	295.6	50.3	NA	345.8	51.1	370.9	113.1
Parametric Technology	289.1	32.1	321.2	NA	NA	321.2	71.5	360.6	118.8
Cadence	209.8	43.8	253.6	NA	4.1	257.7	100.3	314.1	268.1
Fujitsu	134.2	17.2	151.4	59.4	NA	210.8	52.7	246.3	171.2
Hewlett-Packard	33.0	84.8	117.8	NA	NA	117.8	208.9	241.9	36.3
Computervision	109.7	54.0	163.7	NA	NA	163.7	125.5	235.2	119.7
ESRI	81.9	27.3	109.2	NA	NA	109.2	147.7	229.5	24.5
EDS Unigraphics	167.1	25.5	192.5	NA	3.3	195.8	53.0	223.4	64.6
Mentor Graphics	166.0	16.2	182.2	NA	1.7	184.0	32.3	200.0	189.0
Synopsys	189.6	3.9	193.5	NA	NA	193.5	9.0	198.6	91.1
Dassault	NA	NA	NA	NA	194.5	194.5	NA	194.5	34.1
SDRC	68.2	49.4	117.6	NA	NA	117.6	115.0	183.2	86.5
Bentley Systems	NA	89.9	89.9	NA	NA	89.9	170.4	170.4	5.5
MicroCADAM	6.4	122.7	129.2	NA	NA	129.2	143.4	149.8	6.8
MacNeal-Schwendler	91.2	26.3	117.6	NA	NA	117.6	55.2	146.4	12.9
NEC	97.2	12.7	109.9	NA	NA	109.9	40.7	137.9	0.7
Landmark Graphics	63.2	26.7	89.9	NA	NA	89.9	63.6	126.8	49.1
Matra Datavision	66.2	21.3	87.4	NA	NA	87.4	51.4	117.5	14.3
Siemens Nixdorf	74.6	18.6	93.2	NA	NA	93.2	41.2	115.7	45.1
Hitachi	85.1	9.5	94.5	NA	NA	94.5	29.1	114.1	22.3
Viewlogic Systems	42.4	23.0	65.5	NA	11.8	77.3	43.6	97.8	43.7
Nihon Unisys	69.5	7.6	77.1	NA	NA	77.1	24.7	94.1	54.2
All Companies	4,305.7	2,041.6	6,345.8	617.3	298.2	6,345.8	4,473.7	8,779.3	2,499.5

NA = Not applicable
Source: Dataquest (August 1996)

This is the first year we have been able to report detailed revenue by channel, allowing us to estimate that the $6,345.8 million CAD software market, as measured by software factory revenue, translates to an $8,779.3 million market as measured by user spending. Some of this new channel data is based on estimates that we expect to refine—so if you want to take issue with any particular number, or request more detailed data, please call or send e-mail. We do believe our underlying structure is both necessary and correct, and that it has never been entirely realistic to reduce market leadership to a single datapoint in the complex GIS and CAD markets.

Figure 2
CAD/CAM/CAE/GIS Software Market Leaders by Channel, 1995



Source: Dataquest (August 1996)

Table 2
1995 Market Share Based on Company Software Revenue (Percent)

Ranking	Vendor	1995 Market Share (%)
1	IBM	8.3
2	Autodesk	8.1
3	Intergraph	5.4
4	Parametric Technology	5.1
5	Cadence	4.1
6	Fujitsu	3.3
7	EDS Unigraphics	3.1
8	Dassault	3.1
9	Synopsys	3.0
10	Mentor Graphics	2.9

Source: Dataquest (August 1996)

Table 3
1995 Market Share Based on User Software Spending (Percent)

Ranking	Vendor	1995 Market Share (%)
1	Autodesk	12.4
2	IBM	6.1
3	Intergraph	4.2
4	Parametric Technology	4.1
5	Cadence	3.6
6	Fujitsu	2.8
7	Hewlett-Packard	2.8
8	Computervision	2.7
9	ESRI	2.6
10	EDS Unigraphics	2.5

Source: Dataquest (August 1996)

Table 4
1995 Market Share Based on Software Product Revenue (Percent)

Ranking	Vendor	1995 Market Share (%)
1	Autodesk	8.1
2	IBM	7.4
3	Parametric Technology	5.1
4	Intergraph	4.7
5	Cadence	4.0
6	Synopsys	3.0
7	EDS Unigraphics	3.0
8	Mentor Graphics	2.9
9	Computervision	2.6
10	Fujitsu	2.4

Source: Dataquest (August 1996)

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Dataquest
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Perspective

Mechanical CAD/CAM/CAE Worldwide

Technology Analysis

Is Manufacturing Process Simulation Entering a New Phase?

Abstract: *The market for numerically controlled (NC) programming software is expected to grow to $540 million in the year 2000. This Perspective focuses on the fortunes of the NC software industry as they are tied closely to the growth of the machine tool industry and economic cycle.*

By Daya Nadamuni

Machine Tools: A Primer

Machine tools shape or form metal using a variety of techniques, such as milling, drilling, turning, punching, or using high pressure. Metal cutting tools shape parts by removing material from a given piece of metal to create the desired shape. There are several different types of machine tools, and they can be classified broadly as follows: classic machine tools, characterized by manually operated, power-driven stationary machines; and automated machine tools, commonly known as numerically controlled (NC) machine tools.

This Perspective focuses on NC machine tools and the software industry that has evolved to support the programming required to automate these tools.

It is possible to further subdivide automated NC machine tools into other categories, based on the complexity of the software required to program the machines:

- NC machines—Numerically controlled machines that use punched tape, have no intelligence, and cannot be modified in any way without changing the wiring of the machine tool

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- Computer numerically controlled machines (CNCs)—NC machines that are controlled by using a microcomputer
- Distributed numerically controlled machines (DNCs)—A network of several machines that are simultaneously controlled by a centralized computer. Currently each DNC has its own controller but is in turn linked to a central computer system that coordinates the machines and maintains a list of part programs that can be downloaded to a machine as needed.

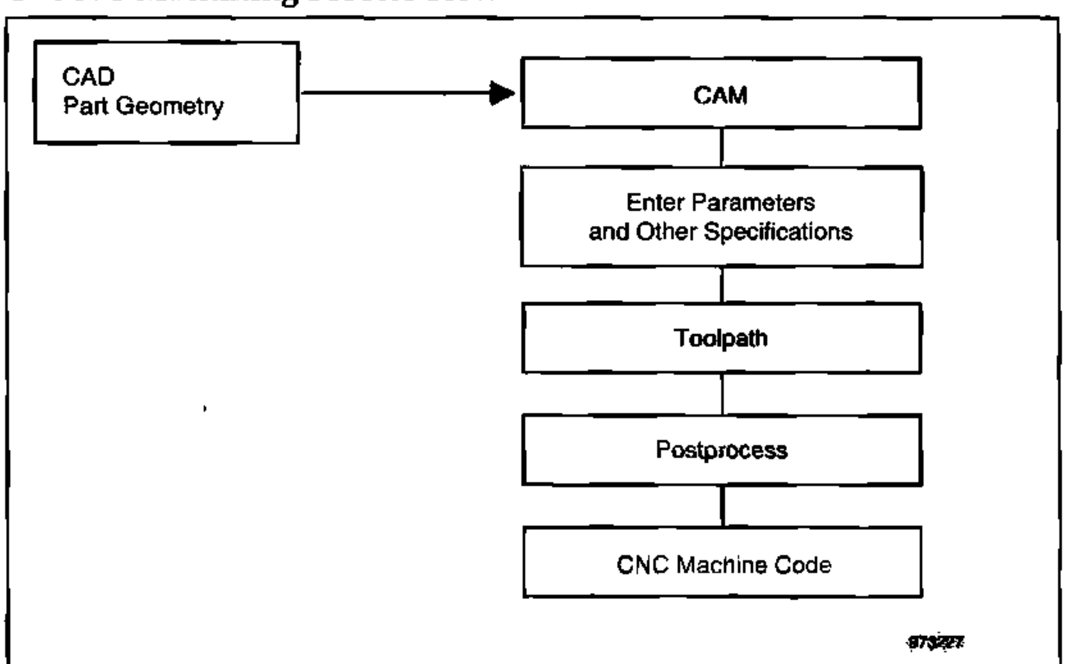
Automated machine tools have certain advantages over classic manual machine tools, including faster production, improved accuracy, and higher quality. Also, certain machining tasks, such as four- and five-axis milling, are so complex that it may not even be possible to perform them manually.

The Process

The NC machining process follows a series of well-defined steps (see Figure 1). Though in the past NC programmers also dealt with creating or refining part geometry in the CAM system, today part geometry is created in the CAD system and imported into the CAM system.

Once the desired geometry has been successfully imported (there are file translation issues that are addressed later in this article) into the CAM environment, the programmer creates a part program by specifying the machining parameters, which could include information like process order number, part orientation, cutter tool types, speed and feed rates, and other relevant information that the system requires. The part shape is displayed as

Figure 1
The NC Machining Process Flow



Source: Dataquest (March 1997)

a series of coordinate points along which the machining or milling will take place to achieve the desired part shape. The software outputs a tool path that the machine tool follows for optimal performance. The post processor outputs a machine-tool-specific code.

Currently available products include visualization packages that can check for collisions and generate alternate tool paths within the specified machining tolerances. Many software packages have built-in libraries that contain data on machine tool types, tool paths, and microcontroller routines, among others, which can be customized. This is definitely a step forward in making the software more powerful and efficient.

NC Software Vendors

Users of NC software range from small, independent job shops to large corporate design and engineering departments. NC vendors provide a wide range of products for their target customers. Some major end-user industries are automotive suppliers, tool, die and mold manufacturers, aerospace, general and industrial machinery manufacturers, consumer products, and general job shops. In the past vendors offered high-end products that ran on UNIX platforms, while the lower-end software packages ran on PCs. But with the growing popularity of the Windows NT platform, more and more commercial software packages are being offered for this platform. Table 1 shows the major NC software vendors for 1995 in a $314 million market.

Table 1
NC Software Vendor Revenue (Millions of U.S. Dollars)

Vendor	1994	1995	Growth (%)	Market Share (%)
IBM	40.52	49.15	21.3	15.6
EDS Unigraphics	36.30	47.19	30.0	15.0
Parametric Technology	19.07	27.30	43.1	8.7
Computervision	16.45	16.40	-0.3	5.2
Camax Manufacturing	11.82	13.62	15.2	4.3
CGTech	6.00	9.99	66.4	3.2
CNC Software	7.60	8.36	10.0	2.7
Applicon	5.03	5.77	14.8	1.8
Gerber Systems	4.95	5.37	8.5	1.7
Surfware	2.70	5.00	85.0	1.6
DP Technology	3.21	4.11	28.2	1.3
Intergraph	4.28	3.78	-11.6	1.2
GRAFTEK	3.34	3.72	11.1	1.2
SDRC	3.10	3.53	13.8	1.1
MCS	2.21	2.99	35.7	1.0
MicroCADAM	1.83	2.58	40.9	0.8
Other Companies	91.61	105.32	NA	33.5
All Companies	260.02	314.19	20.8	100.0

NA = Not available
Source: Dataquest (March 1997)

Issues and Trends in NC Software

File Translation Issues

The customers for NC software companies range from small job shops to design groups within large companies. As a result, a number of different solutions, which reflect the diversity of end users and the CAD packages they use, are available in the market. This also raises certain technical issues related to file translations and the precise import of part geometry from the CAD system into the CAM environment.

CAM systems that support nonuniform rational b-splines (NURBS) are able to import even highly complex part geometry without any significant loss of precision. To minimize error in translation, some CAM vendors support native formats of some CAD packages. File translation issues arise when the CAM system is unable to import the data precisely, or when the data needs to be imported from disparate CAD systems into CAM. In either case, users have to rely on industrywide graphical interchange standards, like IGES or DXF. A file import through such an intermediate process is not always perfect as various translations in and out do not produce the same mapping.

There is also the issue of the same entity being represented in different ways by the graphic format. There is some amount of data loss that has to be rectified before the next step in the process can be undertaken. Most CAM systems do allow the programmer to create some part geometry, which may be sufficient to maintain the integrity of the data. With time-to-market pressures and the high costs of each prototype creation, it is in manufacturers' best interests to get it right the first time. Vendors need to continue to address this issue until it is satisfactorily resolved.

Manufacturing Rule Checking

Incorporating manufacturing rules at the design stage is an important part of the manufacturing process. It saves a lot of time and expenditure if the engineer or designer is aware at the outset of the rules that guide the machining process. For example, the manufacturing process plan may have a specified wall thickness for a part, or it may set feed rates and tolerance limits based on the processing capability of the specific process, to prevent deterioration of material.

Most of the larger packages have built-in rules to help the designer. The software can be customized to meet the needs of the user depending on the intrinsic rules that each business follows. The rules are usually stored in a library, and users can load the rules that they need.

Visualization

Many of the NC packages available today have visualization modules that are able to display the process and the finished part in 3-D. Full color 3-D graphics display of geometry and motion of a solid model with the ability to visualize the machine tool and its movements are a powerful addition to the NC world. The visualization module complements the functions of the verification modules to aid in error-free machining processes.

Verification tools highlight feed errors and other problems that can be encountered while setting up the NC tool path. This kind of error-checking ability becomes extremely useful as NC machines become more sophisticated and correspondingly more expensive. For example, five-axis machines often cost $100,000 or more. The five-axis machine is capable of machining extremely complex parts with great precision. These machines have higher material removal rates and improved surface finish as compared to the less complex machines, but often it is a difficult decision for companies to move to the more complex machines because of higher costs and higher degree of programming complexity required to operate such machines. Given these constraints, software that is easy to use and intuitive as well as flexible is a very useful tool, and opportunities exist in the market for companies that are able to position themselves to take advantage of these circumstances.

Platforms

NC machines, which include CNC and DNC machines, come in various degrees of complexity, ranging from two-axis machines to the highly complex five-axis machines. The more complex the machine, the higher the amount of computing power needed to run the NC software program geared toward that machine. As a result, the software aimed toward the two- to 2.5-axis machine tool tends to be PC-based, while higher axis machine software programs usually run on UNIX platforms.

The winds of change are sweeping through this sphere as well, and the popularity of the Windows NT platform is being felt in the NC software market. Many vendors already offer products that can run on the NT platform and others plan to offer products that run on NT in the near future.

Dataquest expects NT-based computers for CAD/CAM to reach capabilities on par with that of low-end UNIX-based systems in the near future, making the NT platform a viable solution for some UNIX-based NC users who have traditionally sought more powerful UNIX-based machines to run their NC programs. Lower costs for the PC-based machines are a powerful incentive at the low end, especially for the smaller job shops or companies. However, Dataquest also expects lower-end NT-based systems to make inroads into the PC-based NC market.

Generative Machining

Solid computer models allow designers to better understand how their products will look and function before going through the actual production process. Currently available solids-based modeling packages allow mechanical parts to be defined by 3-D models. These models are then imported into the CAM system. All knowledge about a part is captured and stored in a database that can be updated dynamically. The process for machining user-defined and standard features is established and stored in the system. Feature recognition knowledge is often packaged with the software in the form of libraries for materials, tools, and manufacturing processes.

Given this knowledge base, the generative machining process very often requires the input of only a few parameters (such as process order number, material specification, or machine tool definition) to generate a machining strategy that includes the output of an optimal toolpath, material feed, and speed rates, as well as error detection and collision. This generated information is added to the database and stored for later use (or reuse, as the case may be).

Databases that integrate design and machining data are important stages in creating viable knowledge-based systems. One benefit of the use of solids modeling and knowledge-based engineering is the capacity for design reuse, which can be cost-effective over time. In addition, solid modeling packages provide a complete definition of part geometry, and can include other information such as surface contours and machining tolerances. This part geometry can be used for other analytical processes such as finite element analysis.

Solids-based modeling with feature recognition capabilities that drive the generative machining process is part of the computer-aided process planning (CAPP) approach to modern manufacturing.

There are two major CAPP methodologies: variant process planning and generative process planning. Variant process planning implements a plan by which a process plan for a previously planned part is retrieved based on the old part's similarity to the new one. The old process plan can be modified as required to suit the part to be machined. Variant process planning is based on group technology (GT) coding and classification or features technology (FT) type classification to identify part families.

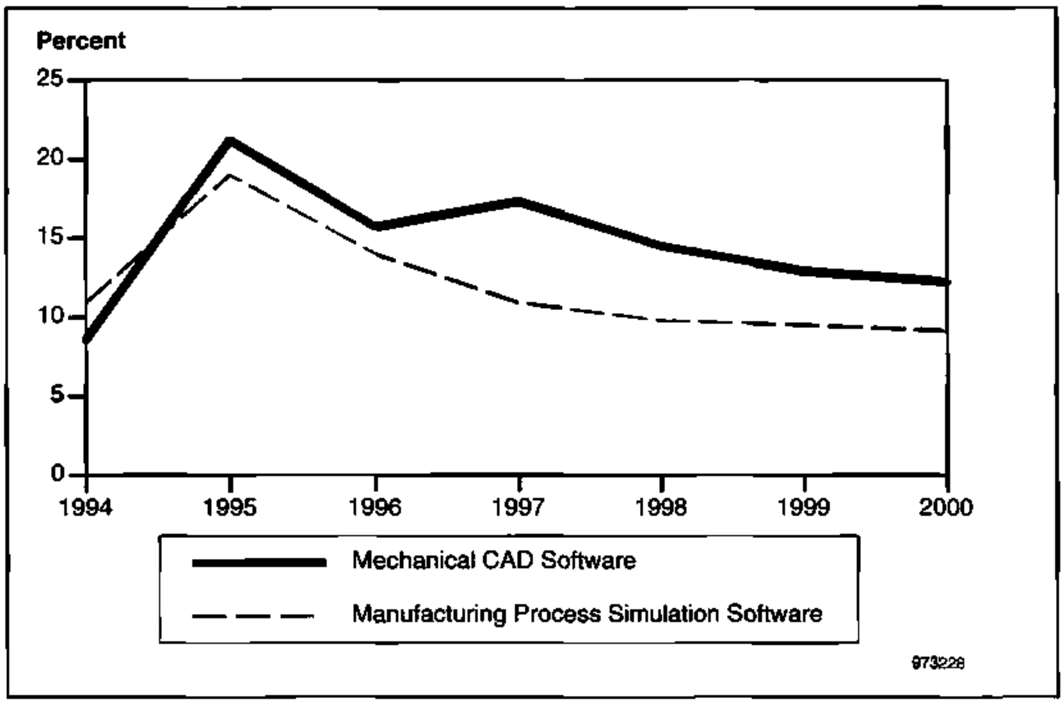
Generative process planning creates a process plan from scratch, provided adequate information is available about a part. It does not necessarily rely on existing plans. Some of the newer NC programming software packages such as Euclid Machinist and SDRC's Generative Machining do have some of this knowledge-based solids modeling and machining capability built in. With increasing pressures on the bottom line and time-to-market considerations, it is inevitable that more and more intelligent automation is going to be the trend of the future, and NC software vendors would do well to position themselves for this changing paradigm.

Dataquest Perspective

Dataquest forecasts that the market for manufacturing process simulation, wherein NC part programming and part processing design is captured, will grow as shown in Figure 2, where growth beyond 1995 is forecast growth. Figure 2 also shows the growth rate for the worldwide mechanical CAD software market, as well as the manufacturing simulation market (for comparison).

The rather stagnant machine tool market moved along at a somewhat smarter pace in 1995 and 1996, in part a result of strong economic growth in

Figure 2
Forecast Growth for Worldwide Mechanical CAD Software Market



Source: Dataquest (March 1997)

the United States. The health of the NC programming software industry is affected by the health of the machine tool industry, whose fortunes are directly tied to the business investment climate. As business investment tends to be greater during periods of economic growth, an upturn in the business cycle and activity, especially in the automotive sector, has been responsible for the rise in the orders for machine tools. According to the OECD and World Bank reports, business sentiment continues to improve in Germany and Japan after having been slow for most of last year. Economic activity in both countries is projected to be supported in part by stronger business investment.

The bottom line is that the machine tool industry affects the purchase of NC programming software. The NC market is a growing one, but its growth rate is slower than the forecast growth for the mechanical CAD software industry as a whole. The market will continue to move along at a comfortable pace; however, vendors are adding sophistication to their offerings for the NC market by trying to bring the products in line with the rest of the CAD/CAM world by adding links to solids modeling software. Many NC vendors are catching up with the rest of the CAD world by adding visualization capabilities—a sign of technological advancement—while a few vendors are incorporating principles of generative machining in the software.

For now, customers seem content with available packages. Vendors should keep in mind that greater and more intelligent process automation is one of the goals of CAPP and should factor that in when planning the next generation of NC offerings. If vendors take a more visionary approach toward NC technology and its potential for tighter links to manufacturing and to CAD, Dataquest can raise its growth forecast for NC software.

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Perspective

Mechanical CAD/CAM/CAE Worldwide

Dataquest Predicts

NT and UNIX in Mechanical Design: Coexistence

Abstract: *Many of the Windows NT-based mechanical CAD/CAM/CAE applications have been available for at least a year now. In this newsletter, we take one more look at the NT versus UNIX debate. We examine the acceptance of Windows NT in today's mechanical CAD/CAM/CAE market and predict how market forces will affect adoption of the Windows NT operating system in the mechanical design world.*
By Sharon Tan

Dataquest Predicts

Last year, we predicted that Windows NT would continue to lay down a strong foundation in the low-end and midrange mechanical CAD/CAM/CAE markets and would significantly impact the high-end market starting 1998. While we still stand by the first part of our prediction, we now believe that Windows NT's impact on the high-end market will not be significant until 1998 at the earliest, and even then it will begin only a long-term coexistence with UNIX-based applications at the high end.

The NT-Based Mechanical Market in 1996

The market for Windows NT-based mechanical CAD/CAM/CAE applications reached $274 million in 1996, representing 8 percent of the $3.421 billion software market for worldwide mechanical applications. The NT platform showed significant growth once again, growing 139 percent from 1995. Parametric Technology again led NT-based sales in mechanical CAD/CAM/CAE (see Figure 1).

Outside of mechanical CAD/CAM/CAE applications, the adoption of Windows NT-based CAD software varies by application, with the greatest

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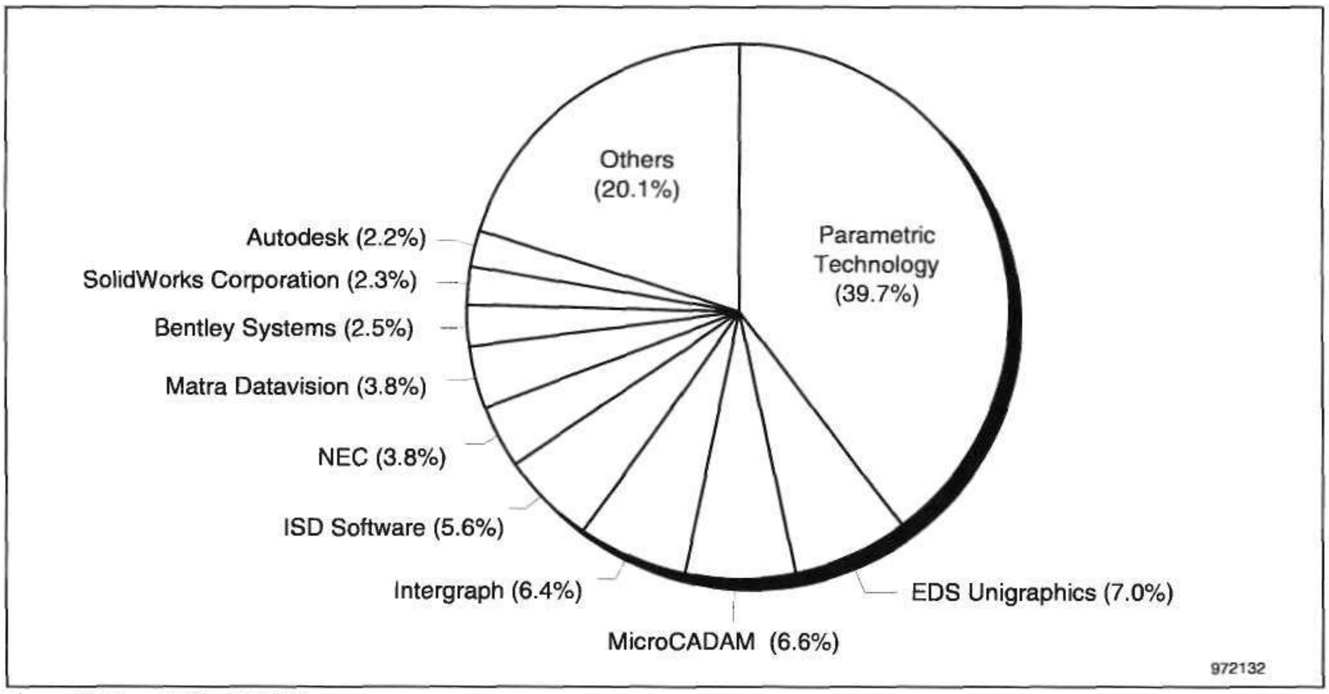
adoption being seen in geographic information systems. Table 1 tracks NT-based sales by CAD application over the past two years.

There are NT-based solutions in mechanical CAD/CAM/CAE at the high end (Parametric Technology's Pro/ENGINEER on NT), at the low end (Baystate Technologies' CADKEY), and everywhere in between. Nearly all of the analysis, numerical control, and product data management vendors have ported their products to NT. Some newer mechanical design packages are available only on the NT platform (SolidWorks' SolidWorks 97 and Intergraph's Solid Edge). With the exceptions of Dassault Systemes/IBM and Computervision, all of the traditional UNIX-based vendors in the mechanical design community have ported their flagship applications to the NT platform. Dassault Systemes will offer CATIA on the NT platform in 1997 (CATIA/CADAM Drafting is already available on NT), and Computervision plans to offer CADDS on the NT platform in the second half of 1997.

Figure 1
1996 Windows NT Market Share in Mechanical CAD/CAM/CAE



Source: Dataquest (March 1997)

Table 1
Windows NT Sales in CAD Applications for 1996

Application	1995 Windows NT-Based Software Sales (% of Total Market)	1996 Windows NT-Based Software Sales (% of Total Market)
Geographic Information Systems	13.3	16.3
Architecture/Engineering/Construction	10.1	14.6
Mechanical CAD/CAM/CAE	3.9	8.0
Electronic Design Automation	2.1	3.9
All Applications	5.6	8.8

Source: Dataquest (March 1997)

NT Viewpoints from the Mechanical Designer

In September 1996, Dataquest surveyed 214 users of mechanical CAD/CAM/CAE software to find out what is driving the decision to use NT. We asked survey respondents to list their reasons for and against moving to the NT operating system for their mechanical design work.

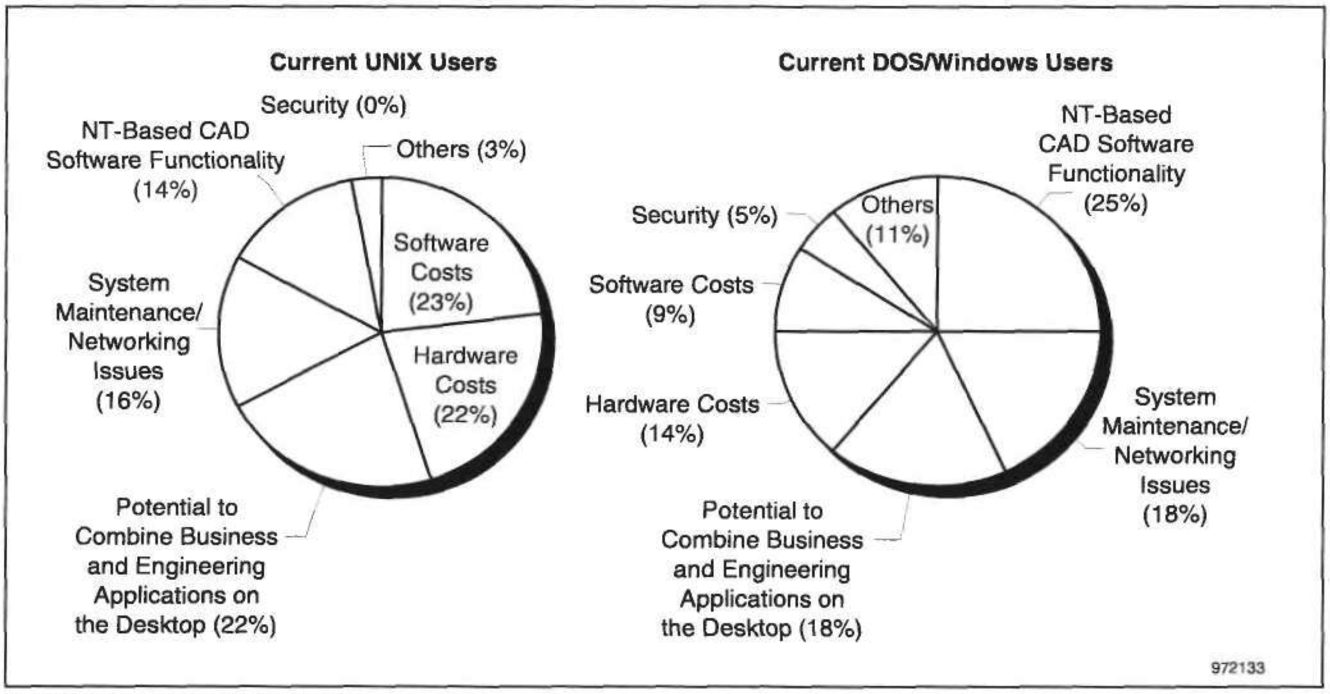
Users are expecting to fully embrace the NT operating system, with over 30 percent of the respondents saying that NT will become their main operating system by 1998 (up from approximately 10 percent at the time of the survey). According to users in our survey, those designers in aerospace are the ones least likely to move to NT.

Among all respondents, the top two reasons to move to NT were the functionality of NT-based CAD software and the potential to combine business and engineering applications on the desktop. However, UNIX users and DOS/Windows users have widely differing viewpoints of the benefits of NT (see Figure 2). Here, UNIX users were looking to save on software and hardware costs by moving to NT while DOS/Windows users were looking for increased CAD functionality and easier system maintenance issues.

We asked respondents to list their primary reasons *not* to move to NT. Here, DOS/Windows users and UNIX users had similar views. Hardware and software costs topped the list, followed by the lack of NT-based CAD solutions available on the market (see Figure 3). Surprisingly, legacy data issues did not rank high among the reasons to not move to NT, even among the current UNIX users in the survey. The "other reasons" in Figure 3 include a wide range of responses, from the "power of UNIX" to corporate edicts to use another operating system.

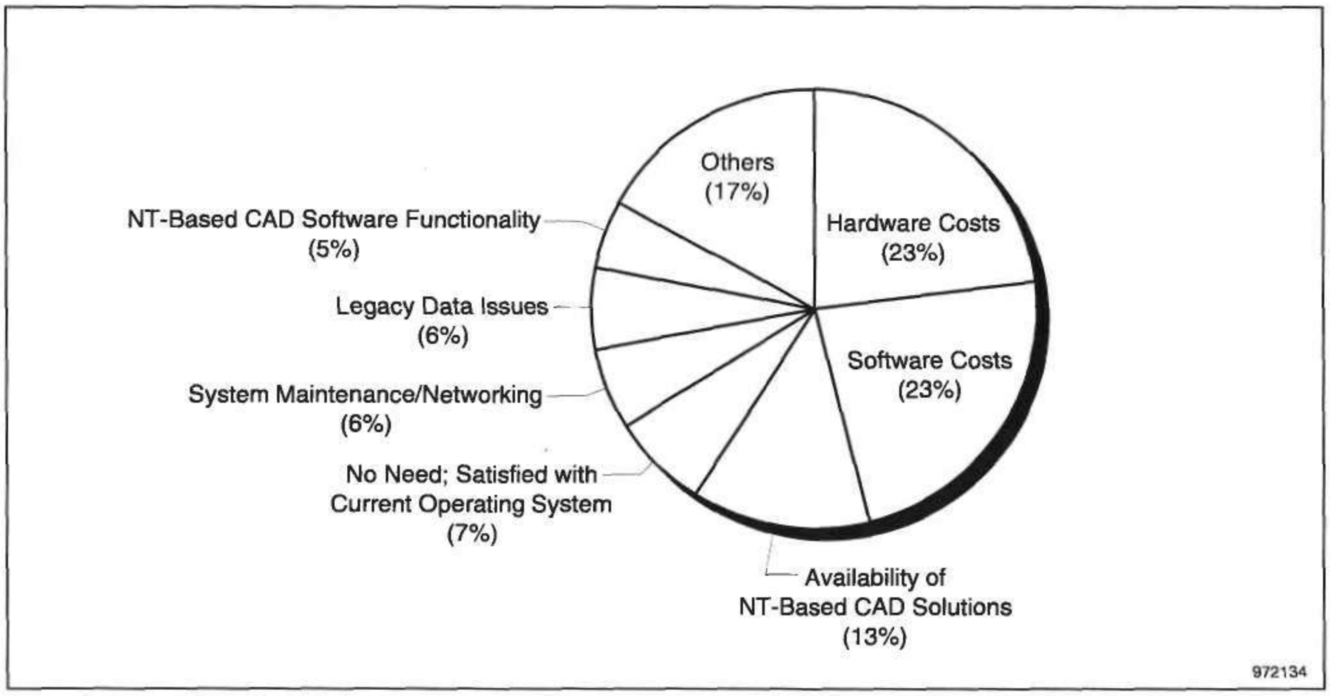
It appears UNIX users foresee reduced hardware/software expenses as primary benefits from moving from UNIX to NT, but some are reluctant to make that move, again because of the up-front hardware/software costs. We believe that this is one of the primary reasons that the substantial UNIX installed base in mechanical design is here to stay for quite some time.

Figure 2
Reasons to Move to NT



Source: Dataquest (September 1996)

Figure 3
Reasons Not to Move to NT



Source: Dataquest (September 1996)

Where Is the Growth Today; Where Will It Be Tomorrow?

Today, NT-based CAD solutions have been relegated to those small, one-to-10-seat deals in mechanical design. UNIX-based solutions continue to win the large, hundred-seat orders. In 1995 and 1996, there were several large CAD investments made by the automotive and aerospace companies (particularly in Europe) that were UNIX-based. Investment cycles in these industries tend to run between four and seven years long, and once again these automotive and aerospace companies have chosen UNIX-based systems for their future design needs.

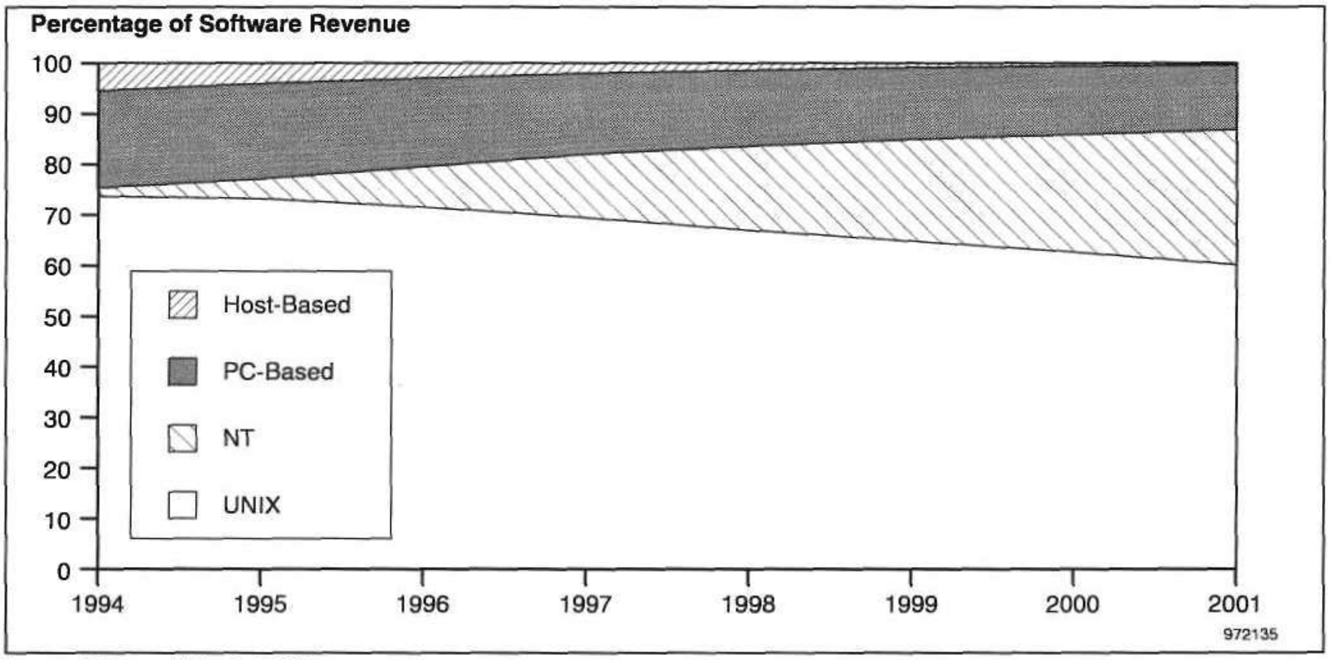
Figure 4 shows our five-year forecast for mechanical CAD/CAM/CAE software by operating system. NT-based revenue is expected to comprise about 26 percent of the market by 2001; UNIX-based revenue is forecasted to comprise 60 percent of the market. We expect a significant portion of the PC-based users to move to NT, with PC-based software making up only 12 percent of the mechanical CAD/CAM/CAE software sales in the year 2001. Again, it is our belief that UNIX and NT solutions will coexist in mechanical CAD/CAM/CAE.

In the near term, the greatest potential for NT-based mechanical CAD solutions are in the low to midrange market. In particular, NT has a real opportunity to snag those users looking to move from 2-D design methods to solid modeling. Here, there are a significant number of designers that still consider 2-D design to be their main method of design. These users can be found in a number of industries outside of aerospace and automotive. According to our September 1996 end-user survey, 55 percent of our respondents were still 2-D focused. As much as 79 percent of industrial machinery respondents and 58 percent fabricated metals respondents considered 2-D design to be their main form of design. It is precisely these users (most of them on DOS/Windows platforms) who represent the greatest immediate potential for NT. This group of designers still feel that 3-D systems are expensive and difficult to learn and use. This opportunity exists not only in North America, but in Europe (particularly among the German CAD designers in industrial machinery), Japan (where there is still a heavy drafting orientation, and companies are beginning to move from proprietary packages), and Asia/Pacific (where users are looking for quantifiable, increased CAD productivity at a low price).

NT's journey down the UNIX path will not be as smooth or fast. Instead, it will be like merging with slow-moving traffic, with NT inching forward a little bit at a time. The mechanical design market is dominated by a handful of traditional UNIX-based vendors with large installed bases, and as we have seen with host-based systems, the changeover to a new operating system is very slow indeed.

True, once Dassault Systemes' CATIA and Computervision's CADDS are ported to the NT platform, we will begin to see some inroads of NT into the high-end users of mechanical design software. But until then, NT will find its greatest acceptance in the low and midrange markets. Both Computervision and Dassault Systemes/IBM have commanding positions in the lucrative

Figure 4
Mechanical CAD/CAM/CAE Forecast by Operating System



Source: Dataquest (March 1997)

automotive and aerospace accounts (particularly in Europe), and as we stated above, many of these accounts have just completed their CAD investment cycles.

A Hardware Perspective

The leading hardware vendors in mechanical CAD/CAM/CAE market are the traditional ones such as Digital, Hewlett-Packard, IBM, Silicon Graphics, and Sun Microsystems. Thus far, these companies have emerged with two straightforward strategies: embrace NT or continue with UNIX systems only.

Those hardware vendors with a combined UNIX and NT strategy include Digital, Hewlett-Packard, and IBM. These companies need to build strong value-added stories to differentiate their Windows NT offerings from competitors coming into the space from the PC side (such as Compaq) and concentrate on transitioning these users as they move up the line from NT. However, having both UNIX and NT isn't necessarily a windfall for these companies. On the contrary, they will face reduced margins, as well as sales channels, customer service needs, and competitors to which they are unaccustomed.

The challenge for the UNIX-focused hardware vendors such as Silicon Graphics and Sun Microsystems will be to differentiate their entry-level workstations from and increase the performance delta between Windows NT/Pentium Pro systems and midrange to high-end workstations. These vendors need to keep in mind exactly who their target market is and what their needs are (for example, advanced graphics, the ability to handle large and complex data sets, or 64-bit operating systems with applications that make use of the 64-bit features). Furthermore, there will always exist a need for powerful systems among the high-end designers in mechanical CAD (for example, those designers doing interactive simulations, complex assembly modeling, or automotive body styling). The workstation vendor who can capitalize on this high-end need will also reap the greatest financial rewards.

Where Are the Opportunities for Vendors?

Clearly, there is room for both NT and UNIX-based solutions in mechanical CAD/CAM/CAE. NT will not kill off UNIX in mechanical CAD, nor will it leave UNIX untouched. There are still many opportunities for software and hardware vendors alike looking for a position in the NT-based CAD market. Vendors should keep in mind that:

- The NT competition will not be in full swing until Dassault Systemes/IBM and Computervision port their flagship products to the NT platform.
- Some industries will be easier to penetrate than others. The aerospace and automotive industries today consist of substantial UNIX-installed bases, and this is not expected to change in the future. Here, vendors should view the opportunity as one where UNIX and NT-based systems will need to coexist.
- Low to midrange CAD systems are ideally suited for those 2-D designers looking to move into 3-D solid modeling. These users, many of them DOS-based, are ideal targets for NT-based solutions that cost the same as Windows-based solutions.
- Software and hardware costs are still top issues in the designer's mind that are preventing migration to NT.

Hardware vendors positioned with a combined UNIX and NT strategy, and those with a UNIX-only strategy, can coexist. However, such hardware vendors—especially PC-oriented competitors, NT-only-based competitors, and combined UNIX- and NT-based competitors encroaching on the low-end UNIX workstations—must differentiate their offerings from their respective competitors.

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Market Trends

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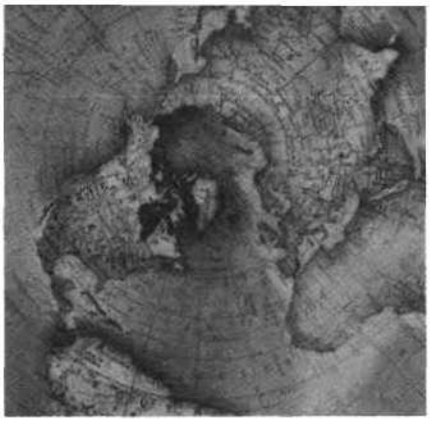

Dataquest

Mechanical Applications: The Road Ahead

Market Trends

Program: Mechanical CAD/CAM/CAE Worldwide
Product Code: CMEC-WW-MT-9701
Publication Date: September 22, 1997
Filing: Market Trends

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Chapter 1
Executive Summary

Study Objectives

Each year, Dataquest takes a comprehensive look at trends and drivers in the mechanical CAD/CAM/CAE market. Our annual Market Trends report provides both a quantitative and qualitative look at the state of the mechanical market today and how it will evolve over the next five years. The information presented in this report is based on Dataquest's ongoing research into mechanical CAD/CAM/CAE.

Key Findings and Highlights

The following are key findings and highlights of this report:

- The leading five mechanical CAD/CAM/CAE vendors continue to solidify their spots at the top, claiming 50 percent of the worldwide 1996 mechanical applications software, and the top 10 vendors claiming 72 percent of the market.
- In U.S. dollar terms, all regions of the world fared well in 1996 except Japan. Growth in these areas outside of North America was a combination of exchange rate fluctuations and actual CAD investment.
- UNIX is still the operating system of choice, but NT-based sales are gaining ground. Despite NT's high growth, it has not yet begun to eat into the UNIX installed base.
- The midrange market is taking shape, developing into two tiers of users—those users who are looking to move from 2-D design to 3-D design, and those users who are looking to extend CAD into the enterprise. Each tier has its own unique set of CAD/CAM/CAE requirements, and the vendors are beginning to align themselves along these two tiers.
- Truly seamless interoperability among CAD/CAM/CAE applications is an elusive proposition, despite the Standard for the Exchange of Product Model Data (STEP) and object linking and embedding (OLE) for Design and Modeling (D&M) work being done today.
- Current collaborative engineering solutions have more potential than any others in the past decade to bring engineering design out of its traditional silo.
- Product data management (PDM) growth is not explosive. Dataquest anticipates that vendors will be revisiting the PDM vision to incorporate elements of collaborative engineering within an intranet or Internet environment.
- Objects in CAD are not quite here yet, but over the next five years there will be a slow but steady infiltration of software that is increasingly populated by smart objects. This infiltration will first take place in architecture/engineering/construction (AEC) and will eventually filter over to the mechanical world. The uptake of objects in CAD would go faster if vendors would focus more on the interoperability of objects and solutions.

Dataquest Perspective

The mechanical CAD/CAM/CAE market continued its second year of double-digit growth in 1996, not an easy feat given the relative maturity of this market. Although such high growth will be difficult to match in the near future, Dataquest expects the market to continue on a robust pace as engineers tackle increasingly complex design problems. We expect mechanical applications, from design to analysis to manufacturing applications, to move more toward the mainstream over the next five years, and we expect high-end users to maintain their investments in design automation. There are many opportunities for well-established vendors and newer players to explore.

Project Analyst: Sharon Tan

Chapter 2
Market Research Methodology and Market Definitions

About This Document

This report is divided into four major sections. Chapter 2 includes an explanation of the market research methodology used in this report. Dataquest's survey methodology and data collection methods are outlined, and our market metrics and subapplications are defined. Chapter 3 discusses the mechanical CAD/CAM/CAE market as it stands today, and Chapter 4 identifies the trends having the greatest impact on the future shape of the market. Chapter 5 looks at each of the mechanical CAD/CAM/CAE subapplications in greater detail. Market share, forecast information, and driving forces for each subapplication are identified and discussed.

Data Collection Process

Fundamental to the way Dataquest conducts research is an underlying philosophy that the best data and analysis come from a well-balanced program. This program includes the following: balance between primary and secondary collection techniques; balance between supply-side and demand-side analysis; balance between focused industry-specific research and coordinated "big picture" analysis aided by integration of data from more than 25 separate high-technology industries that Dataquest covers; and balance between the perspectives of experienced industry professionals and rigorous, disciplined techniques of market researchers.

Supply-Side Data

In the fourth quarter of 1996, Dataquest surveyed all major participants in the mechanical CAD/CAM/CAE industry to obtain preliminary market share data for that year. At that time, each vendor was offered the opportunity to self-report the information required. Although there is a primary contact for each company, large companies are surveyed across product lines and geographic regions. Thus, there is a corresponding increase in the number of contacts at large companies. Examples of job titles of people contacted for information include the following:

- President and chief executive officer
- Vice president and general manager
- Vice president of marketing
- Director of strategic planning
- Director of marketing
- Manager, CAD/CAM/CAE marketing programs
- Market research analyst
- Product manager

Dataquest resurveyed companies during the second quarter of 1997 to verify final annual 1996 results and determine the mechanical subapplication and industry information. The information in this document is based upon final market share data for 1996.

Data supplied by vendors is evaluated against information drawn from many sources, including the following:

- Revenue published by major industry participants
- Government or trade association data
- Annual reports, Securities and Exchange Commission documents, and credit reports
- Company publications and press releases
- Published product literature and price lists
- Reports from financial analysts
- Reseller and supplier reports and reports from a vendor's competitors

Dataquest also sums vendor revenue across other industries covered by Dataquest to make sure that revenue is not credited twice, and we check with multiple sources at one company to cross-check data on that company.

Dataquest believes that the estimates presented here are the most accurate and meaningful estimates generally available today. Dataquest's mechanical CAD/CAM/CAE market numbers are often higher than those reported by other sources. We survey worldwide, which involves more vendors, higher total market revenue, lower market share per vendor, and a more accurate market picture, which is particularly useful when comparing regions or applications.

Demand-Side Data

Dataquest also relies heavily on demand-side, or end-user, data for validating vendor market share and identifying mechanical CAD/CAM/CAE trends. End users are identified using a variety of means, including databases of past survey respondents, corporate intelligence databases, mechanical software vendors' registered users lists, and magazine subscriber lists. End-user surveys are often conducted by telephone to allow for better screening of prospective respondents. At least one major end-user survey is conducted each calendar year, and a number of informal surveys are conducted throughout the year.

Market Segmentation

Market share information presented in this report is based on standard Dataquest market segmentation definitions. The following metrics and definitions are relevant to this document.

Regions

Dataquest defines the regions as follows:

- North America—Includes Canada, Mexico, and the United States
- Europe
  - Western Europe—Includes Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, and the United Kingdom
  - Rest of Western Europe—Includes Andorra, Cyprus, Faeroe Islands, Gibraltar, Greenland, Guernsey, Iceland, Jersey, Liechtenstein, Malta, Monaco, San Marino, and Vatican City
  - Central and Eastern Europe—Includes Albania, Armenia, Azerbaijan, Belarus, Bosnia, Bulgaria, Croatia, Czech Republic, Estonia, Federal Republic of Yugoslavia (including Serbia and Montenegro), Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Macedonia, Moldova, Poland, Romania, Russia (as far as the Urals), Slovakia, Slovenia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan
- Japan
- Asia/Pacific—Includes Australia, Bangladesh, Brunei, Cambodia, China, Hong Kong, India, Indonesia, Korea, Laos, Malaysia, Maldives, Myanmar, Nepal, New Zealand, Pakistan, the Philippines, Singapore, Sri Lanka, Taiwan, Thailand, and Vietnam
- Rest of World—Includes Africa, the Caribbean, the Middle East, Oceania, and South America

Operating Systems

Dataquest defines the operating systems as follows:

- UNIX—Includes all UNIX variants and older workstation operating systems
- Host/proprietary—Includes minicomputer and mainframe operating systems in which the functions of external workstations are dependent on a host computer
- Windows NT—The Microsoft Windows NT operating system
- Personal computer—Includes DOS, Windows, Windows 95, and Apple operating systems

Distribution Channels

The CAD/CAM/CAE software industries make extensive use of complex distribution channels throughout the world. Our data architecture accurately reflects revenue flow from the CAD software vendor to the end user. Specifically, our database allows us to report software revenue as it accrues in the following ways:

- Directly through a company salesforce
- Indirectly from sales to dealers and other resellers

- As revenue earned as a reseller of another company's products (for example, Intergraph's resale of MicroStation product)
- As revenue earned supplying OEM software products that are sold under another name by a separate company (for example, AutoCAD's OEM version)
- As company software revenue, or revenue a vendor puts in the bank (the sum of direct, indirect, reseller, and OEM revenue)
- As dealer revenue (revenue earned by a vendor's dealers for selling the product)
- As user software spending—the total amount actually spent by end users (which is the sum of direct and dealer revenue)

Figure 2-1 shows how Dataquest accounts for all these elements in the mechanical CAD market while not counting revenue twice. To calculate company software revenue for a particular company, we sum revenue from direct, indirect, reseller, and OEM revenue. The total size of the market here is equal to the sum of direct and indirect revenue for all companies (OEM and reseller revenue are excluded in market size, so as to avoid double counting the market). This same methodology is used to calculate end-user spending and end user market size—the only difference is that, instead of using indirect revenue, we use dealer revenue. Dealer revenue is based on a multiplier of indirect revenue. Calculation of these multipliers will vary by vendor, region, and platform.

Mechanical CAD/CAM/CAE Subapplications

Figure 2-2 depicts the mechanical subapplications that Dataquest tracks. We have adopted the following definitions for the mechanical CAD/CAM/CAE subapplications:

Computer-Aided Design (CAD)

- Design applications—Software applications used in the design of components and assemblies from conceptual design to detail design. This subapplication includes software for styling, conceptualization, assembly modeling, component design, and manufacturing tool and fixture design.
- Drafting and documentation—Representation of a part in standard geometric drafting format, including all part geometry dimensions and notations describing mechanical, functional, and material characteristics. This subapplication also includes schematics and technical illustration.

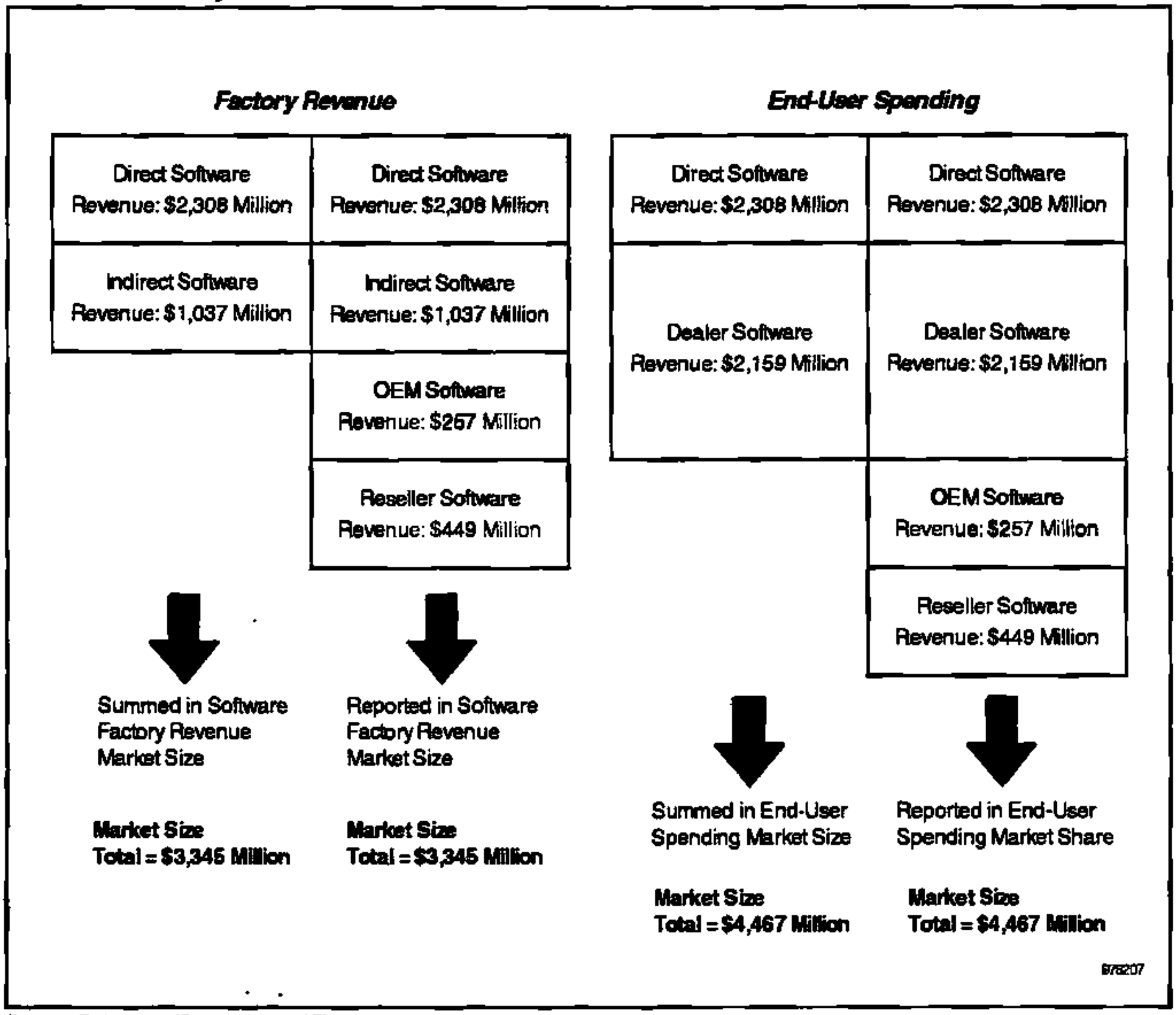
Computer-Aided Engineering (CAE)

- Analysis—Analysis of a physical system, part, or assembly; including structural, thermal, vibrational, composite, fatigue, stack-up, and mass property analysis
- Linkage/mechanism—Motion simulation and analysis of an assembly of components with two or more movable parts

Computer-Aided Manufacturing (CAM)

- Manufacturing process simulation

Figure 2-1
1996 Revenue by Distribution Channel, Mechanical



Source: Dataquest (September 1997)

- Numerical control (NC) part programming—Programming of a numerical control machine tool or automated processing system
- Part processing design—Design of a series of manufacturing steps

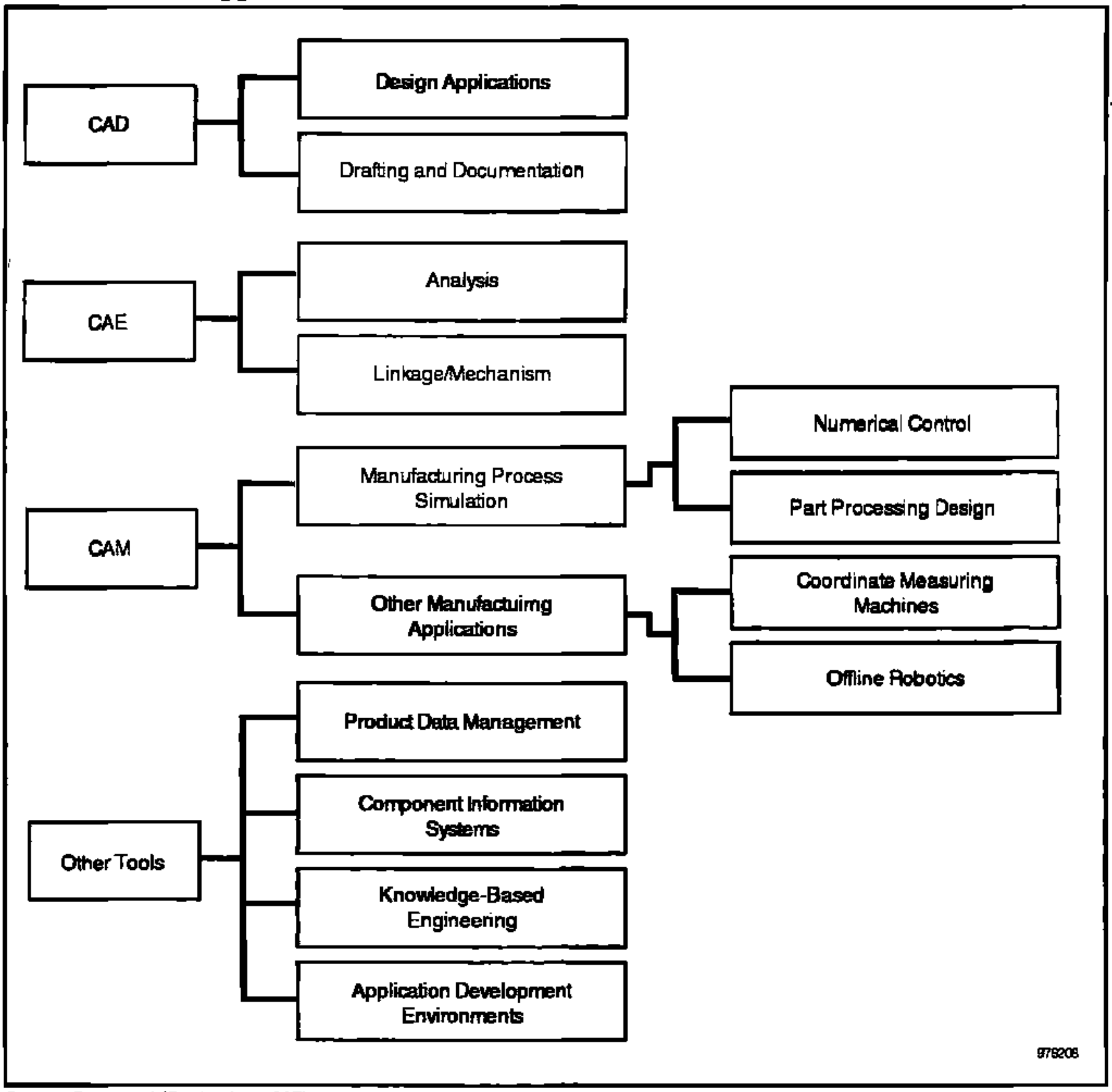
■ Other manufacturing applications
- Coordinate measuring machines—Programming of machines used to measure the physical dimensions of a part
- Offline robotics—Process simulation that represents the sequence of steps to program a robot for a particular operation and downloads data to a robot to update its control program

Other Tools

■ Knowledge-based engineering tools—Tools used to capture design intent and build standard practices for controlling, modifying, and automating design and manufacturing activities. This is also known as rule-based engineering.

- Application development tools—Programming tools to aid in the generation of user-defined programs that drive or interface with CAD/CAM/CAE applications
- Product data management—Software typically used in an engineering or manufacturing environment to manage product data. Product data management includes product structure management, workflow, and vault/document management.
- Component information systems—Software used to navigate within and manage a repository of mechanical engineering parts and associated data

Figure 2-2
Mechanical Subapplications



Source: Dataquest (September 1997)

Chapter 3
The Mechanical CAD/CAM/CAE Market Today

This chapter provides a mostly quantitative assessment of the mechanical applications market in 1996.

Regional Differences

North America and Asia/Pacific fared well last year, growing 17 percent and 28 percent, respectively (see Table 3-1). Growth in other regions—Europe and Japan—is partly because of exchange rate differences and partly because of actual CAD investment. The Japanese market grew 15 percent when measured in Japanese yen, but because of the dollar appreciation against the yen, it grew only 8 percent in U.S. dollar terms. MICROCADAM Inc., Information Services International Dentsu, and Parametric Technology Corp. all fared well in Japan in 1996 (see Table 3-1).

In contrast, Europe grew 12 percent when measured in U.S. dollars but grew only 6 percent in ECU terms. Europe was also affected by exchange rate fluctuations in 1996, though Dataquest can safely say that some of the European growth can be attributed to real investment in CAD/CAM/CAE tools from some of the large aerospace and automotive manufacturers. IBM continues to dominate the European CAD market, with the nearest competitor significantly far behind (see Table 3-1).

Table 3-1
Mechanical CAD/CAM/CAE Vendor Performance by Region, Top Five Vendors

	1996 Software Revenue ($M)	1995-1996 Growth (%)	1996 Market Share (%)
North America			
Parametric Technology	217.8	35.6	21.5
IBM	123.9	30.3	12.3
EDS Unigraphics	112.8	20.9	11.2
SDRC	73.3	7.3	7.2
Autodesk	73.2	-12.2	7.2
Europe			
IBM	298.5	19.6	26.0
Parametric Technology	173.3	58.6	15.1
Dassault Systemes	132.3	19.7	11.5
Computervision	78.3	9.2	6.8
Matra Datavision	68.8	-1.6	6.0
Japan			
MICROCADAM	123.1	17.6	12.7
Info. Services International Dentsu	117.2	37.6	12.1
IBM	109.8	3.5	11.3
Fujitsu	107.3	10.7	11.1
Hitachi	79.9	12.7	8.2

Source: Dataquest (September 1997)

Channel Differences

As discussed in Chapter 2, the CAD market has evolved from a turnkey market with products sold by a direct salesforce to a rich collection of channel and packaging schemes worldwide. Comparing the revenue of one company that sells primarily direct (at retail prices) with another that sells primarily indirect (at wholesale prices) distorts the picture, both in terms of market share and in terms of assessing true market opportunity. Dataquest is now modeling the CAD market by channel, allowing us to report market share based on a number of channel metrics. Table 3-2 outlines the market position in software for the leading mechanical CAD/CAM/CAE companies according to these new metrics.

For 1996, IBM has more revenue in the bank for the mechanical CAD/CAM/CAE software it sells, including the Dassault Systemes software that it sells exclusively and the MICROCADAM software that it resells. However, users spend dramatically more for Autodesk CAD products ($366 million in end-user spending) compared to what Autodesk actually puts in the bank ($177 million of company software revenue). It is little wonder, then, that Autodesk so dominates user minds.

Growth by Industry

User investment is heavily concentrated in the automotive and aerospace industries, as these industries continue to hold more than 34 percent of the worldwide mechanical CAD/CAM/CAE software market (see Table 3-3), a figure that has remained steady over the last five years. Particularly in Europe, the automotive and aerospace companies continued to place large orders for CAD tools in 1996, which will drive growth in these industries for at least two more years (as some of these contracts are multiyear agreements, with revenue spread out over the agreement period). Dataquest is finally seeing an upswing in electrical equipment and consumer electronics, an area some people refer to as mechatronics.

It is worth noting that users in the shipbuilding industry buy both mechanical and AEC software for similar design problems. Of the $39 million in mechanical software sold to the shipbuilding industry in 1996, $54 million of AEC software was also sold. As a result, Dataquest recommends readers evaluate the shipbuilding opportunity at about twice the $39 million in mechanical revenue, keeping in mind that more than half of the revenue is generated by software normally sold to the AEC users.

Table 3-2
1996 Mechanical CAD/CAM/CAE Software Market Leaders by Channel (Revenue in Millions of Dollars)

Vendor	Direct Software Revenue	Indirect Software Revenue	OEM Software Revenue	Reseller Software Revenue	Company Software Revenue	Dealer Software Revenue	User Software Revenue
IBM	485.6	NA	NA	94.1	579.7	NA	579.7
Parametric Technology	445.5	49.5	NA	NA	495.0	110.6	556.1
Autodesk	18.7	156.0	1.8	NA	176.5	345.5	366.0
Computervision	117.6	56.8	NA	NA	174.4	125.7	243.3
SDRC	84.6	68.4	NA	NA	153.0	153.3	237.9
Dassault Systemes	NA	NA	228.6	NA	228.6	NA	228.6
MICROCADAM	7.6	144.4	NA	NA	152.0	212.8	220.4
EDS Unigraphics	163.5	27.7	NA	NA	191.3	55.1	218.6
MacNeal-Schwendler	94.4	29.9	NA	NA	124.3	60.4	154.8
Matra Datavision	65.0	26.8	NA	NA	91.8	66.5	131.5
All Companies	**2,307.2**	**1,037.1**	**257.0**	**449.5**	**3,344.6**	**2,159.0**	**4,466.2**

Note: NA = Not applicable
Source: Dataquest (September 1997)

Table 3-3
1996 Mechanical CAD/CAM/CAE Software Revenue by Industry

Industry	1996 Software Revenue ($M)	1995-1996 Growth (%)
Automotive	697.9	16.1
Aerospace	442.8	13.0
Industrial and Commercial Machinery	310.4	8.2
Electrical and Electronic Equipment	286.9	19.2
Computers/Office Equipment/Peripherals	247.3	12.9
Fabricated Metals	204.7	2.3
Telecommunications	156.8	14.2
Consumer Electronics	152.3	31.3
Manufacturing Not Elsewhere Classified	135.0	28.7
Medical	107.6	10.4
All Industries	**3,345.0**	**13.0**

Source: Dataquest (September 1997)

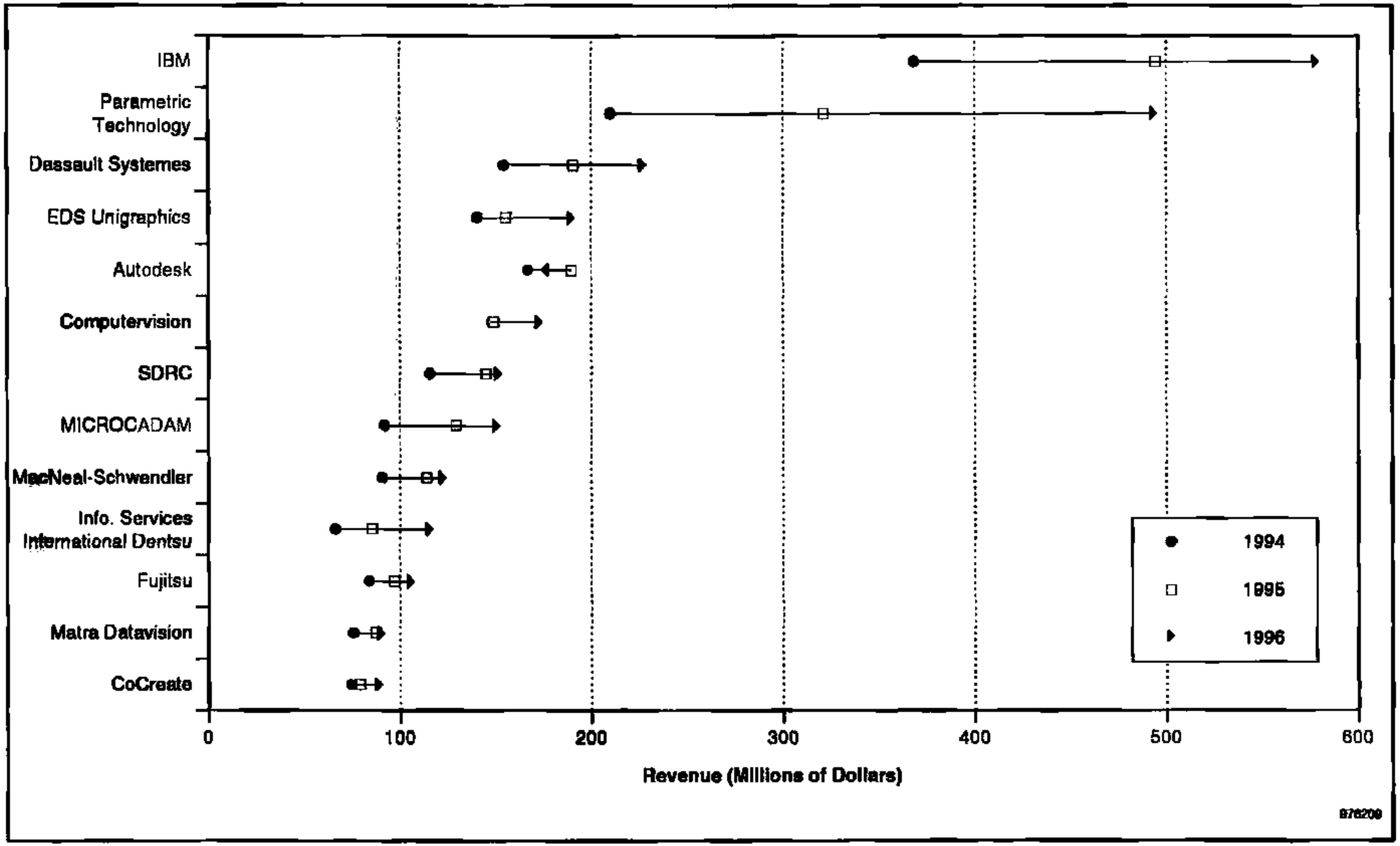
Prognosis of the Market Leaders

The year 1996 was another year of double-digit growth for the mechanical CAD/CAM/CAE software vendors as a group, with a handful of vendors showing growth of more than 20 percent, not an easy feat in what some might call a mature market. Over the past three years, the top 10 vendors have been claiming more of the market (now 72 percent of the $3,347 million in revenue in 1996) at the expense of everyone else.

IBM, still the market leader, has been on the upswing for at least the past three years (see Figure 3-1), as has the CATIA software developer Dassault Systemes. Meanwhile, Parametric Technology, again repeating unprecedented growth in 1996, has been inching up on IBM for at least the past five years. EDS Unigraphics and MICROCADAM continue to turn in consistently good growth year after year, with their core sales in North America and Japan, respectively. Autodesk, the one top 10 player showing negative growth, is in a state of transition. At last, Autodesk has a credible product (Mechanical Desktop) and an entry strategy to make a real play at the mechanical CAD market. (Also, it is important to note that revenue of Autodesk in Figure 3-1 includes sales of both AutoCAD and Mechanical Desktop for 1996. Slow sales of AutoCAD R13 may be masking Mechanical Desktop's true market performance.) Although 1996 figures indicated that Computervision may be in store for a turnaround, early software sales results from 1997 do not bode well for the company.

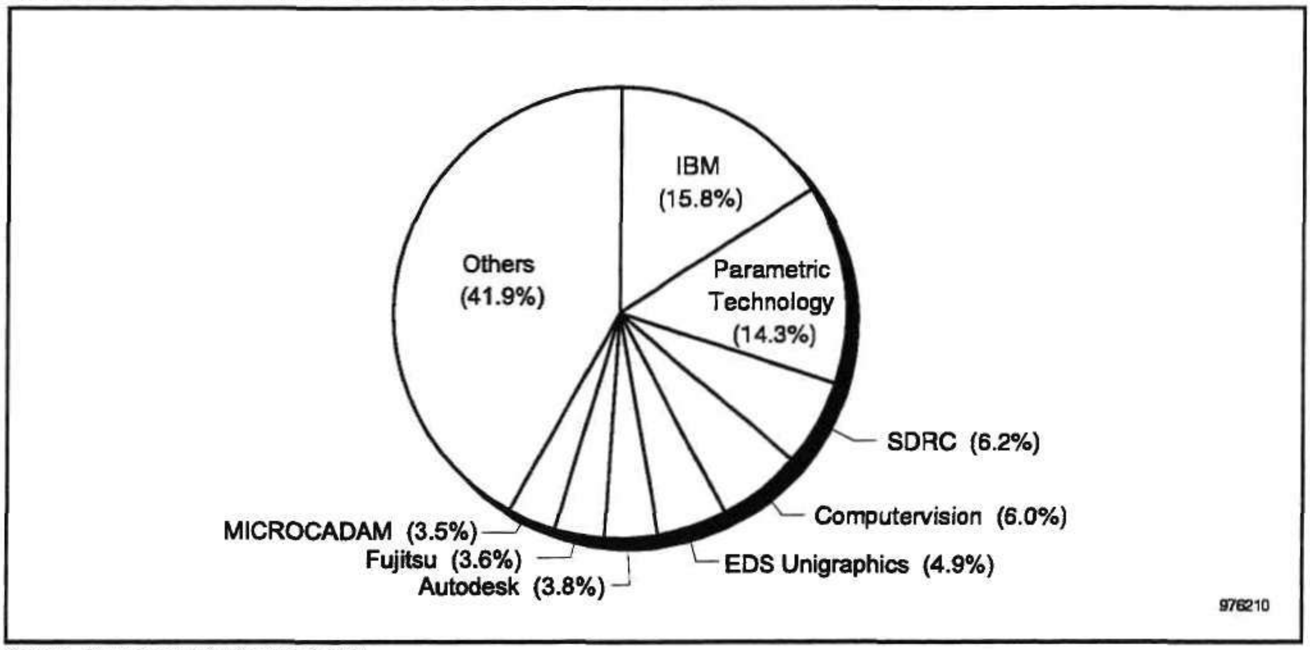
While the above analysis is based on software sales alone, the role of software services cannot be ignored in vendor rankings. Figure 3-2 shows 1996 market share by vendor for software and software services combined. This view particularly affects ranking of companies with large service revenue such as SDRC. In this scenario, SDRC and Computervision gain market share while Autodesk and EDS Unigraphics lose a little bit of ground. Again, a ranking of market players by software and services combined is as valid a view of the market by one that considers only software revenue.

Figure 3-1
Historical Software Revenue by Vendor



Source: Dataquest (September 1997)

Figure 3-2
1996 Market Share, Software and Software Services Combined

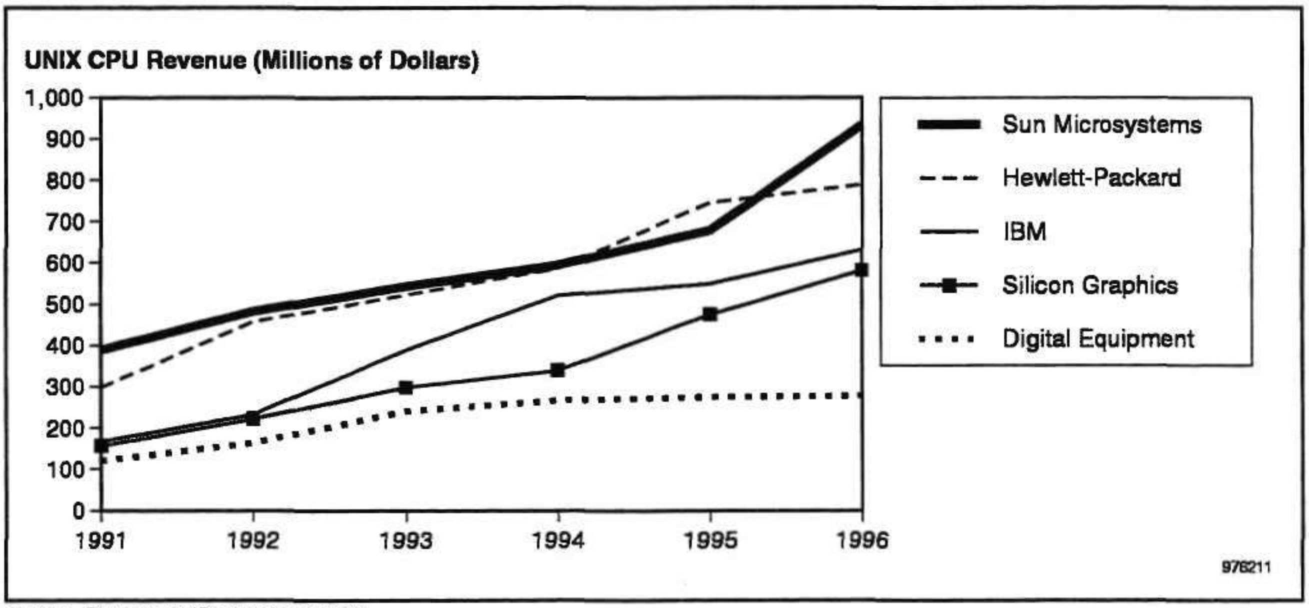


Source: Dataquest (September 1997)

The Hardware Vendors

No analysis of the mechanical CAD/CAM/CAE market would be complete without understanding fundamental shifts among the hardware vendors. For every dollar spent on mechanical applications software, nearly 1.4 times that amount is spent on computing hardware. The big four UNIX players—Hewlett-Packard, IBM, Silicon Graphics, and Sun Microsystems continue to battle it out for market leadership and growth leadership. Figure 3-3 shows UNIX hardware vendor performance for 1996.

Figure 3-3
UNIX Hardware Vendor Performance



Source: Dataquest (September 1997)

Chapter 4
Market Drivers

This chapter explores the trends that will most influence the mechanical CAD/CAM/CAE landscape over the next five years. Although the market is showing the first signs of slowing down from its 1995 and 1996 double-digit growth, many opportunities for vendors still exist in key regions of the world, with certain emerging technologies, and in specific market segments. The trends identified in the following paragraphs are a rich mixture of technology, vendor, and end-user factors.

The Ongoing UNIX—NT Debate

This section discusses the effect of Windows NT on the mechanical CAD/CAM/CAE landscape from a number of different perspectives.

A Software Perspective

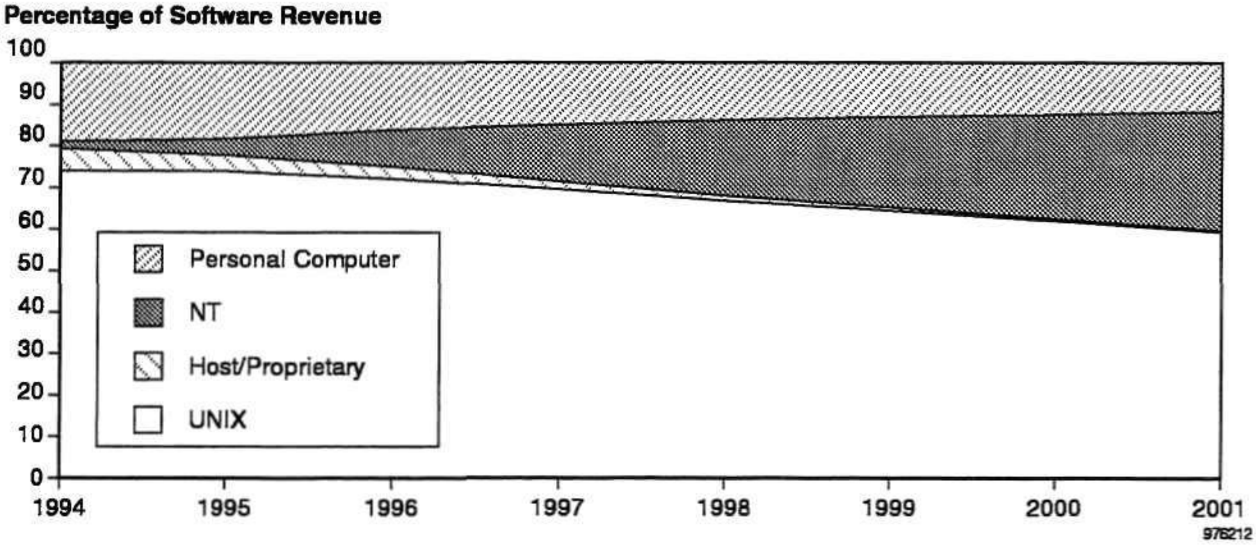
Since 1994, sales of Windows NT-based mechanical applications have grown from $42 million to $295 million in 1996. Despite the fast growth of NT-based mechanical software, it really has not begun to affect the revenue generated from UNIX-based mechanical application sales. The overall mechanical market has grown enough to accommodate increased sales by both operating systems. It is important to keep in mind that the top vendor in the mechanical market today, IBM, still has yet to port its full CATIA product line to the NT platform. Further, nine of the top 10 mechanical CAD/CAM/CAE vendors generate the bulk of their revenue from UNIX-based sales, and an NT-based offering by these vendors is, at best, a port of their existing UNIX code to NT rather than a ground-up design of new software aimed at taking advantage of specific features of the NT operating system. With a port, these vendors, too, can join the "we have an NT solution" bandwagon. Figure 4-1 shows Dataquest's mechanical applications software forecast by operating system through the year 2001.

All signs are pointing to the fact that NT will not eat into the UNIX *installed* base for at least a few more years. Where NT will have its biggest impact in the near term is in the high-growth midrange CAD market, discussed later in this chapter.

A Hardware Perspective

As indicated earlier, the mechanical applications market is expected to remain dominated by UNIX-based software sales in the future, at least from a revenue perspective, much as it is today. Nevertheless, it is important to examine what is happening on the Windows NT hardware vendor front. In the past 18 months, three of the top five established workstation vendors—Digital, Hewlett-Packard, and IBM—have released Intel and Windows NT-based workstation product families alongside their UNIX-based systems. Only Silicon Graphics and Sun Microsystems are staying solidly in the UNIX camp. Other vendors, such as Intergraph and NeTpower, have adopted an exclusively Intel/Microsoft strategy, and new players have entered the market, most notably Compaq Computer Corporation.

Figure 4-1
Mechanical CAD/CAM/CAE Forecast by Operating System



Source: Dataquest (September 1997)

Since the introduction of Windows NT, some high-end PC configurations have been sold into some mechanical applications traditionally considered to be the domain of RISC/UNIX workstation vendors, blurring the boundaries between the two market segments. The biggest threat to the strong foothold of the UNIX hardware vendors in mechanical CAD/CAM/CAE is the introduction of Intel's Pentium Pro. Here, Intel-based systems could compete on equal footing with entry-level RISC systems, accelerating the penetration of Windows NT into the UNIX-dominated workstation market. Nevertheless, the mechanical CAD/CAM/CAE market moves slowly, and toppling the entrenched market leader for mechanical applications, UNIX, will be a long, arduous process for any operating system.

A User's Perspective

The speed at which NT-based software becomes a standard in mechanical design depends on end-user purchases and interest. In early 1997, Dataquest asked 198 users what their main CAD operating system will be in 1999 and in 2001. According to end users, UNIX will indeed cede some ground to Windows NT in mechanical CAD; over the next two years, 18 percent of users plan to move to the Windows NT operating system, and by 2001, 28 percent expect NT to be their primary mechanical CAD operating system. However, the overall numbers do not give the whole picture. According to end users, NT will make its greatest gains in electrical and electronic machinery and aerospace, and those respondents in automotive tend to be more guarded about their transition to NT.

It is important to keep in mind that the survey respondents identified UNIX as their main CAD operating system today, so these results start from a base of 100 percent UNIX users, and that these responses are from end users and are not a Dataquest forecast of mechanical CAD operating systems. Previous end-user surveys have shown that users tend to be much more optimistic about change than in reality. Expect actual movement to NT to be slower than the numbers cited above.

Emergence of the Midrange

There is no shortage of midrange mechanical design packages on the market today—Autodesk's Mechanical Desktop, Bentley Systems' MicroStation Modeler, EDS Unigraphics' UG/Creator Bundle, Intergraph's Solid Edge, Parametric Technology's PT/Modeler, SDRC's Artisan Series, and SolidWorks' SolidWorks. This section identifies the issues facing expansion of the midrange market.

Understanding the Two Tiers

At this time last year, the midrange market was too immature to clearly define. What will develop over the next year is a midrange market with two distinct tiers. The first tier consists of those users who are looking to move from 2-D design to 3-D design. This group perhaps uses one of the various versions of AutoCAD and is looking to move up to solid modeling for some of its design work. The second tier consists of those users who are looking to extend CAD into the enterprise. For instance, an automotive company may be using a full-blown UNIX-based system for their primary design package and a midrange package (with a common solid modeling engine) among its suppliers.

Selling mechanical CAD systems to the first tier is different from selling to the second tier. The first tier of users, those moving from 2-D to 3-D, have the following characteristics:

- Lack budgets for more expensive UNIX-based CAD systems
- Lack a lot of investment in historical, legacy data that would make switching CAD systems something to be avoided
- Have limited needs in analysis and CAM, at least today
- Work in smaller groups or teams of designers
- Rely on value-added resellers (VARs) and dealers for their CAD needs and training

In contrast, those in the second tier, who are looking to extend CAD further into the enterprise, have:

- Lack budgets for more UNIX-based CAD systems, but have budgets that are larger than the first tier
- Have investments in historical and legacy data that must be preserved
- Are looking for seamless data transfer among CAD systems and downstream and upstream applications
- Purchase CAD systems via direct sales as part of a larger companywide CAD or information technology (IT) strategy

Clearly, among the midrange products mentioned earlier, some fit more naturally among the first tier than among the second tier. In particular, EDS Unigraphics, Parametric Technology, and SDRC all offer midrange and higher-end packages that are based on a common, proprietary solid modeling engine, making data transfer seamless, both upstream and downstream. On the other hand, Autodesk, Bentley Systems, Intergraph, and SolidWorks sell midrange products today almost exclusively through the indirect channel and typically in smaller two- to five-seat deals.

Indirect Channel; Qualified Dealers

Growth of the midrange mechanical CAD market, as well as any one vendor's success in that market, will depend heavily on the distribution channels and strength of the VARs. For years, mechanical VARs and dealers have taken a back seat in the UNIX-dominated mechanical CAD/CAM/CAE market that has relied heavily on direct sales. Given the number of midrange mechanical design packages being sold through dealers and VARs today, software vendors are undoubtedly having to work to attract and retain qualified dealers. Nevertheless, CAD VARs today are becoming more sophisticated, either offering software products themselves (like Visionary Design Systems is doing) or expanding their network through acquisition (like Rand Technologies). At the same time, mechanical CAD users will become more sophisticated and demanding in their needs, as well. Keeping up with technology is a challenge to all, and VARs and designers are no exception.

Interoperability—A Never-Ending Story

Truly seamless interoperability among CAD/CAM/CAE applications is an elusive proposition. The concept of interoperability has been bandied about for years, as have the so-called solutions to interoperability—direct translators, data exchange standards like IGES, STEP, and OLE for D&M. Interoperability is less of an issue for those companies that use one single CAD/CAM/CAE package from art to part. But, with the exception of a few industries like aerospace and automotive, art-to-part software supplied by one vendor is becoming less of a reality. Further, interoperability issues hang like a dark cloud over the midrange market, especially for those midrange packages that are focused on just design today.

Because the entire world of CAD users does not use identical geometry engines, interoperability problems stand out like sore thumbs. Proprietary solid modeling engines are the traditional mainstay of the mechanical CAD/CAM/CAE market. In past years, there has been an influx of solid modeling kernels (Spatial Technology's ACIS, EDS Unigraphics' Parasolid, and Ricoh's DesignBase) for which their respective developers have set up OEM deals. Users have different modeling needs, and the various modeling kernels all have different functionalities and capabilities.

Unfortunately, Dataquest does not envision standardization around one particular modeling kernel at any time in the near or far future, if at all. Thus said, vendors and users have no choice but to attack interoperability issues via standards. STEP and OLE for D&M are two solutions to interoperability that appear to be moving forward, albeit slowly at times.

The STEP Standard

STEP is a collection of international standards being developed in smaller pieces via worldwide committees. One of STEP's original visions was to have various systems accept and use standard product data so that suppliers, vendors, and manufacturers could receive and supply information about product parts and the interrelationships of parts and materials. The initial focus of STEP was on mechanical parts; however, this is not the only focus today. There are STEP development efforts in process plant design and electrical design as well. STEP is viewed not necessarily as a successor to IGES, but as a broader exchange standard because it incorporates manufacturing information on product features such as size, materials, properties, and part relationships. In a nutshell, STEP consists of application protocols that govern the technicalities of how files and data are represented and transferred.

STEP has always shown stronger backing in Europe than in the rest of the world, though there are STEP-related initiatives in North America, Japan, and Asia/Pacific. Because STEP is such a comprehensive standard, it is expected that no one vendor will develop software that is fully compliant with every aspect of STEP. Instead, vendors will implement those aspects of STEP that are pertinent to their customers' lines of business or product applications. At this point in time, the major mechanical CAD/CAM/CAE vendors have been supporting STEP as far as it has gone, making available the ability to create a STEP file from their proprietary data models.

The problem for the users today is that even the STEP processors available right now do not yet exchange data perfectly. ProSTEP e.V. recently announced the results of a benchmark it did with 10 STEP interfaces from various vendors exchanging solid modeling data. The quality of the interfaces has certainly improved, but by no means can a user expect seamless data transfer yet. At heart of the issue are the demands of the users, who can't afford to fiddle around with exchange standards that are close, but not quite right. Even with the strong vendor support that STEP is receiving, particularly in Europe, the bottom line is that designers and engineers are paid for designing products and manufacturing them. They do not have the time to rework CAD model imports and try to figure out where the errors are.

OLE for Design and Modeling

OLE for D&M specifies a standard set of geometry and topology interfaces for mechanical applications. It is a set of component object model (also known as COM from Microsoft) interface specifications developed specifically for the mechanical design industry. OLE for D&M has received strong backing from a number of mechanical CAD/CAM/CAE vendors with products on the PC or NT platforms.

The organization facilitating the development of OLE for D&M is the Design & Modeling Application Council (DMAC), established in early 1995 and pioneered by Intergraph. The DMAC held a major demonstration of CAD/CAM/CAE application interoperability using OLE for D&M earlier this year.

Because of the common interfaces, software that supports OLE for D&M allows for data exchange *without translation* (for example, no IGES translations are needed), thus making geometry exchange neater and more seamless. The breadth of OLE for D&M is being extended to include such things as support for nonmanifold topology, interchange of product structure data, and features interface (something akin to smart CAD objects). If OLE for D&M can be expanded to include these additional functionalities as well as others, it will become a very plausible mechanism for seamless interoperability among CAD, CAM, and CAE applications.

Opportunities in Asia/Pacific

Dataquest expects the Asia/Pacific region to grow faster than any other region of the world over the next five years (see Table 4-1). A mixture of local government, multinational companies, and industry initiatives is driving mechanical applications software growth in this region. While we can produce a market share table showing a market leader in Asia/Pacific, it appears as if no single software vendor has a dominant position in every country. Dataquest also has found that success in one country doesn't necessarily translate to success in another country, and good growth by a vendor one year doesn't ensure good growth in the following year. The Asia/Pacific CAD market can accommodate many vendors and dealers that keep the following factors in mind:

- Particularly in Southeast Asia, mechanical designers are not as advanced in their use of CAD as are their counterparts worldwide. There exists a large number of 2-D users who can be migrated to 3-D design methodologies. Here, midrange solutions will do well.
- In regions where labor is cheap, corporations believe it is more cost-effective to hire more workers than to automate portions of the design and manufacturing processes.
- Local and national governments play a heavy role in development of IT in many Southeast Asian countries, and strong initiatives for jump-starting or growing a country's IT infrastructure have begun. These initiatives typically will include CAD as part of the strategy.
- The growing automotive industries in Indonesia, Korea, Malaysia, and Thailand, as well as aerospace initiatives in China and Indonesia, all bode well for future mechanical CAD sales.
- Users will need implementation and consulting services to get the most from their CAD systems. Typically, there is no CAD guru who fully understands CAD/CAM/CAE technology and can oversee its deployment.

Table 4-1
Forecast Asia/Pacific Growth by Country, Mechanical CAD/CAM/CAE

Country	1996 Revenue ($M)	1996-2001 CAGR (%)
China	24.5	27.7
Hong Kong	16.5	14.6
Korea	43.9	18.7
Singapore	13.9	15.3
Taiwan	30.1	15.3
Rest of Asia	51.8	25.5
Total Asia/Pacific	**180.7**	**21.1**

Note: Rest of Asia includes Australia, Brunei, Cambodia, India, Indonesia, Laos, Malaysia, Maldives, Myanmar, Nepal, New Zealand, Pakistan, Philippines, Sri Lanka, Thailand, and Vietnam.
Source: Dataquest (September 1997)

Product Data Management—Time for a New Focus

Despite the hype, PDM as it stands today has not exploded into a vast market opportunity for vendors. Although the problems that PDM addresses are very real, the methods by which PDM has tackled these problems are less than ideal. Many of the solutions on the market have focused heavily on vaulting/engineering document management first and product structure second. Workflow capabilities have been available, but these solutions required that processes be predefined in a rigid structure. This methodology may fit products once they are released from engineering to manufacturing, but it does not facilitate the less structured engineering design process.

Last year, Dataquest could have said that integration of PDM with manufacturing resource planning (MRP) solutions from companies like SAP and Baan was the trendy thing to do. This year, it has been Web-enabling the PDM solution (that is, creating a Web-based interface for the PDM client). Neither trend will create explosive growth in the market. The PDM vision must be revisited to incorporate elements of collaborative engineering (discussed later) within an intranet or Internet environment—and even then, it will still be a missionary sale. On a positive note, some of the vendors understand this need and are beginning to roll out products that are more than just Web-enabled solutions of their old PDM solutions. PDM market and players are discussed in greater detail in Chapter 5.

Collaborative Engineering

Only a few years ago, collaborative engineering meant electronic whiteboarding, a technology that few designers were interested in because it wasn't connected tightly to the CAD model; there was no efficient way to take those marked-up whiteboarding changes and link them directly to CAD geometry. That has changed with the advent of Internet and intranet technology. The race to collaborative engineering is on again, with both PDM and CAD/CAM/CAE vendors sprinting to offer something that fits under that rubric.

Right now, vendors have nothing to lose and everything to gain by putting some sort of Web spin on their products, as users today are not really sure of what they need or want in terms of Internet/intranet/Web capabilities in their automation tools. What is certain is that the collaborative engineering solutions today have greater potential than anything in the past 10 years to bring engineering design out of its traditional silo.

Clearly, collaborative engineering, or what used to be called concurrent engineering, is reinventing itself. Although no single definition has emerged yet, Dataquest believes there needs to be some element of CAD, data management, and workflow for the designer, customer, and supplier (that is, the extended enterprise). Solutions that are making headway at defining the potential of collaborative engineering include Bentley Systems' Engineering Back Office suite of products, CoCreate's concept of shared-space design, Computervision's EPD.Connect, Dassault Systemes/IBM focus on process-centric users, and Parametric Technology's Pro/INTRALINK.

Mechanical and Electrical Co-design

In the past few years, there have been two opportunities for mechanical and electrical design tools and methodologies to merge. One is with system-level design. True system-level design automation (SDA) tools are still years ahead. Much of the SDA work today is project-oriented, and these programs are funding some new tool development. Two well-known SDA programs are the Ford 2000 program and the European AIT consortium; a well-known precursor to SDA (before the term SDA became popular) was the Boeing 777 project.

Only a few SDA tools are commercially available today. They are primarily high-level architectural system design and modeling tools and tend to be academic in their approach to SDA. There is still a disconnect between translating those system requirements to actual design requirements, whether they are electrical or mechanical. There is a System Level Design Language Working Group, whose goal is to come up with an electronic/mechanical systems language by the year 2006.

The second opportunity for mechanical and electrical disciplines to merge is with mechanical and electrical co-design tools. Electromechanical systems have their own set of design problems beyond just mechanical ones—signal integrity, electromagnetic radiation, and thermal issues can all affect a product's intended function. Most of the tools that fall into this emerging category are cabling tools. True, companies like Computervision have had cabling and wire harness solutions for years. But today, a handful of vendors, mostly from the electrical side, is addressing the mechanical/electrical co-design issue. This group includes Mentor Graphics, Viewlogic, and Mechtronix. For these electronic design automation vendors to succeed in this category, they will have to offer tools that give mechanical designers the precise geometry modeling that they need—ones that have the ability to do simulations and are priced lower than the typical electrical designer's seat.

The Promise of Objects—If and When

Beginning in 1995 and continuing through 1997, CAD vendors began unveiling products or architectures based on object-oriented technology, including Autodesk (ObjectARX), Bentley Systems (MicroStation/J), Computervision (Pelorus), Intergraph (Jupiter), and Matra Datavision (CAS.CADE). The promise of objects and object-oriented technology in CAD is moving slowly ahead, albeit faster in AEC and more slowly in mechanical CAD/CAM/CAE.

The discussion that follows is extracted from a Dataquest Perspective sent to our worldwide AEC CAD clients—"Smart Objects in CAD Software: How Far, How Fast?" (CAEC-WW-DP-9708), dated August 18, 1997. Although the extracted text focuses on CAD in general and AEC users in particular, we feel that readers of this report will find the discussion of interest, as many of the object-based developments in AEC may one day filter over to the mechanical applications side.

The Confusion about Object Technology

The object-oriented world promised to help software vendors bring products to market faster by exploiting reusable code while dramatically reducing user design time by increasing certainty of design outcome and freeing users from the worries of data translation and integration with other CAD programs. The dividing lines among objects, object-oriented architectures, component technology, and object-oriented programming are not easy to ascertain. Adding to the confusion, some CAD vendors have taken the liberty of calling their software object-oriented, even though the amount of "object-orientation" in their software might actually be quite small. This has given vendors the freedom to market their products as being object-oriented even if the software has only a few smart objects or only has portions of the code written using an object-oriented programming language like C++.

Today, object-oriented CAD applications seem to be divided in two camps. At one end, there are those applications that are built using object-oriented programming languages. Benefits to the end user are limited, but benefits to the application developers are theoretically greater (in terms of code reuse and faster application development). At the other end, there are those applications that actually allow the user to place smart objects within their CAD drawings. (First, a definition: Objects seek to represent real world entities by encapsulating their attributes and behavior. The term "smart" is used to denote that the objects carry all the knowledge about themselves with them. This knowledge can include business rules, design rules, or manufacturing processes. For instance, a smart door object is more than just a collection of lines and arcs. It knows that it can't be placed on a window or in a firewall.) Here is where end users begin to see the benefits of object technology. The user begins designing less with lines, arcs, and circles and more with doors, windows, and walls. Of course, this is a very simplified view of where vendors are coming from today in marketing object technology to the CAD world.

The Bottom Line

The bottom line is that users are less concerned with the object orientation of a solution as compared with its ability to address their design needs. They would also like software solutions that can be extended with ease, instead of having to invest in programming resources to develop a custom solution and to be able to access objects or CAD applications across platforms without having to work around interoperability issues. To date, the object-based architectures and solutions being offered by vendors in the CAD world still do not solve the ever-important user concerns of proprietary data models, data exchange, and interoperability. The promise of objects in CAD will have reached its promise once smart objects are able to carry knowledge from one application to another and users will be able to operate in a hybrid environment where legacy (nonsmart) data is involved.

Objects in CAD are not quite here yet, but over the next five years there will be a slow but steady infiltration of software that is increasingly populated by smart objects. This infiltration will first take place in AEC and will eventually filter over to the mechanical world. The uptake of objects in CAD would go faster if vendors would focus more on the interoperability of objects and solutions. One can only hope that the OLE for D&M committee is beginning to think about smart objects like smart screws, bolts, and motors.

Interactive Product Simulation

Although rapid prototyping may be a reality in CAD today, what has been called virtual prototyping has not been widely embraced by the design community. CAD vendors have ventured in this direction of designing and visualizing assemblies in a virtual environment (for example, Computervision's electronic product definition strategy). Hardware vendors like Silicon Graphics and IBM have seen its customers use its workstations to complete virtual tasks, such as fly-throughs of complex product assemblies to simulations of a manufacturing plant. And there has been the occasional animation-based software vendor eyeing a piece of the virtual prototyping market. But "virtual prototyping" has never been clearly defined, resulting in a mix of hardware and software solutions looking for a market and a group of users. The ambiguity of this market's definition has made sizing this market a challenge for Dataquest.

Dataquest believes we have finally stumbled on a term that may better describe this market (and enable us to eventually size the market opportunity)—interactive product simulation (IPS). As Division Inc. describes IPS, it is the ability to create, interact with, manipulate, share, and analyze a virtual product in real time. We feel that this term and definition fit more closely with the mechanical design process. With this definition, we can include such companies as Engineering Animation (with VisMockUp and VisFly), Division Inc. (with its dVise family of products), and Tecnomatix Technologies (with DYNAMO), and we can exclude such companies as Transom Technologies Inc. (with its Jack software). Dataquest will be looking at IPS more closely in 1998, refining the boundaries of IPS and defining the market players.

Chapter 5

Mechanical Market by Subapplication

Chapter 2 provided a definition of Dataquest's mechanical subapplication structure. This chapter provides a detailed look at the market by subapplication. For the convenience of our readers, here we reprint Figure 2-2, our subapplication outline, as Figure 5-1. Table 5-1 gives the 1996 market size by subapplication and the five-year CAGR forecast.

There are two important points to be made about Dataquest's subapplication database. First, while we report a vendor's market share and revenue based on *company software revenue*, or the sum of direct, indirect, OEM, and reseller revenue, we report a vendor's *subapplication revenue* based on *software product revenue*, or the sum of direct and indirect revenue. Thus, for some companies, in particular IBM, the sum of all subapplication revenue will be lower than what we normally report in our standard market share tables (because of the exclusion of OEM and reseller revenue in the subapplication database).

Secondly, this year, Dataquest is reporting less detailed subapplications than in previous years under the Computer-Aided Design heading. Because the boundaries among functional design, conceptual design, and tool and fixture design are not that distinct, we are reporting those three subapplications under the heading Design Applications.

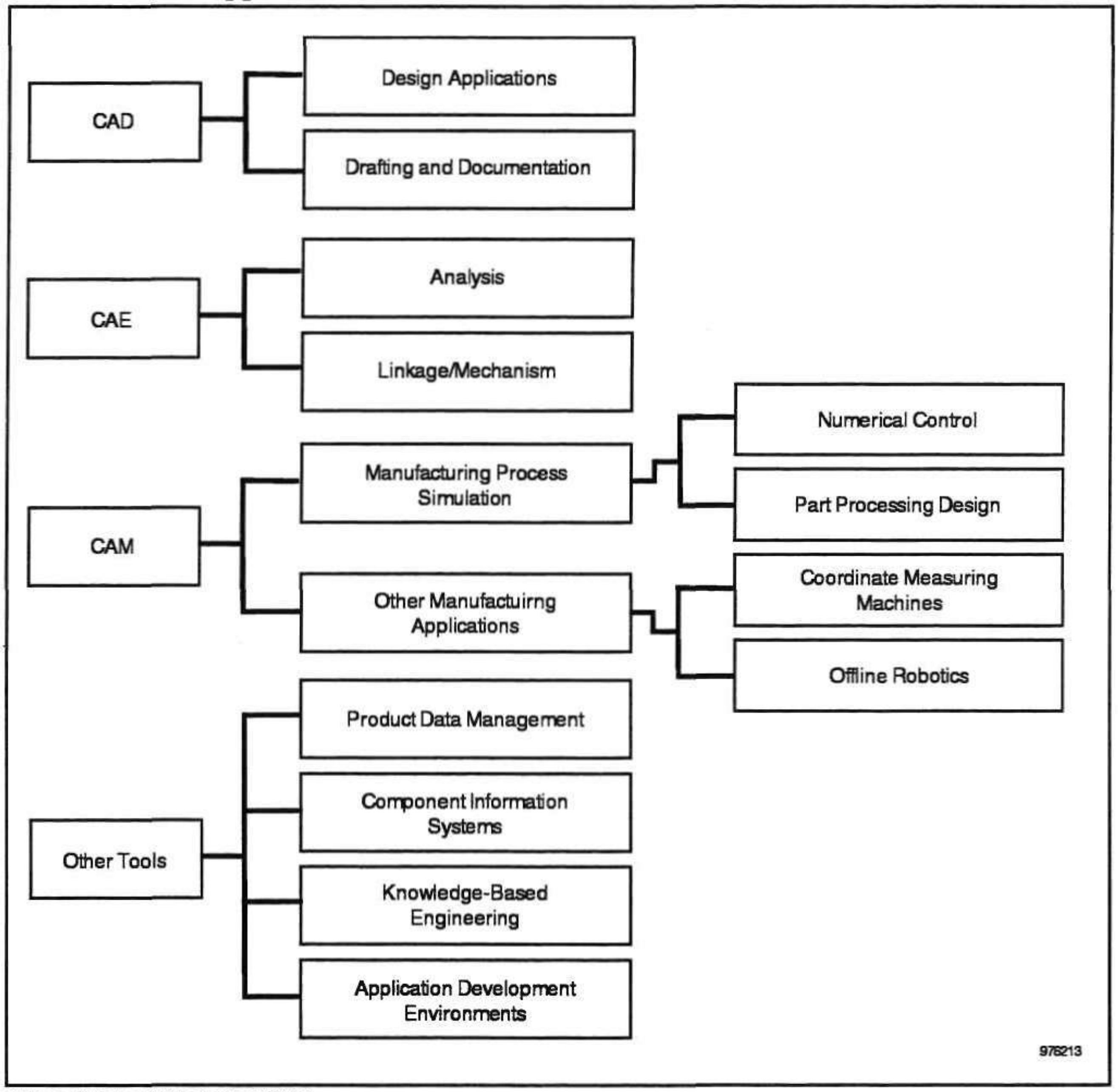
Computer-Aided Design

Design Applications

Design applications are the mainstay of the mechanical CAD/CAM/CAE market. Investment in basic CAD tools by end users is reflected in the high growth rate of this subapplication in both 1996 and 1995 (17 and 32 percent, respectively). Vendor penetration into the untapped Asia/Pacific region and reinvestment/rethinking of CAD strategy by a large number of European automotive and aerospace firms have re-energized this subapplication over the past few years. Outstanding performance by perennial market players Parametric Technology, IBM, EDS Unigraphics, Computervision, and MICROCADAM in 1996 also have helped to boost this segment. Figure 5-2 shows the 1996 software market share of the leaders in design applications.

This subapplication will continue to grow, albeit more slowly, over the next five years. It is expected to show a five-year CAGR of 11 percent until 2001, slightly above the total market CAGR of 10 percent over that same time period. Better modeling tools will be needed to drive downstream applications like CAM and rapid prototyping, and users are beginning to design increasingly complex assemblies. The midrange vendors will become strong factors in driving this subapplication beginning in mid-to-late 1998, especially in sales for manufacturing tool and fixture design.

Figure 5-1
Mechanical Subapplications



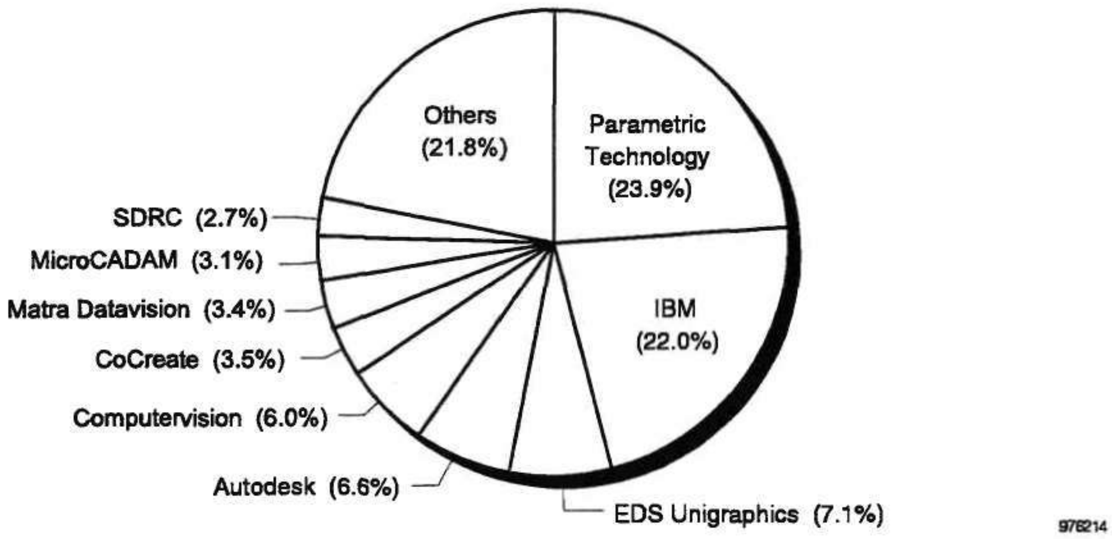
Source: Dataquest (September 1997)

Table 5-1
Mechanical Subapplications Market Size and Forecast

	1996 Software Revenue ($M)	1995-1996 Growth (%)	1996-2001 CAGR (%)
Computer-Aided Design	2,108.9	10.4	8.3
Design Applications	1,382.6	17.2	10.9
Drafting and Documentation	726.3	-0.6	2.4
Computer-Aided Engineering	553.6	15.9	11.8
Analysis	507.4	15.1	11.7
Linkage/Mechanism	46.2	25.5	12.5
Computer-Aided Manufacturing	393.8	18.7	11.6
NC Part Programming	322.7	16.3	10.8
Part Processing Design	32.5	42.4	15.9
Other Manufacturing Applications	38.5	22.6	14.0
Other Tools	287.9	19.9	13.5
Knowledge-Based Engineering Tools	22.3	43.1	11.5
Application Development Environments	23.8	13.0	14.7
Product Data Management	236.2	17.1	12.2
Component Information Systems	5.7	235.7	45.3
All Subapplications	**3,344.6**	**12.9**	**9.8**

Note: Revenue does not add to $3,344.6 million because of rounding
Source: Dataquest (September 1997)

Figure 5-2
1996 Design Applications Market Share



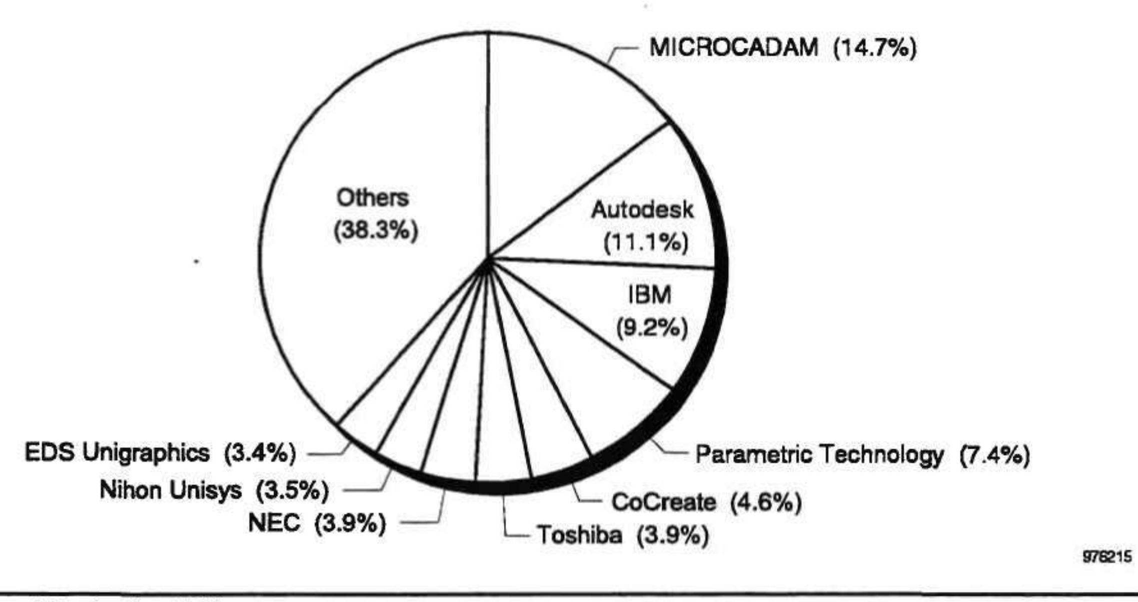
Source: Dataquest (September 1997)

Drafting and Documentation

Similar to design applications, drafting and documentation is the bread and butter of the mechanical CAD/CAM/CAE market; in fact, in the earliest days of CAD, drafting was the only subapplication in the market. This subapplication has continued to be one of the largest (comprising more than 20 percent of the 1996 mechanical CAD/CAM/CAE software revenue). Despite its size, it is also one of the slowest-growing subapplications. In 1996, it reached $726 million; in 2001, it is expected to reach only $818 million. Figure 5-3 gives the market share of the top players in this subapplication.

Although drafting is not an area of rapid change or innovation, drafting's large market size confirms that, even after 25 years of mechanical CAD development, this subapplication is still essential to the design process. A new crop of players, like Visio and 3D/Eye (now part of Visionary Design Systems), could shake up this sleepy application in the near term, though they will not drive huge expansion here. Instead, they have the potential to take market share away from established players, particularly those with largely standalone drafting-only packages. Looking further out, however, 3-D and solid models are becoming more common in the design process, and these models are being sent directly to downstream manufacturing applications, leaving out the intermediate drafting and drawing step.

Figure 5-3
1996 Drafting and Documentation Market Share



Source: Dataquest (September 1997)

Computer-Aided Engineering

Analysis

Dataquest has been waiting for years for the analysis market to take off—so far, it still hasn't happened. Instead, revenue from this subapplication have hovered around the average mechanical CAD/CAM/CAE market growth rate, performing neither well above nor well below the average growth. Although MacNeal-Schwendler and SDRC still lead this market (see Figure 5-4), no single vendor is growing largely at the expense of another. This is one subapplication that features a host of small players and specialty analysis vendors.

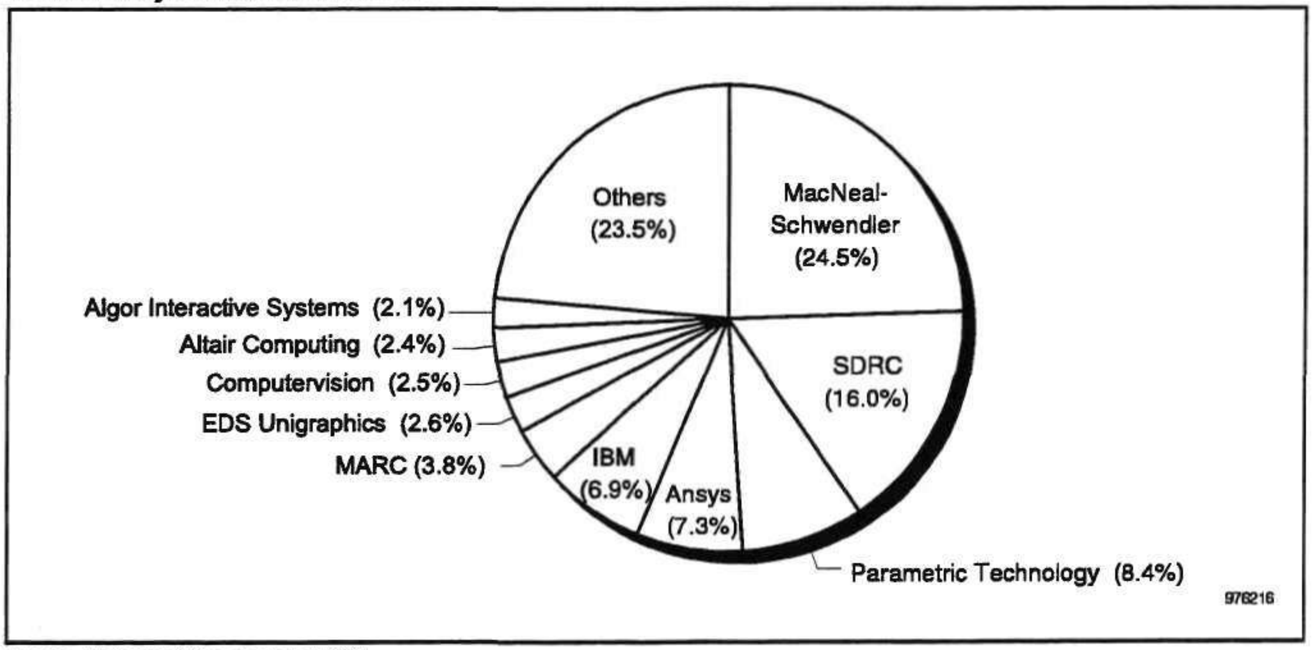
Analysis vendors have been responding to designers' needs by developing better user interfaces, error-checking codes, and automatic mesh generators and healers The next step is to pursue tighter integration of these analysis packages with solid modelers, something Ansys is already doing. Additionally there are still untapped areas within this market to pursue, such as nonlinear analysis, and nontraditional industries, such as in electronic packaging (though Dataquest can no longer consider this area "untapped"). The analysis market is badly in need of a visionary to spearhead this subapplication's next big step forward—to date, Ansys is the only company that has attempted to do just that. For the most part, many of the vendors in this market have been busy pursuing some of these untapped opportunities rather than putting forth a vision of what analysis should be in the next five years.

Linkage/Mechanism

Linkage/mechanism reached $46 million in 1996, up 26 percent from the previous year. While Mechanical Dynamics was one of the pioneers of this market, Parametric Technology's overall robust growth have given it the No. 1 spot (see Figure 5-5).

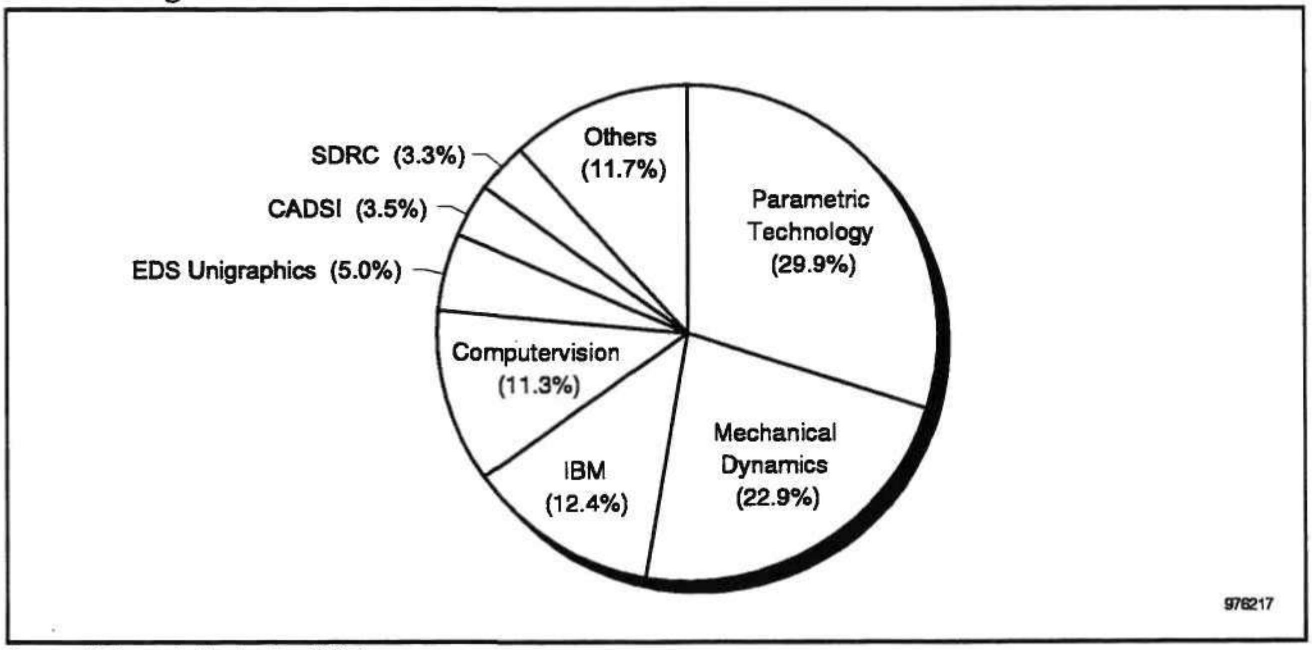
Dataquest sees this subapplication growing at about the same rate as the analysis market until 1999, at which point we predict that it will grow faster than analysis until the year 2001. We see real benefits in an engineer's ability to do quick simulations, what-if scenarios, and analysis of designs before the design and any associated problems move further downstream. The one limiting factors to good growth in this subapplication is the lack of tight integration with CAD software. Right now, the integration is primarily with analysis packages. Linkage/mechanism, similar to analysis, will not become "mainstream" until that integration with CAD occurs.

Figure 5-4
1996 Analysis Market Share



Source: Dataquest (September 1997)

Figure 5-5
1996 Linkage/Mechanism Market Share



Source: Dataquest (September 1997)

Computer-Aided Manufacturing

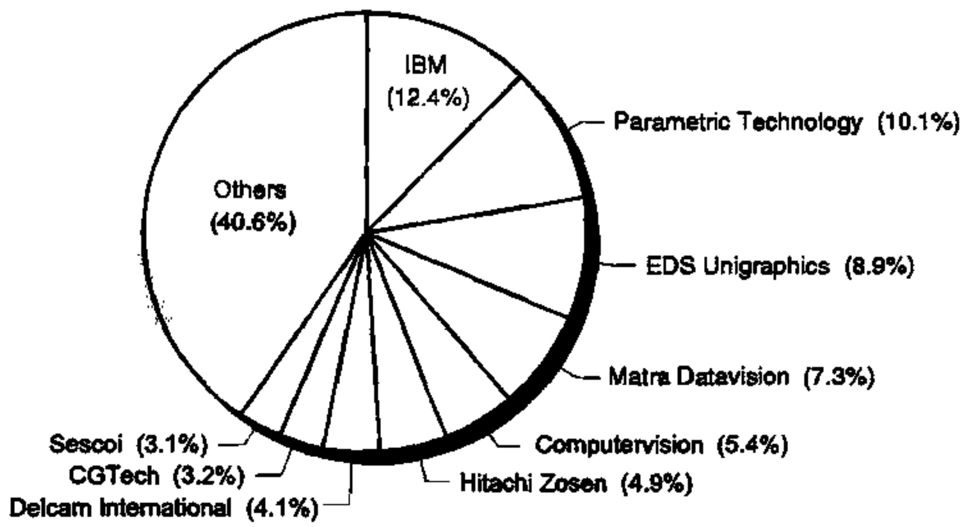
Manufacturing Process Simulation

Numerical Control

Figure 5-6 shows the 1996 software revenue market share of the leading vendors. Nearly all of the leading mechanical applications vendors play in this subapplication, including several Japanese companies (like Hitachi Zosen and Nihon Unisys) with their own products developed in-house as well as a number of NC-only vendors (like CGTech, Pathtrace, CNC Software, and Surfware). Despite the continuing fragmented nature of this subapplication, Dataquest does not expect a shakeout anytime soon.

It can be expected that increased sales in CAD software translate to increased sales in numerical control (NC) software. Dataquest has found that growth of NC software typically lag that of CAD software, but not by much. We expect NC sales to show a five-year CAGR of 11 percent, nearly the same as the forecast sales growth of design applications.

Figure 5-6
1996 Numerical Control Market Share



Source: Dataquest (September 1997)

The key factor for growth in this market will come from the ability of these tools to close the gap between design and manufacturing. More specifically, a key driver will be the ability to extract information from design data and bring that intelligent information to the manufacturing process, and vice versa. This is one area where new software, in the form of intelligent or smart objects as discussed earlier in Chapter 4, could really find a niche in the mechanical CAD/CAM/CAE market. (Such systems could include feature recognition knowledge for machining user-defined and standard features.) Dataquest is already seeing steps in more tightly integrated in-house knowledge, business practices design activities, and manufacturing with software packages that incorporate manufacturing rule-checking and design rule-checking, as well as generative machining principles (closely linked to part processing design, discussed in the next section).

Part Processing Design

Part processing design is concerned with the design of a series of manufacturing steps needed to manufacture a part, which can include tool path optimization, material speed and feed rates, machine tool definitions, and machining operations. Few vendors actually offer tools that can be considered in this subapplication; hence, Dataquest is not showing market share of the part processing design players. This subapplication is expected to grow faster than average over the next five years. Today's players and products include IBM's Prismatic Machining Assistant, Matra Datavision's Euclid Machinist, SDRC's I-DEAS Generative Machining, and Tecnomatix Technologies PART.

Dataquest believes this is one area poised to grow well over the next five years, as much of this work is still done manually or with a patchwork of different programs. The real impediment to growth will be capturing mind share in the fragmented collection of job shops and manufacturing outfits, particularly in the United States, that are accustomed to a lot of manual processes.

Other Manufacturing Applications

Coordinate measuring machines and offline robotics round out the CAM subapplications. Because of the small size of these subapplications, Dataquest has chosen not to show market share of the vendors. We do not expect to see any large growth opportunity in coordinate measuring machine software as it exists today.

On the other hand, offline robotics technology presents some real opportunities for vendors. Currently, Deneb Robotics, IBM, and Tecnomatix Technologies compete in this space. Revenue for this subapplication was at $36 million in 1996, but the real market opportunity today is slightly larger than that, as Dataquest currently does not track all players (such as SILMA). Although the initial investment required for offline robotics applications is high, the potential benefits in time and production cost savings are huge. And, the big CAD spenders—those in automotive, aerospace, and industrial machinery—are fueling growth in this subapplication.

Other Tools

Knowledge-Based Engineering

Generative technologies, expert systems, and knowledge- or rule-based engineering (RBE) have existed for quite some time, and vendors have come and gone in this market. Today, the way Dataquest has defined knowledge-based engineering, the market has two mainstay players—Concentra and Stone & Webster—and a handful of small players offering knowledge-based engines or larger players (like Trilogy) building applications on top of knowledge-based engineering technology. The only player that we track in this market today is Concentra. Thus, we will not show market share or a growth forecast for this subapplication.

RBE can be best envisioned as a technology to automate repetitive portions of the engineering design process. For instance, a company can use an RBE system to develop a model that captures the full spectrum of engineering rules, industry standards, manufacturing constraints, cost information, and scheduling constraints. As a result of capturing these processes and knowledge, new designs can be generated directly from functional specifications.

The major benefit to the end user is a reduction in product development time and, consequently, cost. RBE requires a significant amount of programming, typically in a vendor-proprietary language, and a fair amount of consulting work, to develop a usable application for the end user. Dataquest expects growth in the rule-based engineering subapplication to come when the task of building (which today means programming) applications becomes easier or more robust applications are developed based on the technology. Nevertheless, the line is blurring between rule-based engineering, which is really a technology and not a market, and related areas like salesforce automation. Concentra has already had some success in this area with its salesforce automation tool introduced in 1995. We expect our definition of this subapplication to evolve as the technology and its applications change over the next few years.

Application Development Environments

Application development environments are the programming tools used to aid in the generation of user-defined, custom programs. These tools include CAD customization tools like EDS Unigraphics' UG/GRIP and Parametric Technology's Pro/DEVELOP. It also includes some of the new architectures announced over the past few years, like Matra Datavision's CAS.CADE, Computervision's Pelorus (though sales here are negligible), and Bentley Systems' MicroStation/J (announced in June). Again, because of the small size of this market ($24 million in 1996), Dataquest has chosen not to show any market share information.

The newer application development environments are closely aligned with object-oriented software and architectures for CAD applications. As the concept of object-oriented technology and component software technology for CAD takes off, so will this new breed of application development environments.

Product Data Management

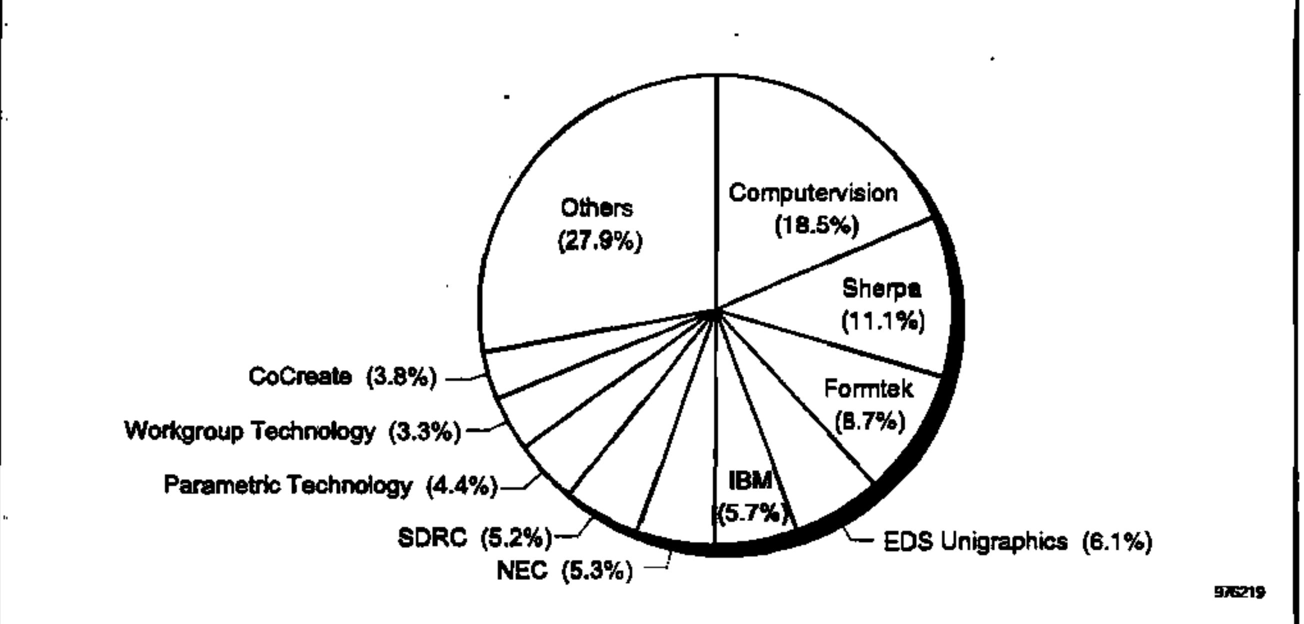
In following the PDM market, Dataquest tracks only those vendors that specifically offer PDM functionality—that is, a combination of vault, workflow, and product structure. We do not track systems integrators, consultants, companies offering conversion services, companies offering redlining/markup software, or hardware providers (for example, companies offering scanning devices). Nor do we track those companies that are primarily document management vendors (like Documentum and Cimage). As a result, our market size of $236 million in PDM software (excluding services) is smaller than what is typically quoted by other market research firms.

Of course, as some of these vendors become more PDM-focused and less document management-focused, we will begin to include those vendors in our PDM subapplication. Since last year, new players have entered the market, most notably Agile Software, ConsenSys, Right Angle, and Smart Solutions. When these companies show revenue streams greater than $2 million, we will add them to our database.

Figure 5-7 shows the 1996 market share of the leading PDM vendors. Computervision has led this market for the past three years, followed by Sherpa and Formtek. The market as a whole grew 17 percent in 1996. PDM purchases are still largely being made by discrete manufacturing companies, and a sizable chunk of the revenue generated in this market is still going to the mechanical CAD vendors.

Product data management has never exploded as many have hoped, and Dataquest continues to be conservative in our growth estimates. We expect PDM's software growth to remain slightly above the overall mechanical applications growth rate, especially from 1999 and beyond (prior to that time, it will show more growth compared to the average). Interestingly, one of the big factors inhibiting growth in this market is CAD to PDM integration, according to a PDM end-user survey we conducted in early 1997. Users rated CAD to PDM integration the most important in a series of PDM features. Further, the difference between their importance ratings and their satisfaction ratings for CAD to PDM integration was the greatest of all the features (meaning users were most dissatisfied with that area).

Figure 5-7
1996 Product Data Management Market Share



Source: Dataquest (September 1997)

PDM systems are also fighting the same organizational/cultural barriers they have fought since the beginning. We also asked our survey respondents to identify the single greatest impediment to expanded use of PDM in their companies, and 29 percent said the company's structure and culture was the biggest roadblock to expansion.

To date, few vendors have ventured out beyond the discrete manufacturing umbrella, although there is always talk of moving into the process industries like pharmaceuticals and insurance. Those companies eyeing new places for PDM to go have targeted two areas: electronic design and process plant design. This year, vendors announced either data management solutions that interface to electronic design automation software or wholly new software being developed to target the unique PDM requirements of the electronic designer. The other area of vendor attention, plant design, is an industry that could benefit from a standards-based approach to PDM. Plant design can be characterized as large, one-design/one-build projects with a need for standards and persistent data. Nevertheless, PDM cannot simply be brought into new markets or industries without understanding what end-user needs and industry-specific processes are. Until that changes, PDM will largely be a solution that resides in with discrete manufacturers.

Dataquest asks readers to refer to our PDM and collaborative engineering discussions in Chapter 4 for other growth/impediment opportunities for PDM.

Component Information Systems

Component information systems (CIS) is a unique subapplication that straddles mechanical, electrical, and architectural design/construction. Currently, Dataquest defines this subapplication as it applies to discrete manufacturing. Dataquest tracks only two mechanical-oriented CIS players—CADIS and Autodesk—but we will be adding CenTOR later this year. If we were to include CIS vendors geared toward electronic design, the market would expand to include Aspect Development and Information Handling Systems (IHS). If we were to expand the market to architectural/construction vendors, we would add The Sweets Group, other Autodesk products, and numerous smaller players with electronic catalogs. Because of the small size of this subapplication the way we track it today, we are not reporting market share information at this time.

The CIS players differentiate themselves from one another based on a number of factors, including the following:

- Electrical, mechanical, or materials component emphasis
- Revenue generated from legacy data conversion services, content or subscription services, and search/retrieval engines
- Search/retrieval capabilities
- Interfaces to PDM, CAD, or MRP systems
- Web/Internet/intranet capabilities

This subapplication will be a rising star over the next five years, with growth much greater than any other mechanical subapplication Dataquest currently tracks. Both low-end and high-end CIS applications are expected to do well. On one hand, there is still a lot of component and part selection done manually (with the engineer searching through paper-based catalogs). We expect much of this to be automated over the next five years, provided the price of these lower-end CIS systems stays low. On the other hand, high-end CIS deployments that involve corporate re-engineering and a significant amount of database development will also show healthy growth. Here, particularly in discrete manufacturing environments, the rising interest in corporate intranets as a delivery vehicle for information will further advance the market. The only limit to growth at the high end is the fact that these high-end CIS systems are often competing for dollars with PDM deployment and MRP systems.

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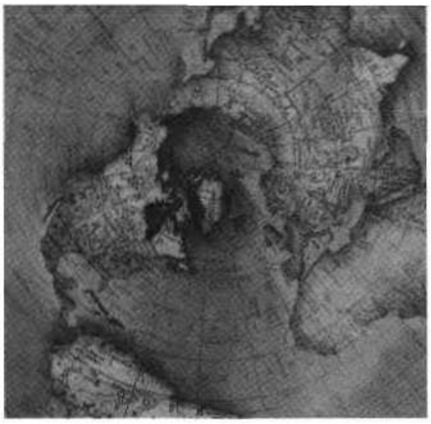

Dataquest

CAD/CAM/CAE and GIS Market Definitions

Dataquest Guide

Program: Mechanical CAD/CAM/CAE Applications Worldwide
Product Code: CMEC-WW-GU-9601
Publication Date: February 26, 1996
Filing: Guides

CAD/CAM/CAE and GIS Market Definitions

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Chapter 1

Market Share Survey Overview

Each year, Dataquest surveys CAD/CAM/CAE/GIS vendors in order to estimate their annual revenue. The survey for 1995 covers 300 vendors worldwide by six main applications segments, four operating systems groups, four world regions, European and Asian countries, hardware, software, services, and distribution channels. This exercise provides input for Dataquest's dynamic database of CAD/CAM/CAE/GIS shipments/revenue by world region/country, operating systems, and applications segment. The information gained is supplemented by, and cross-checked with, Dataquest's other information sources.

The CAD/CAM/CAE market share survey takes place twice each year. The first survey in the fourth quarter is to prepare early estimates for the calendar year. This is followed by a second survey in the spring in order to finalize estimates for the previous calendar year. The first survey takes place from October to December. Our preliminary estimates are completed by the end of the calendar year under review, and the results are summarized in a fax report that is released in January of the following year and published in a Source: Dataquest document by January 31.

The second survey takes place during April. Our final CAD/CAM/CAE/GIS market share estimates are again published in a Source: Dataquest document by May 31. There is usually minimal difference between early and final rankings, as Dataquest makes every effort to ensure preliminary estimates are as accurate as possible. However, there are usually some surprises at year-end, and our numbers do change. It should also be noted that when new information becomes available concerning a previous year's numbers, the database is updated to reflect the best information available.

The categories for which CAD/CAM/CAE/GIS revenue is reported are defined comprehensively for the purpose of clarity and guidance to survey participants. These definitions may occasionally be revised, altered, or expanded to reflect changes in the industry. To support these definitions, Dataquest will send an annual survey guide to all participants in its CAD/CAM/CAE/GIS market share survey program. This document comprises the 1995 survey guide.

Methodology

Dataquest utilizes both primary and secondary sources to produce market share data. In addition to the annual market share survey, Dataquest uses the following sources in order to accurately quantify market activity:

- Information published by major industry participants
- Estimates made by knowledgeable and reliable industry spokespersons
- Government data or trade association data
- Published product literature and price lists
- Interviews with knowledgeable manufacturers, distributors, and users

- Relevant economic data
- Information and data from online or CD-ROM data banks
- Articles in both the general and trade press
- Reports from financial analysts
- Annual reports, Securities and Exchange Commission documents, credit reports
- Reseller and supplier reports and reports from a vendor's competitors
- User studies

Dataquest also sums vendor revenue across other industries covered by Dataquest to make sure revenue is not credited twice, and checks with multiple sources at one company to cross-check data on that company.

Dataquest analysts have many years of experience in how to apply the tools described to get the most accurate information possible on a particular company (such as what to use when, and what industry averages are). It is the CAD/CAM/CAE/GIS group's policy to continually update our market information for any year, based on any new data received, in order to arrive at the most accurate market representation possible.

We survey worldwide, which involves more vendors and therefore presents higher total market revenue, lower market share per vendor, and a more accurate overall market picture.

Despite the care taken in gathering, analyzing, and categorizing the data in a meaningful way, careful attention must be paid to the definitions and assumptions used herein when interpreting the estimates presented in this document. Various companies, government agencies, and trade associations may use slightly different definitions of product categories and regional groupings, or they may include different companies in their summaries. These differences should be kept in mind when making comparisons between data provided by Dataquest and data provided by other suppliers.

Chapter 2

CAD/CAM/CAE/GIS Companies to Be Surveyed Worldwide for 1995

Dataquest will survey the following CAD/CAM/CAE/GIS companies throughout the world for 1995 data.

The North American Companies

- 3Soft
- Accel Technologies
- Accugraph
- ACTEL
- Adina R&D
- ADRA Systems
- ael Advance Graphics Systems
- ALDEC
- Algor Interactive Systems
- Alias Research
- Altair Computing
- Altera
- Analogy
- Ansoft
- Ansys
- Applicon
- Aptix
- Ashlar
- Aspec Technology
- Aspect Development
- Aspen Technology
- AT&T Bell Laboratories
- Auto-Trol
- Autodesk
- Autometric
- Avant!
- B.A. Intelligence Networks
- Bentley Systems
- Boothroyd Dewhurst

- CAD WORKS
- Cadence
- Cadis Software
- CADKEY
- CADSI
- CAE Plus
- CAMAX
- Carrier Corporation
- Cascade Design Automation
- CGTech
- Chronology
- Chrysalis Symbolic Design
- Cimlinc
- Cimplex
- Claritas/NPDC
- CMstat
- CNC Software
- Compact Software
- COMPASS Design Automation
- Computer Aided Design Software
- Computervision
- Concentra
- Contec Microelectronics
- Cooper & Chyan Technology
- CrossCheck Technology
- CSAR Corporation
- Data I/O
- Database Applications Inc.
- Deneb Robotics
- Design Acceleration
- Digital Equipment Corporation
- DP Technology
- Dynamic Graphics
- EA Systems
- Eagle Design Automation
- Eagle Point

- Earth Resource Mapping
- EDS-Unigraphics
- Enghouse Systems Ltd. (Canada)
- Engineered Software
- Engineering Mechanics Research
- EOSTAT
- EPIC Design Technology
- Equifax/NDS
- ERDAS
- Escalade
- ESRI
- ETAK
- Evolution Computing
- Fintronic
- Formtek
- Frontline Design Automation
- Genasys II
- Geo/SQL
- Geographic Data Technology
- Geomax International
- Gibbs and Associates
- Graftek Inc.
- GRAPHSOFT
- Harris EDA
- Hewlett-Packard
- Hibbit, Karlsson & Sorensen
- High Level Design Systems
- i-Logix Inc.
- IBM
- Ikos Systems
- IMSI
- Information Handling Services
- Intergraph
- InterHDL
- International Software Systems
- Intusoft

- ISICAD
- Landmark Graphics
- Livermore Software Technologies
- LSI Logic
- LV Software
- MacNeal-Schwendler Corporation
- Macon
- MapInfo
- MARC
- MCS
- Mechanical Dynamics
- Mentor Graphics
- Meta-Software
- Micrografx
- Microsim
- Minc Software
- Motorola
- Nextwave Design Automation
- NovaSoft Systems
- OEA International
- Optem Engineering
- Orcad
- Pacific Numerics
- PacSoft
- PADS Software
- Parametric Technology
- PCI Remote Sensing Corporation
- PRC
- Protel Technology
- Quantic Laboratories
- Quickturn Systems
- Radian Corporation
- Rebis
- Research Engineers—Civilsoft
- Royal Digital Centers
- Scientific & Engineering SW

- SDRC
- Sherpa Corporation
- SHL Systemhouse
- Sigma Design
- Silicon Graphics
- Silicon Valley Research Inst.
- SIMUCAD
- Simulation Technology
- Softdesk
- Spatial Technology Inc.
- Speed
- SpeedSim
- Spot Image
- SRAC
- Strategic Mapping
- Summitt Design Inc.
- Sun Microsystems
- Surfware
- Sweet's Electronic Publishing
- Synopsys
- Synplicity
- Systems Science
- T D Technology
- Tactician Corporation
- Tanner Research
- Terr-Mar Resource Information Systems
- Terra Sciences
- TYDAC Technologies Inc.
- Unicad
- Unisys Corporation
- Variation System Analysis
- Veritools
- Viagrafix
- Viewlogic Systems
- VISTA Environmental Inf.
- VLSI Libraries

- VLSI Technologies
- Workgroup Technology
- Xilinx
- Zeelan Technology
- Zycad

The European Companies

- ABB Industria
- Abstract Hardware
- ACA Ltd.
- ALS Design
- Anilam Electronics
- APIC Systemes
- ARKTEC SA
- ASCAD/ASCAM
- Assigraph
- CAD Centre Ltd
- CAD Lab S.p.A.
- Cad-Distribution AG
- CAD-UL
- Cadtronic Computer Systeme
- CATALPA Groupe Missler
- Cimatron
- CIMTEK SA
- Cisigraph
- Clemessy Innovation SA
- Complansoft CAD GmbH
- Computational Mechanics
- Computer Services Consultants
- Dapco SA
- Dassault
- debis Systemhaus GmbH
- Delcam Systems International
- Eigner+Partner GmbH
- Elstree Computing Ltd
- Engineering Computer Services
- Exapt

- FHECOR
- Fides Industrielle Automation
- Framasoft
- Gable CAD Systems
- Geometria GIS Systems House
- Graphisoft Software Development
- Ground Modeling Systems Ltd.
- Han Dataport
- Hochtief
- ICEM Technologies
- ICL Finland OY
- IEZ CAD-Systeme GmbH
- Investronica SA
- ISD Software und Systeme GmbH
- ISDATA GmbH
- ISKA
- Kloeckner-Moeller GmbH
- Kockums Computer Systems AS
- Laser-Scan
- M.O.C.
- Marcus Computer Systeme
- Matra Datavision
- mb Programme
- Moss Systems Group
- Nemetschek Programmsystem GmbH
- Norlinvest Ltd Visionics
- Number One Systems
- PAFEC
- Pathtrace Engineering Systems
- Poppenhaeger Grips GmbH
- PROCAD GmbH und Co.KG
- Radan Computational Ltd.
- RIB/RZB
- RoboCAD Solutions Ltd.
- Sagantec Europe BV
- Sener Ingenieria y Sistemas SA

- Serbi SA
- Siemens Nixdorf Informationssysteme
- Sinus Software GmbH
- Smallworldwide
- Soft-Tech Software Technologies
- Softronics
- Speed
- Star Infromatic
- Straessle AG
- Superdraft
- Sysdeco Innovation AS
- Tebis
- Technische Computer Systeme GmbH
- Triplan
- ULTImate Technology
- VEDA—Design Automation
- Vero International Software
- Whessoe Computing Systems
- Wiechers Datentechnik
- Ziegler Informatics

The Japanese Companies

- Andor
- ARGO Graphics
- C. Itoh Techno-Science
- Cadix
- Century Research Center
- CPU
- Design Automation
- Fujitsu
- Graphtec Engineering
- Hakuto
- Hitachi
- Hitachi Zosen Information Systems
- Information Services International Dentsu
- Informatix
- INS Engineering

- Kubota Computer
- Marubeni Hytech
- Mitsubishi Electric
- Mitsui Engineering
- Mutoh Industries
- NEC
- Nihon Itek
- Nihon Unisys
- Omron
- Pasco
- Ricoh
- Seiko Instruments
- Sharp System Products
- Sony
- Sophia Systems
- Sumisho Electronics
- Sumitomo Denko Workstation
- Tokyo Electron
- Toshiba
- Toyo Information Systems
- Uchida Yoko
- Wacom
- Zuken-Redac

Of the 302 companies to be surveyed, 179 are North American, 85 are European, and 38 are Japanese.

Chapter 3
Research Metrics

Definitions for the research metrics used in this survey are as follows:

- Total revenue with the original equipment manufacturer (OEM): The total amount of money received by a company for all goods and services sold into the CAD/CAM/CAE/GIS market. This figure is typically only released when requested.
- Distribution channels: Distribution channels are defined as follows:
  - Direct channel—The channel through which product moves directly from the manufacturer or vendor to the end user, usually by means of a professionally trained salesforce
  - OEM—The channel through which vendors or manufacturers sell their finished product to other companies for resale through an agreement. Once sold, the product is usually modified slightly and then resold directly to the end user or through an indirect channel. Vendors that resell nonbranded product differ from VARs in that they often add their name to the product and back up its warranties.
  - Indirect channels—All other channels through which the finished product moves to the end user, including VARs, dealers, and mass merchandisers
- Turnkey: Bundling hardware and software for sale as a unit
- Total factory revenue: Money received by a company for its goods, excluding OEM revenue or consulting revenue
- Hardware revenue: Revenue derived from the sales of CPUs (including operating systems), terminals (for host-dependent systems), and peripherals
- Software revenue: Revenue derived from the sales of bundled (part of a turnkey system) and applications software. It does not include operating systems revenue, which is part of the hardware revenue.
- Service revenue: Revenue derived from the service and support of CAD/CAM/CAE/GIS systems. Service revenue can be calculated in the market share tables by subtracting hardware and software revenue from total factory revenue. Service revenue includes the following:
  - Applications development—Adding new functionality through design and development of new customized CAD/CAM/CAE/GIS software applications, or the modification, enhancement, or customization of existing software applications
  - Consulting—Including an assessment of a company's CAD/CAM/CAE/GIS business IT needs and formulation of a plan based on needs identification
  - Integration services—Planning, implementing, migrating, and integrating software products
  - Maintenance—Fees for hardware and software

- Management and operations services—Includes help desk, education and training, disaster recovery, vaulting, facilities management, configuration management, and relocation services
- Service bureau—Includes construction of database, data conversion, product design, analysis, or manufacturing

- Seats: The number of possible simultaneous users
- Unit shipments: The number of seats delivered, excluding those sold to another company for resale (OEM). CPU shipments are defined as the number of CPUs delivered, which is the same as unit shipments for all platforms but host-dependent platforms.
- Average selling price (ASP): The average amount of money received by the factory for the sale of a turnkey/hardware system. The database forces reconciliation of a company's revenue and unit shipments with the average selling prices of each application and platform.
- Installed base: The total number of seats/CPUs in use, calculated by forecasting the previous year's installed base plus the year's unit/CPU shipments, less retirements.
- Compound annual growth rate (CAGR): A computed, compounded growth rate used in forecasting

Chapter 4
Worldwide Geographic Region Definitions and Exchange Rates

Dataquest divides the different geographic regions as follows:

- North America: Includes Canada, Mexico, Puerto Rico, and the United States
- Europe
  - Western Europe: Includes Austria, Benelux (Belgium, the Netherlands, Luxembourg), France, Germany (including former East Germany), Italy, Scandinavia (Denmark, Finland, Norway, Sweden), Switzerland, the United Kingdom, and the Rest of Western Europe (Andorra, Cyprus, Gibraltar, Iceland, Liechtenstein, Malta, Monaco, San Marino, Spain, Sweden, Turkey, Vatican City, and others)
  - Eastern Europe: Includes all countries currently categorized as Central Europe in addition to Albania, Bulgaria, the Czech Republic and Slovakia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, and the republics of the former Yugoslavia. Also included in this group is Russia and the other republics of the former Soviet Union (Belarus, Ukraine, Georgia, Moldova, Armenia, Azerbaijan, Kazakhstan, Uzbekistan, Tajikistan, Kyrgyzstan, and Turkmenistan)
- Japan
- Asia/Pacific: Includes Hong Kong, Korea, Singapore, Taiwan, and Rest of Asia (Australia, Brunei, Cambodia, China, India, Indonesia, Laos, Malaysia, Maldives, Myanmar, Nepal, New Zealand, Pakistan, the Philippines, Sri Lanka, Thailand, and Vietnam)
- Rest of World: Includes Africa, Central America, the Caribbean, the Middle East, Oceania, and South America

When converting a company's local currency sales into U.S. dollars, or vice versa, it is important to use the 1995 exchange rates provided below (see Table 4-1). These rates will prevent inconsistencies in the conversion of offshore sales between each company. These are the exchange rates that will be used in the final 1995 CAD/CAM/CAE and GIS market share survey. Exchange rates for historical years are available on request.

Table 4-1
Average 1994 and 1995 Exchange Rates against the U.S. Dollar

Country	1994 Rate	1995 Rate
Austria (Schilling)	11.33	10.06
Belgium (Franc)	33.36	29.42
China (Renminbi)	8.68	8.35
Denmark (Krone)	6.31	5.59
ECU	0.84	0.77
Finland (Markka)	5.21	4.37
France (Franc)	5.54	4.97
Germany (Mark)	1.62	1.43
Hong Kong (Dollar)	7.73	7.74
Italy (Lira)	1,609.19	1,628.21
Japan (Yen)	101.81	93.90
Netherlands (Gulden)	1.81	1.60
Norway (Krone)	7.04	6.33
Singapore (Dollar)	1.52	1.43
South Korea (Won)	802.40	770.57
Spain (Peseta)	133.48	124.40
Sweden (Krona)	7.7	7.14
Switzerland (Franc)	1.37	1.18
Taiwan (Dollar)	26.46	26.48
United Kingdom (Pound)	0.65	0.63

Note: The annual rate is estimated as the arithmetic mean of the 12 monthly rates.
Source: Dataquest (February 1996)

Chapter 5

CAD/CAM/CAE/GIS Operating Systems Group Definitions

Dataquest segments CAD/CAM/CAE/GIS data by four main operating system groups. These groups are as follows:

- UNIX—UNIX is a 32-bit, multitasking, multiuser operating system, originally developed at AT&T Bell Laboratories. It is portable and can be found on most CISC and RISC MPUs, including the Intel 80xxx, Motorola 68xxx, and Sun SPARC. UNIX includes all UNIX variants. A complete list of UNIX operating systems can be found in Chapter 8.
- Host-dependent systems—These systems include all minicomputer and mainframe operating systems in which the functions of external workstations are dependent on a host computer. The dominant operating systems in this group are IBM's VM and Digital Equipment's VMS operating systems.
- Windows NT—Windows NT is Microsoft's multiplatform, 32-bit operating system (either Windows NT or Windows NT Advanced Server) for high-end PCs, servers, and workstations.
- Personal computer (PC)—This group includes MS-DOS, PC-DOS, or DR-DOS operating systems. MS-DOS was designed by Microsoft for the original IBM PC. It is the dominant operating system on PC and PC-clone computing systems. PC-DOS is IBM's version of the disk operating system for PC and PC clones. DR-DOS is the Digital Research (Novell) version of this operating system. Other proprietary DOS variants such as NEC-DOS and J-DOS are included in this category.
- Also in the personal computer group are Mac OS, OS/2, Windows 3.1, and Windows 95. Mac OS is Apple's proprietary graphical user interface (GUI) operating system. OS/2 is IBM's GUI operating system for high-end PCs and PC servers. Windows 3.1 and Windows 95 are Microsoft's GUI operating systems for the PCs and PC clones. Windows 3.1 is a 16-bit operating system that runs on top of DOS. It is the dominant GUI operating system for PC and PC clones. Windows 95 is Microsoft's 32-bit version of Windows. Windows 95 is intended to replace Windows 3.1 and does not require a DOS foundation.

Chapter 6

CAD/CAM/CAE/GIS Software Applications Definitions

Dataquest segments data by application types. They are as follows:

- Mechanical—This segment refers to computer-aided tools used by engineers, designers, analysts, and drafters working predominantly in discrete manufacturing industries. Common design applications include conceptual design, industrial design, structural or thermal analysis, and detail design. Common manufacturing applications include tool and fixture design, numerical control part programming, and off-line robotics programming.
- Electronic design automation (EDA)—This segment covers computer-based tools that are used to automate the process of designing an electronic product, including printed circuit boards, ICs, and systems. EDA includes electronic CAE, IC layout, and PCB/hybrid/MCM, as follows:
  - Electronic computer-aided engineering (CAE)—These are computer-aided tools used in the engineering or design phase of electronic products (as opposed to the physical layout phase of the product). Examples of electronic CAE applications are schematic capture and simulation.
  - IC layout—This is a software applications tool that is used to create and validate the physical implementation of an integrated circuit (IC). The IC layout category comprises polygon editors, symbolic editors, placement and routing (gate array, cell, and block), design verification tools (DRC/ERC/logic-to-layout), compilers, and module development tools.
  - Printed circuit board (PCB)/hybrid/multichip module (MCM)—This segment covers products that are used to create the placement and routing of the traces and components laid out on a printed circuit board. Also included in this category are thermal analysis tools.
- Architecture, engineering, and construction (AEC)—This segment covers the use of computer-aided tools by architects, contractors, plant engineers, civil engineers, and other people associated with these disciplines to aid in designing and managing buildings, industrial plants, ships, and other types of nondiscrete entities.
- Geographic information systems (GIS)/mapping—This is a computer-based technology, composed of hardware, software, and data used to capture, edit, display, and analyze spatial (tagged by location) information.

Chapter 7
CAD/CAM/CAE Subapplications Segmentation

Additional surveys are conducted to further segment the industry with software revenue sales by subapplication. The applications are divided as follows:

Mechanical

Modeling Technology

The modeling technology applications are as follows:

- Solid modeling—The representation of a part or assembly capturing all relevant data describing solid characteristics of a project. This can include shape, weight, color, surface texture, and mass properties. Boolean operations are commonly used to add and subtract volumes together to define the final shape of the object.
- 2-D modeling—The representation of a part in two dimensions (it has an x and y coordinate). This format requires three or more views (top, front, and side) to depict all aspects of the part. 2-D is the most common geometric modeling format and is used extensively with a drafting function.
- 3-D modeling—The representation of a part in three dimensions, usually in a wire-frame format (it has an x, y, and z coordinate). This format is commonly used in high-level CAD systems to determine the placement and fit of components in an assembly. It is generally not used for final drafting, although some systems have the capability to translate the 3-D image to a 2-D standard drafting format.
- Integrated—The integration of all 3 modeling technologies

Mechanical CAD/CAM/CAE Subapplication

The mechanical CAD/CAM/CAE subapplications are as follows:

- Conceptual design
  - Industrial design—A process that provides a common environment for the entire conceptual design process, including painting, modeling, rendering, and visualization
  - Design layout—An initial design process in which the major components and part interfaces are defined
  - Styling—A detailed design process in which aesthetic considerations are foremost in importance
- Functional design
  - Component design—Design of the individual components in an assembly
  - Assembly verification—Integration of components' designs into an assembly to test the size/shape and function characteristics

- Linkage/mechanism—An assembly of components with two or more movable parts, usually providing some means of power, control, or fastening application
- Analysis—The analysis of a physical system, part, or assembly; includes structural, thermal, vibrational, composite, fatigue, stack-up, mass property, and quality-control analysis

- Drafting and documentation
  - Detail drafting—Representation of a part in standard geometric drafting format, including all part geometry dimensions and notations describing mechanical/structural, functional, and material characteristics
  - Schematic/detailed diagrams—Schematics used to describe hydraulic and pneumatic systems
  - Technical illustration—Drawing of a component or assembly that is generally intended for publication
- Manufacturing engineering
  - Tool design—The design of custom-made tooling to facilitate a manufacturing process
  - Fixture design—The design of structural aids that hold the component or assembly during the manufacturing process
  - Part processing design—The design of a series of manufacturing processes
- Manufacturing process simulation
  - Numerical control part programming—The programming of a numerical control machine tool or automated processing system
  - Coordinating measuring machines—The programming of machines used to measure the physical dimensions of a part
  - Offline robotics—A process simulation that graphically represents the sequence of steps to program a robot for a particular operation and downloads data to a robot to update its control program
- System management and other tools
  - Product data management (PDM)—Software typically used in an engineering or manufacturing environment to manage product data. Characteristics of PDM systems include product/structure management, workflow, and vault/document management capabilities.
  - Engineering data management—Software with vault management capabilities and limited workflow capabilities designed for use within an engineering environment
  - Component information systems—Software used to navigate within and manage a repository of engineering parts and associated data
  - Knowledge-based engineering tools—Tools used to capture design intent and build standard practices for controlling, modifying, and automating design and manufacturing activities. Also known as rule-based engineering.

- Applications development environments—Programming tools to aid in the generation of user-defined programs that drive or interface with CAD/CAM/CAE.

EDA

For the past few years, Dataquest has subdivided the electronic CAE market in an entirely new way. The subdivisions are based on design methodologies such as gate-level design, register transfer (RT)-level design, and electronic system (ES)-level design.

Under the methodology, a design is first entered and simulated, usually at the RT level. It is then synthesized or compiled down to the level below it. This process continues (simulation and synthesis) until the design is placed and routed at the physical design level, at which point timing information is extracted from the physical design. At this point, the verification process begins.

For verification, the process flows in an upward direction. From the physical design level, timing information is extracted, and design rule checkers and logic rule checkers are used to ensure a correct design at the physical level. Verification continues in this upward fashion until the level at which the design process originally began is reached. The electronic design automation subapplications are as follows:

CAE

The CAE subapplications are as follows:

- ES level
  - ES-level design—Design at the conceptual level, including hardware/software co-design, design partitioning, and specification; it includes neither RT- nor logic-level descriptions.
  - Behavioral simulation—Nontiming-based simulation
  - Behavioral synthesis—Synthesis of an ES-level design description to the RT level
  - Formal verification—The process of mathematically proving that an RT-level description equates to an ES-level description (or less specifically, that any design representation equates to another)
- RT level
  - RT-level design—Tools designed to assist engineers in entering a design or analyzing the simulated results of that design. This includes the use of graphical symbols to represent RT-level VHDL or Verilog.
  - RT-level simulation—Simulation at the RT level
    - VHDL—Simulation using the VHSIC Hardware Description Language
    - Verilog—Simulation using the Verilog Hardware Description Language

- Logic synthesis—Synthesis or translation of an RT-level description to a gate-level description
- Target compiler—A translation of an RT-level description to the silicon implementation
- Timing analysis—Verification of the timing of a design; the process usually involves providing inputs to a physical circuit model or computer simulation to test the nondynamic functions of a design; static-timing verification does not require the use of test vectors to determine timing violations.
- Design for test tools—Tools used to determine, improve, or add to the testability of electronic circuits
- Silicon synthesis—Tools that estimate silicon-level performance at the RT-level by synthesizing the RT-level description to a virtual silicon implementation of that code and reflecting the estimated silicon performance back up to the RT level
- PCB synthesis—A process similar to silicon synthesis but without using synthesis technology. PCB synthesis uses a virtual representation of the PCB to estimate physical effects, bringing those effects back up to the CAE level of design.

- Gate level
  - Schematic capture—A design process that consists of graphical schematic entry and net-list extraction
  - Simulation—The use of representative or artificial data to reproduce conditions in a model that could occur in the performance of a system. Simulation is used to test the behavior of a system under different operating conditions.
    - Gate-level simulation—Simulation based upon a gate-level netlist (not VHDL or Verilog)
    - Analog simulation—Simulation in which both digital and analog inputs are used
    - Mixed-signal simulation—Simulation in which both digital and analog inputs are used
    - SPICE simulation—Simulation using a derivative of the Berkeley SPICE transistor-level simulator
  - Analysis tools—Tools used for the analysis of designs
    - Signal analysis (including transmission line and cross-talk analysis)—Analysis of high-speed coupling effects between signal line and reflection/degradation of the high-speed signal on PCBs, MCMs, or ICs
    - Power analysis—Analysis of the power consumption of PCBs, ICs, MCMs, and systems
    - Electromagnetic interference—Analysis of electromagnetic generation and interference for PCBs, ICs, and cables/connectors/packaging

    - Metal migration or electromigration—The unauthorized movement of metal in an IC because of excessive current density

- Miscellaneous
  - Accelerators—Dedicated hardware/software or optimized software used to speed up simulation, typically at the gate level
  - Emulators—Dedicated hardware/software that allows a designer to observe the function of a circuit or design prior to prototype
  - Fault simulation/grading—A process that determines which nodes in a design can be detected by a given set of test vectors
  - Interoperability tools—Software used for database, library, and tool management; they also include backplanes, file translators, and design environments (in general, all tools used specifically to integrate a set of EDA tools).
  - Libraries—Description of elements used in EDA designs (for example, components, simulation models, and symbols)
  - Field-programmable gate array (FPGA) toolset—Dedicated EDA software sold as a package for FPGA/complex-programmable logic device (CPLD) design
- IC CAD
  - DRC—The design rule and logic rule checkers used to perform final verification on an IC design prior to making masks
  - Floor planner—A tool that allows a designer to place elements of a design so that the designer can look at estimations of the effects of the final place and router.
  - FPGA place and route—Tools used to implement designs into the targeted FPGA or CPLD. These are also called "fitters" because they fit designs into the already existing logic structure of the targeted FPGA or CPLD.
  - IC place and route—Tools used to implement (lay out) designs into silicon
    - Gate array place and route—Tools used to lay out designs into a fixed-based array
    - Cell-based IC place and route—Tools used to lay out nonfixed, cell-based designs
    - Custom IC layout—Silicon design tools working at the transistor level. These tools can size transistors, accomplish analog design, and generally hand craft silicon implementation. Sometimes called "layout editors."
- PCB design
  - PCB design tools—Tools used to design, place, and route a PCB
  - MCM9 and hybrid design tools—Tools used to design, place, and route a multichip module or hybrid substrate

AEC/Architectural, Engineering, and Construction

The AEC, or architectural, engineering, and construction, subapplications are as follows:

- Architectural—Software used in the design and drafting of buildings and grounds
- Civil—Software for both site and structural engineering, typical for design and drafting of sites for buildings, roads, bridges, and airports and for the design of steel and concrete structures
- Facilities design/management—Software used to lay out, inventory, and manage assets such as personnel space, equipment, and utilities within a building or geographic service area
- Process plant design—Software used in design, analysis, drafting, and management of process, power, and manufacturing plants as well as ships

GIS/Mapping Software

GIS/Mapping Software is used to capture, edit, display, and analyze spatial (tagged by location) information. It can be categorized as follows:

- Base data—Software used to create baseline geographic data
  - Photogrammetry and surveying—Software used in developing original data for a GIS system based on ground surveying or on remotely sensed data. Examples include aerial photography or satellite imagery.
  - Data for resale—Includes both GIS software used to create data for resale to end users and revenue from the sale of geographic data
- Land information—Software used to gather and manage land data
  - Land records—GIS software used to manage land ownership or parcel information; the typical user is a tax assessor.
  - Planning and land use—GIS software used to manage land use; the typical user is a city planner.
- Biological—Software used to manage and analyze plant and animal life
  - Environmental public health and safety—GIS software used to manage natural resources and to monitor and analyze environmental factors that contribute to the welfare of the earth and its people
  - Forestry and agriculture—GIS software used for the management of forests and crops
- Geoscience (formerly energy exploration)—GIS software used to manage oil, gas, and mineral exploration projects. The emphasis of geoscience is typically on subsurface data.
- Infrastructure management—Management and analysis of man-made assets (not including utilities)
  - Transportation and logistics—GIS software used in transportation applications such as road or rail network modeling or route planning

  - Emergency and dispatch services—GIS software used to manage emergency services such as "911" services and also for-profit dispatch management systems

- Automated mapping/facility management—GIS software used for managing utility industry networks, based on the following categories:
  - Telecommunications/telephone
  - Electric
  - Water and waste water
  - Other utilities (primarily gas)
- Business marketing and sales—GIS software used to promote and sell services and products, and to identify and evaluate opportunities in a competitive environment.
  - Demographic and location analysis—GIS software used to analyze problems in demographics or site characteristics. Examples include sales territory selection, site selection, or population analysis. Typical users are in advertising, marketing, insurance, banking, and real estate.
  - Sales and directional support—GIS software used to help salespeople locate targets of a sales effort (for example, to locate potential customers, specific properties for sale and driving routes to the properties). This also includes software used to help customers locate establishments, typically used as travelers' aids.
- Geopolitics—The sum of software used in defense/military and political districting applications
  - Defense/military—GIS software used to manage military or defense projects for the purpose of command and control
  - Political districting—GIS software used to manage the redistricting process based on census data
- Cartography—GIS software used in mapmaking applications

Chapter 8
CAD/CAM/CAE/GIS Operating System and Industry Segmentation

Additional surveys segment the software revenue by operating systems and by industry, providing yet another look at the CAD/CAM/CAE/GIS software market. These segments are as follows:

Operating Systems

- Apollo AEGIS
- Apple AUX
- Apple Macintosh/OS
- AT&T Systems V Derivatives
- CDC CYBER NOX/VE
- CONVEX UNIX
- CRAY UNIX
- Digital Equipment Corporation OSF
- Digital Equipment Corporation ULTRIX
- Digital Equipment Corporation VMS
- DOMAIN/Apollo UNIX
- DOS
- DOS with Windows
- Hewlett-Packard UX
- Hitachi HI-UX/G (UNIX)
- IBM AIX
- IBM VM/VMS
- Intergraph UNIX
- MIPS UNIX
- NEC EWS-UX (UNIX)
- OS2
- Prime PRIMOS
- Siemens-Host/Proprietary
- Siemens-UNIX
- Silicon Graphics Inc. UNIX
- Solaris
- Sony NEWS-OS (UNIX)
- Sun—UNIX/OS

- Windows
- Windows NT
- XENIX/SCO UNIX
- Others—UNIX
- Others
- All Operating Systems

Industry Sectors

- Aerospace, guided missiles, and space vehicles
- Agriculture, forestry, and fishing
- Automotive, motorcycles, and bicycles
- Chemical, allied, and petroleum products
- Computers, office equipment, and computer peripherals
- Conservation management and waste management
- Construction, contractors, and building
- Consumer electronics (TV, VCR, and CD)
- Education
- Electrical/electronic equipment (power, appliances, test, and measurement)
- Fabricated metal products, except machinery and transportation
- Finance, insurance, and real estate
- Government: environment and public health resource
- Government: general, executive, public order, and taxation
- Government: national security (defense)
- Government: public works and engineering
- Industrial and commercial machinery (engines and heavy equipment)
- Industrial controls, robotics, and AGVs
- Manufacturing not elsewhere classified (textiles, furniture, and foundries)
- Medical manufacturing (instrument/x-ray)
- Mining
- Semiconductors
- Service companies (including architecture firms, engineering consulting firms, and design services firms)
- Shipbuilding, ship repairing, and developing offshore rigs
- Telecommunications and data communications (telephone, radio, television, and cable)
- Transportation (rail, public transit, and freight transport)

- Utilities and pipelines (electric, gas, sanitary services, and water)
- Others
- All industries

Results from these surveys and the subapplications' surveys are scheduled to be published in mid-1996.

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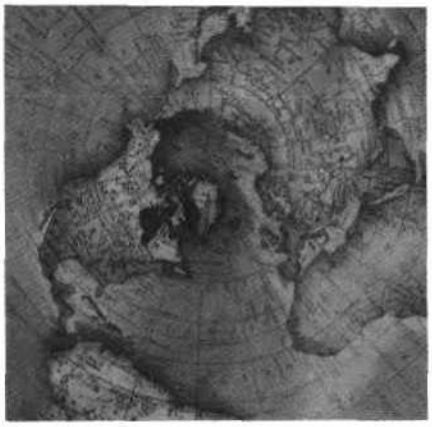

Dataquest

Mechanical Applications: The Road Ahead

Market Trends

Program: Mechanical CAD/CAM/CAE Worldwide
Product Code: CMEC-WW-MT-9701
Publication Date: September 22, 1997
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Chapter 1
Executive Summary

Study Objectives

Each year, Dataquest takes a comprehensive look at trends and drivers in the mechanical CAD/CAM/CAE market. Our annual Market Trends report provides both a quantitative and qualitative look at the state of the mechanical market today and how it will evolve over the next five years. The information presented in this report is based on Dataquest's ongoing research into mechanical CAD/CAM/CAE.

Key Findings and Highlights

The following are key findings and highlights of this report:

- The leading five mechanical CAD/CAM/CAE vendors continue to solidify their spots at the top, claiming 50 percent of the worldwide 1996 mechanical applications software, and the top 10 vendors claiming 72 percent of the market.
- In U.S. dollar terms, all regions of the world fared well in 1996 except Japan. Growth in these areas outside of North America was a combination of exchange rate fluctuations and actual CAD investment.
- UNIX is still the operating system of choice, but NT-based sales are gaining ground. Despite NT's high growth, it has not yet begun to eat into the UNIX installed base.
- The midrange market is taking shape, developing into two tiers of users—those users who are looking to move from 2-D design to 3-D design, and those users who are looking to extend CAD into the enterprise. Each tier has its own unique set of CAD/CAM/CAE requirements, and the vendors are beginning to align themselves along these two tiers.
- Truly seamless interoperability among CAD/CAM/CAE applications is an elusive proposition, despite the Standard for the Exchange of Product Model Data (STEP) and object linking and embedding (OLE) for Design and Modeling (D&M) work being done today.
- Current collaborative engineering solutions have more potential than any others in the past decade to bring engineering design out of its traditional silo.
- Product data management (PDM) growth is not explosive. Dataquest anticipates that vendors will be revisiting the PDM vision to incorporate elements of collaborative engineering within an intranet or Internet environment.
- Objects in CAD are not quite here yet, but over the next five years there will be a slow but steady infiltration of software that is increasingly populated by smart objects. This infiltration will first take place in architecture/engineering/construction (AEC) and will eventually filter over to the mechanical world. The uptake of objects in CAD would go faster if vendors would focus more on the interoperability of objects and solutions.

Dataquest Perspective

The mechanical CAD/CAM/CAE market continued its second year of double-digit growth in 1996, not an easy feat given the relative maturity of this market. Although such high growth will be difficult to match in the near future, Dataquest expects the market to continue on a robust pace as engineers tackle increasingly complex design problems. We expect mechanical applications, from design to analysis to manufacturing applications, to move more toward the mainstream over the next five years, and we expect high-end users to maintain their investments in design automation. There are many opportunities for well-established vendors and newer players to explore.

Project Analyst: Sharon Tan

Chapter 2
Market Research Methodology and Market Definitions

About This Document

This report is divided into four major sections. Chapter 2 includes an explanation of the market research methodology used in this report. Dataquest's survey methodology and data collection methods are outlined, and our market metrics and subapplications are defined. Chapter 3 discusses the mechanical CAD/CAM/CAE market as it stands today, and Chapter 4 identifies the trends having the greatest impact on the future shape of the market. Chapter 5 looks at each of the mechanical CAD/CAM/CAE subapplications in greater detail. Market share, forecast information, and driving forces for each subapplication are identified and discussed.

Data Collection Process

Fundamental to the way Dataquest conducts research is an underlying philosophy that the best data and analysis come from a well-balanced program. This program includes the following: balance between primary and secondary collection techniques; balance between supply-side and demand-side analysis; balance between focused industry-specific research and coordinated "big picture" analysis aided by integration of data from more than 25 separate high-technology industries that Dataquest covers; and balance between the perspectives of experienced industry professionals and rigorous, disciplined techniques of market researchers.

Supply-Side Data

In the fourth quarter of 1996, Dataquest surveyed all major participants in the mechanical CAD/CAM/CAE industry to obtain preliminary market share data for that year. At that time, each vendor was offered the opportunity to self-report the information required. Although there is a primary contact for each company, large companies are surveyed across product lines and geographic regions. Thus, there is a corresponding increase in the number of contacts at large companies. Examples of job titles of people contacted for information include the following:

- President and chief executive officer
- Vice president and general manager
- Vice president of marketing
- Director of strategic planning
- Director of marketing
- Manager, CAD/CAM/CAE marketing programs
- Market research analyst
- Product manager

Dataquest resurveyed companies during the second quarter of 1997 to verify final annual 1996 results and determine the mechanical subapplication and industry information. The information in this document is based upon final market share data for 1996.

Data supplied by vendors is evaluated against information drawn from many sources, including the following:

- Revenue published by major industry participants
- Government or trade association data
- Annual reports, Securities and Exchange Commission documents, and credit reports
- Company publications and press releases
- Published product literature and price lists
- Reports from financial analysts
- Reseller and supplier reports and reports from a vendor's competitors

Dataquest also sums vendor revenue across other industries covered by Dataquest to make sure that revenue is not credited twice, and we check with multiple sources at one company to cross-check data on that company.

Dataquest believes that the estimates presented here are the most accurate and meaningful estimates generally available today. Dataquest's mechanical CAD/CAM/CAE market numbers are often higher than those reported by other sources. We survey worldwide, which involves more vendors, higher total market revenue, lower market share per vendor, and a more accurate market picture, which is particularly useful when comparing regions or applications.

Demand-Side Data

Dataquest also relies heavily on demand-side, or end-user, data for validating vendor market share and identifying mechanical CAD/CAM/CAE trends. End users are identified using a variety of means, including databases of past survey respondents, corporate intelligence databases, mechanical software vendors' registered users lists, and magazine subscriber lists. End-user surveys are often conducted by telephone to allow for better screening of prospective respondents. At least one major end-user survey is conducted each calendar year, and a number of informal surveys are conducted throughout the year.

Market Segmentation

Market share information presented in this report is based on standard Dataquest market segmentation definitions. The following metrics and definitions are relevant to this document.

Regions

Dataquest defines the regions as follows:

- North America—Includes Canada, Mexico, and the United States
- Europe
  - Western Europe—Includes Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, and the United Kingdom
  - Rest of Western Europe—Includes Andorra, Cyprus, Faeroe Islands, Gibraltar, Greenland, Guernsey, Iceland, Jersey, Liechtenstein, Malta, Monaco, San Marino, and Vatican City
  - Central and Eastern Europe—Includes Albania, Armenia, Azerbaijan, Belarus, Bosnia, Bulgaria, Croatia, Czech Republic, Estonia, Federal Republic of Yugoslavia (including Serbia and Montenegro), Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Macedonia, Moldova, Poland, Romania, Russia (as far as the Urals), Slovakia, Slovenia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan
- Japan
- Asia/Pacific—Includes Australia, Bangladesh, Brunei, Cambodia, China, Hong Kong, India, Indonesia, Korea, Laos, Malaysia, Maldives, Myanmar, Nepal, New Zealand, Pakistan, the Philippines, Singapore, Sri Lanka, Taiwan, Thailand, and Vietnam
- Rest of World—Includes Africa, the Caribbean, the Middle East, Oceania, and South America

Operating Systems

Dataquest defines the operating systems as follows:

- UNIX—Includes all UNIX variants and older workstation operating systems
- Host/proprietary—Includes minicomputer and mainframe operating systems in which the functions of external workstations are dependent on a host computer
- Windows NT—The Microsoft Windows NT operating system
- Personal computer—Includes DOS, Windows, Windows 95, and Apple operating systems

Distribution Channels

The CAD/CAM/CAE software industries make extensive use of complex distribution channels throughout the world. Our data architecture accurately reflects revenue flow from the CAD software vendor to the end user. Specifically, our database allows us to report software revenue as it accrues in the following ways:

- Directly through a company salesforce
- Indirectly from sales to dealers and other resellers

- As revenue earned as a reseller of another company's products (for example, Intergraph's resale of MicroStation product)
- As revenue earned supplying OEM software products that are sold under another name by a separate company (for example, AutoCAD's OEM version)
- As company software revenue, or revenue a vendor puts in the bank (the sum of direct, indirect, reseller, and OEM revenue)
- As dealer revenue (revenue earned by a vendor's dealers for selling the product)
- As user software spending—the total amount actually spent by end users (which is the sum of direct and dealer revenue)

Figure 2-1 shows how Dataquest accounts for all these elements in the mechanical CAD market while not counting revenue twice. To calculate company software revenue for a particular company, we sum revenue from direct, indirect, reseller, and OEM revenue. The total size of the market here is equal to the sum of direct and indirect revenue for all companies (OEM and reseller revenue are excluded in market size, so as to avoid double counting the market). This same methodology is used to calculate end-user spending and end user market size—the only difference is that, instead of using indirect revenue, we use dealer revenue. Dealer revenue is based on a multiplier of indirect revenue. Calculation of these multipliers will vary by vendor, region, and platform.

Mechanical CAD/CAM/CAE Subapplications

Figure 2-2 depicts the mechanical subapplications that Dataquest tracks. We have adopted the following definitions for the mechanical CAD/CAM/CAE subapplications:

Computer-Aided Design (CAD)

- Design applications—Software applications used in the design of components and assemblies from conceptual design to detail design. This subapplication includes software for styling, conceptualization, assembly modeling, component design, and manufacturing tool and fixture design.
- Drafting and documentation—Representation of a part in standard geometric drafting format, including all part geometry dimensions and notations describing mechanical, functional, and material characteristics. This subapplication also includes schematics and technical illustration.

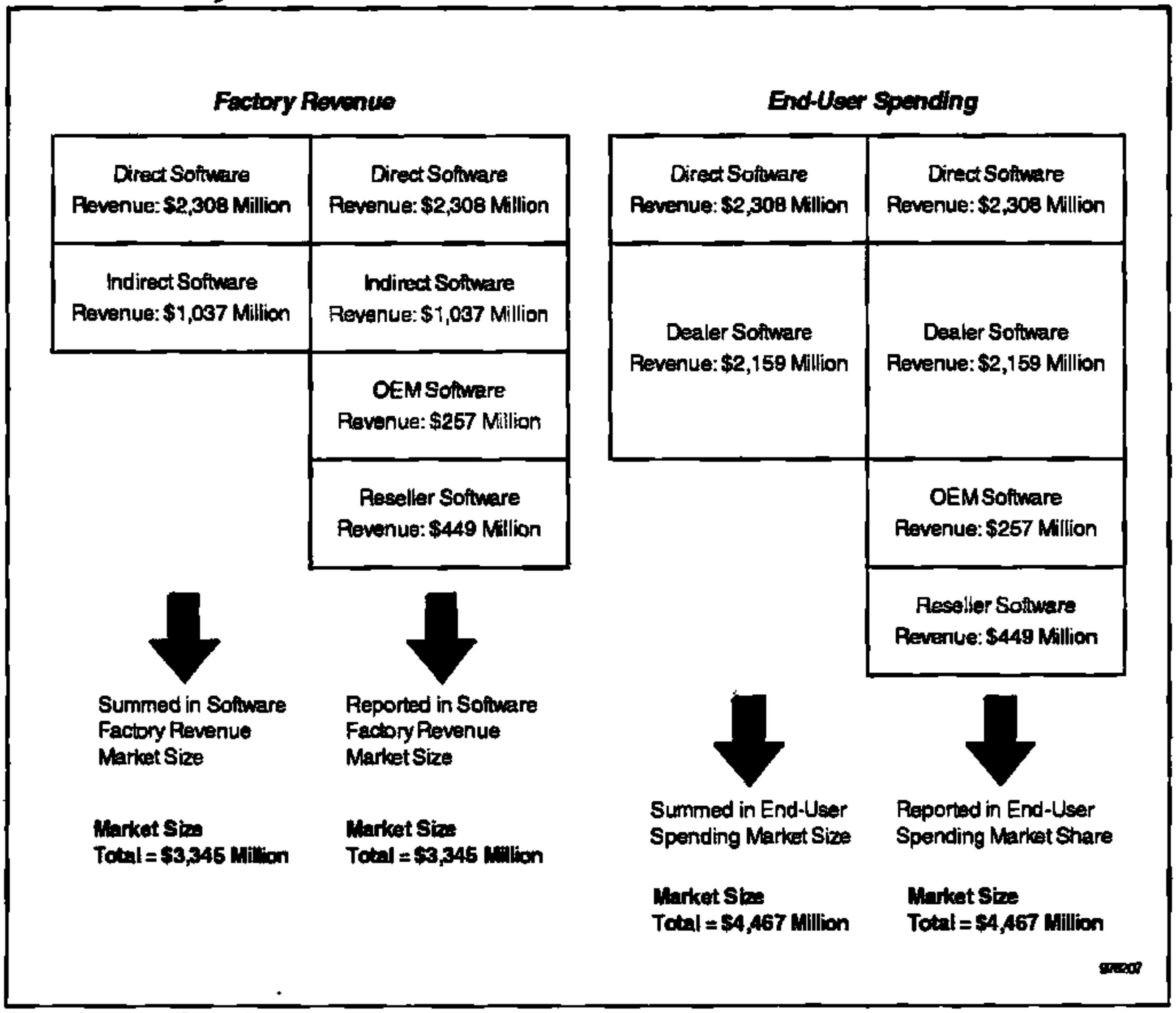
Computer-Aided Engineering (CAE)

- Analysis—Analysis of a physical system, part, or assembly; including structural, thermal, vibrational, composite, fatigue, stack-up, and mass property analysis
- Linkage/mechanism—Motion simulation and analysis of an assembly of components with two or more movable parts

Computer-Aided Manufacturing (CAM)

- Manufacturing process simulation

Figure 2-1
1996 Revenue by Distribution Channel, Mechanical



Source: Dataquest (September 1997)

- Numerical control (NC) part programming—Programming of a numerical control machine tool or automated processing system
- Part processing design—Design of a series of manufacturing steps

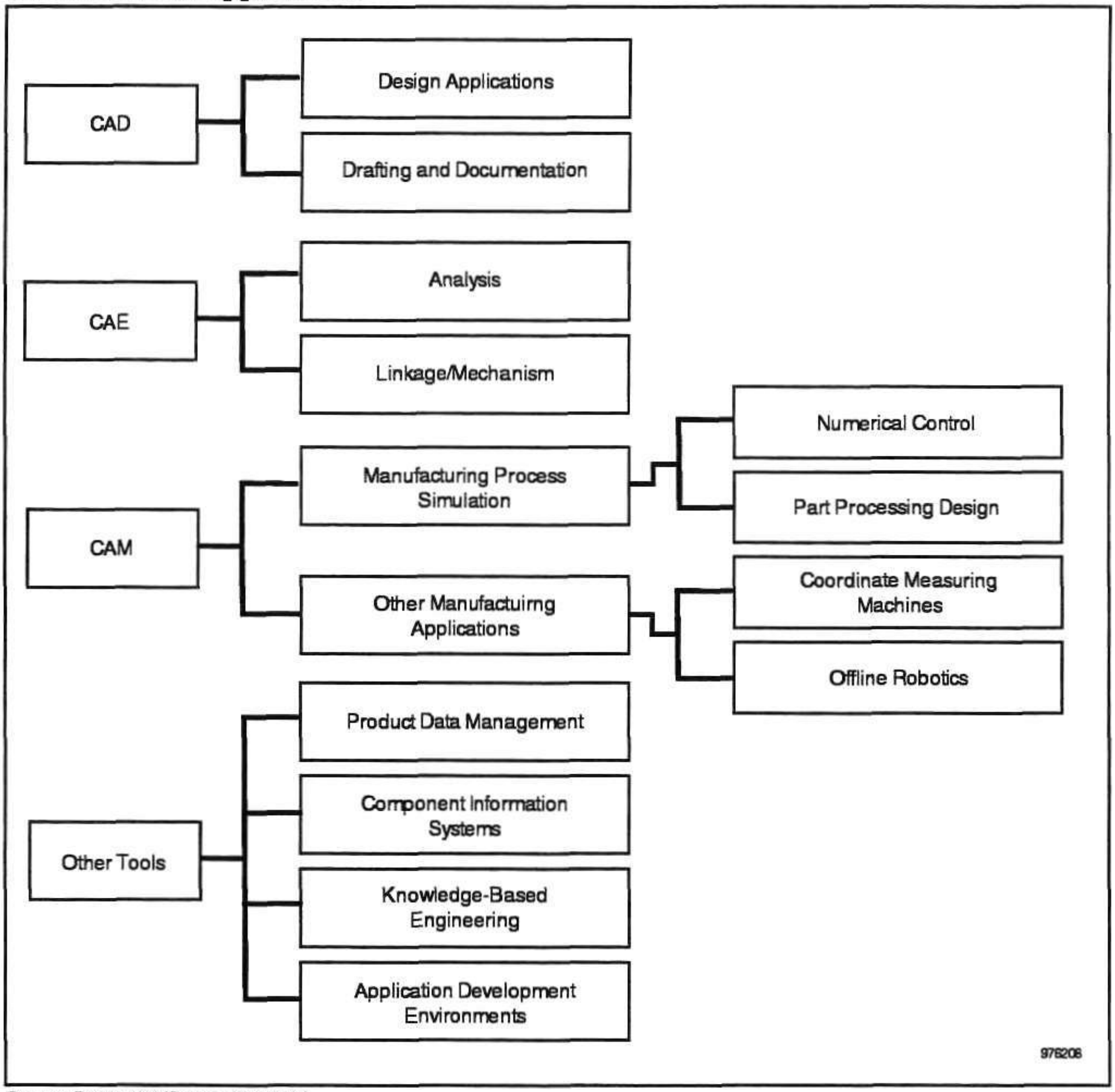
- Other manufacturing applications
  - Coordinate measuring machines—Programming of machines used to measure the physical dimensions of a part
  - Offline robotics—Process simulation that represents the sequence of steps to program a robot for a particular operation and downloads data to a robot to update its control program

Other Tools

- Knowledge-based engineering tools—Tools used to capture design intent and build standard practices for controlling, modifying, and automating design and manufacturing activities. This is also known as rule-based engineering.

- Application development tools—Programming tools to aid in the generation of user-defined programs that drive or interface with CAD/CAM/CAE applications
- Product data management—Software typically used in an engineering or manufacturing environment to manage product data. Product data management includes product structure management, workflow, and vault/document management.
- Component information systems—Software used to navigate within and manage a repository of mechanical engineering parts and associated data

Figure 2-2
Mechanical Subapplications



Source: Dataquest (September 1997)

Chapter 3
The Mechanical CAD/CAM/CAE Market Today

This chapter provides a mostly quantitative assessment of the mechanical applications market in 1996.

Regional Differences

North America and Asia/Pacific fared well last year, growing 17 percent and 28 percent, respectively (see Table 3-1). Growth in other regions—Europe and Japan—is partly because of exchange rate differences and partly because of actual CAD investment. The Japanese market grew 15 percent when measured in Japanese yen, but because of the dollar appreciation against the yen, it grew only 8 percent in U.S. dollar terms. MICROCADAM Inc., Information Services International Dentsu, and Parametric Technology Corp. all fared well in Japan in 1996 (see Table 3-1).

In contrast, Europe grew 12 percent when measured in U.S. dollars but grew only 6 percent in ECU terms. Europe was also affected by exchange rate fluctuations in 1996, though Dataquest can safely say that some of the European growth can be attributed to real investment in CAD/CAM/CAE tools from some of the large aerospace and automotive manufacturers. IBM continues to dominate the European CAD market, with the nearest competitor significantly far behind (see Table 3-1).

Table 3-1
Mechanical CAD/CAM/CAE Vendor Performance by Region, Top Five Vendors

	1996 Software Revenue ($M)	1995-1996 Growth (%)	1996 Market Share (%)
North America			
Parametric Technology	217.8	35.6	21.5
IBM	123.9	30.3	12.3
EDS Unigraphics	112.8	20.9	11.2
SDRC	73.3	7.3	7.2
Autodesk	73.2	-12.2	7.2
Europe			
IBM	298.5	19.6	26.0
Parametric Technology	173.3	58.6	15.1
Dassault Systemes	132.3	19.7	11.5
Computervision	78.3	9.2	6.8
Matra Datavision	68.8	-1.6	6.0
Japan			
MICROCADAM	123.1	17.6	12.7
Info. Services International Dentsu	117.2	37.6	12.1
IBM	109.8	3.5	11.3
Fujitsu	107.3	10.7	11.1
Hitachi	79.9	12.7	8.2

Source: Dataquest (September 1997)

Channel Differences

As discussed in Chapter 2, the CAD market has evolved from a turnkey market with products sold by a direct salesforce to a rich collection of channel and packaging schemes worldwide. Comparing the revenue of one company that sells primarily direct (at retail prices) with another that sells primarily indirect (at wholesale prices) distorts the picture, both in terms of market share and in terms of assessing true market opportunity. Dataquest is now modeling the CAD market by channel, allowing us to report market share based on a number of channel metrics. Table 3-2 outlines the market position in software for the leading mechanical CAD/CAM/CAE companies according to these new metrics.

For 1996, IBM has more revenue in the bank for the mechanical CAD/CAM/CAE software it sells, including the Dassault Systemes software that it sells exclusively and the MICROCADAM software that it resells. However, users spend dramatically more for Autodesk CAD products ($366 million in end-user spending) compared to what Autodesk actually puts in the bank ($177 million of company software revenue). It is little wonder, then, that Autodesk so dominates user minds.

Growth by Industry

User investment is heavily concentrated in the automotive and aerospace industries, as these industries continue to hold more than 34 percent of the worldwide mechanical CAD/CAM/CAE software market (see Table 3-3), a figure that has remained steady over the last five years. Particularly in Europe, the automotive and aerospace companies continued to place large orders for CAD tools in 1996, which will drive growth in these industries for at least two more years (as some of these contracts are multiyear agreements, with revenue spread out over the agreement period). Dataquest is finally seeing an upswing in electrical equipment and consumer electronics, an area some people refer to as mechatronics.

It is worth noting that users in the shipbuilding industry buy both mechanical and AEC software for similar design problems. Of the $39 million in mechanical software sold to the shipbuilding industry in 1996, $54 million of AEC software was also sold. As a result, Dataquest recommends readers evaluate the shipbuilding opportunity at about twice the $39 million in mechanical revenue, keeping in mind that more than half of the revenue is generated by software normally sold to the AEC users.

Table 3-2
1996 Mechanical CAD/CAM/CAE Software Market Leaders by Channel (Revenue in Millions of Dollars)

Vendor	Direct Software Revenue	Indirect Software Revenue	OEM Software Revenue	Reseller Software Revenue	Company Software Revenue	Dealer Software Revenue	User Software Revenue
IBM	485.6	NA	NA	94.1	579.7	NA	579.7
Parametric Technology	445.5	49.5	NA	NA	495.0	110.6	556.1
Autodesk	18.7	156.0	1.8	NA	176.5	345.5	366.0
Computervision	117.6	56.8	NA	NA	174.4	125.7	243.3
SDRC	84.6	68.4	NA	NA	153.0	153.3	237.9
Dassault Systemes	NA	NA	228.6	NA	228.6	NA	228.6
MICROCADAM	7.6	144.4	NA	NA	152.0	212.8	220.4
EDS Unigraphics	163.5	27.7	NA	NA	191.3	55.1	218.6
MacNeal-Schwendler	94.4	29.9	NA	NA	124.3	60.4	154.8
Matra Datavision	65.0	26.8	NA	NA	91.8	66.5	131.5
All Companies	**2,307.2**	**1,037.1**	**257.0**	**449.5**	**3,344.6**	**2,159.0**	**4,466.2**

Note: NA = Not applicable
Source: Dataquest (September 1997)

Table 3-3
1996 Mechanical CAD/CAM/CAE Software Revenue by Industry

Industry	1996 Software Revenue ($M)	1995-1996 Growth (%)
Automotive	697.9	16.1
Aerospace	442.8	13.0
Industrial and Commercial Machinery	310.4	8.2
Electrical and Electronic Equipment	286.9	19.2
Computers/Office Equipment/Peripherals	247.3	12.9
Fabricated Metals	204.7	2.3
Telecommunications	156.8	14.2
Consumer Electronics	152.3	31.3
Manufacturing Not Elsewhere Classified	135.0	28.7
Medical	107.6	10.4
All Industries	**3,345.0**	**13.0**

Source: Dataquest (September 1997)

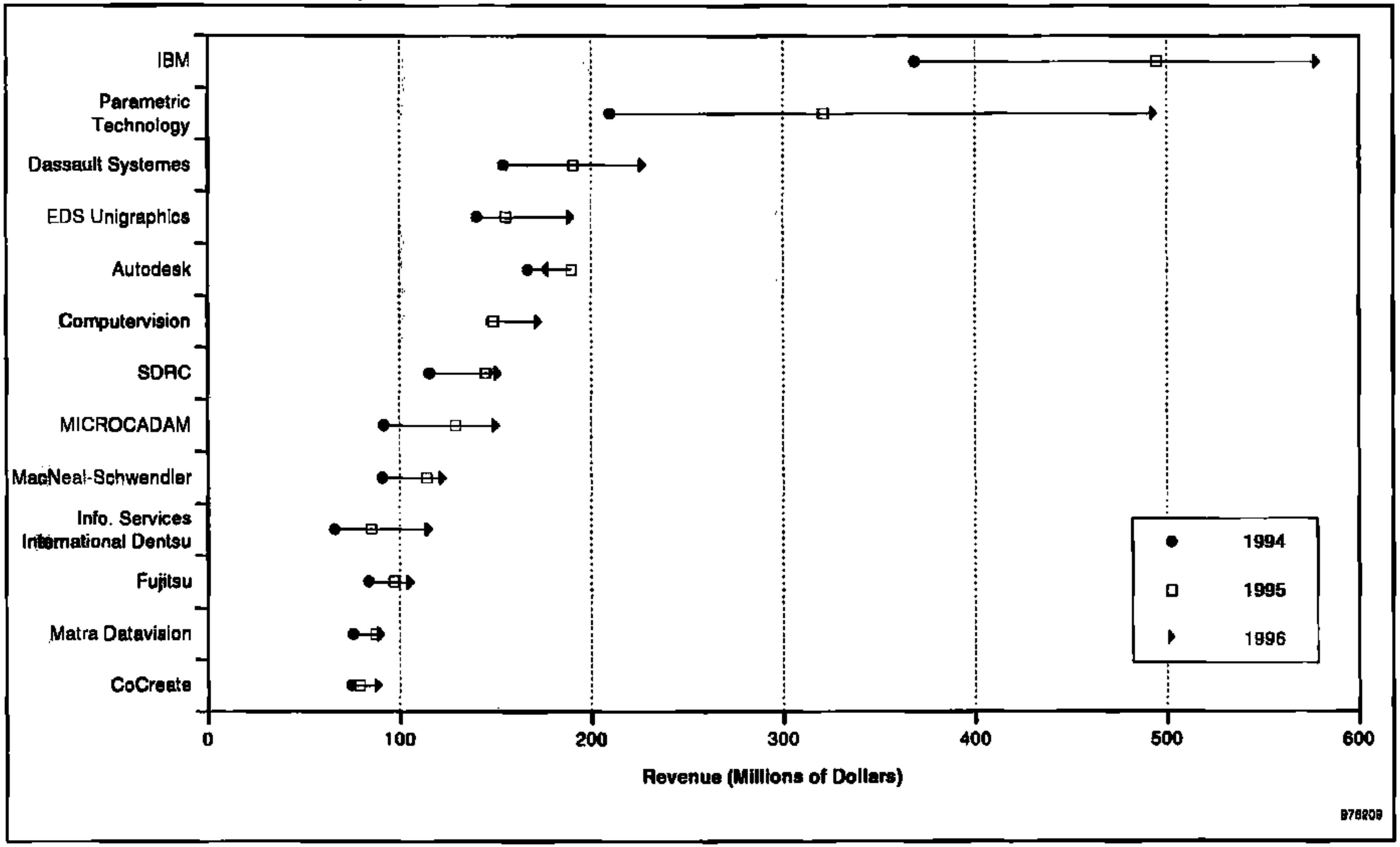
Prognosis of the Market Leaders

The year 1996 was another year of double-digit growth for the mechanical CAD/CAM/CAE software vendors as a group, with a handful of vendors showing growth of more than 20 percent, not an easy feat in what some might call a mature market. Over the past three years, the top 10 vendors have been claiming more of the market (now 72 percent of the $3,347 million in revenue in 1996) at the expense of everyone else.

IBM, still the market leader, has been on the upswing for at least the past three years (see Figure 3-1), as has the CATIA software developer Dassault Systemes. Meanwhile, Parametric Technology, again repeating unprecedented growth in 1996, has been inching up on IBM for at least the past five years. EDS Unigraphics and MICROCADAM continue to turn in consistently good growth year after year, with their core sales in North America and Japan, respectively. Autodesk, the one top 10 player showing negative growth, is in a state of transition. At last, Autodesk has a credible product (Mechanical Desktop) and an entry strategy to make a real play at the mechanical CAD market. (Also, it is important to note that revenue of Autodesk in Figure 3-1 includes sales of both AutoCAD and Mechanical Desktop for 1996. Slow sales of AutoCAD R13 may be masking Mechanical Desktop's true market performance.) Although 1996 figures indicated that Computervision may be in store for a turnaround, early software sales results from 1997 do not bode well for the company.

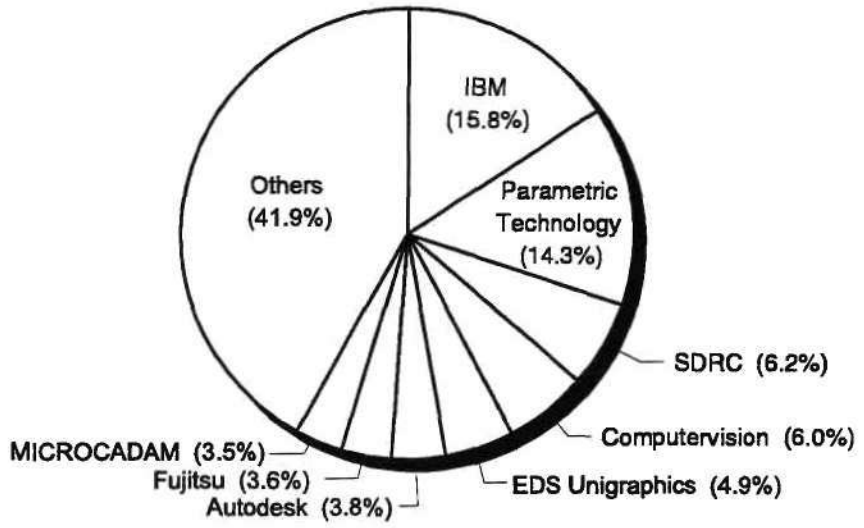
While the above analysis is based on software sales alone, the role of software services cannot be ignored in vendor rankings. Figure 3-2 shows 1996 market share by vendor for software and software services combined. This view particularly affects ranking of companies with large service revenue such as SDRC. In this scenario, SDRC and Computervision gain market share while Autodesk and EDS Unigraphics lose a little bit of ground. Again, a ranking of market players by software and services combined is as valid a view of the market by one that considers only software revenue.

Figure 3-1
Historical Software Revenue by Vendor



Source: Dataquest (September 1997)

Figure 3-2
1996 Market Share, Software and Software Services Combined

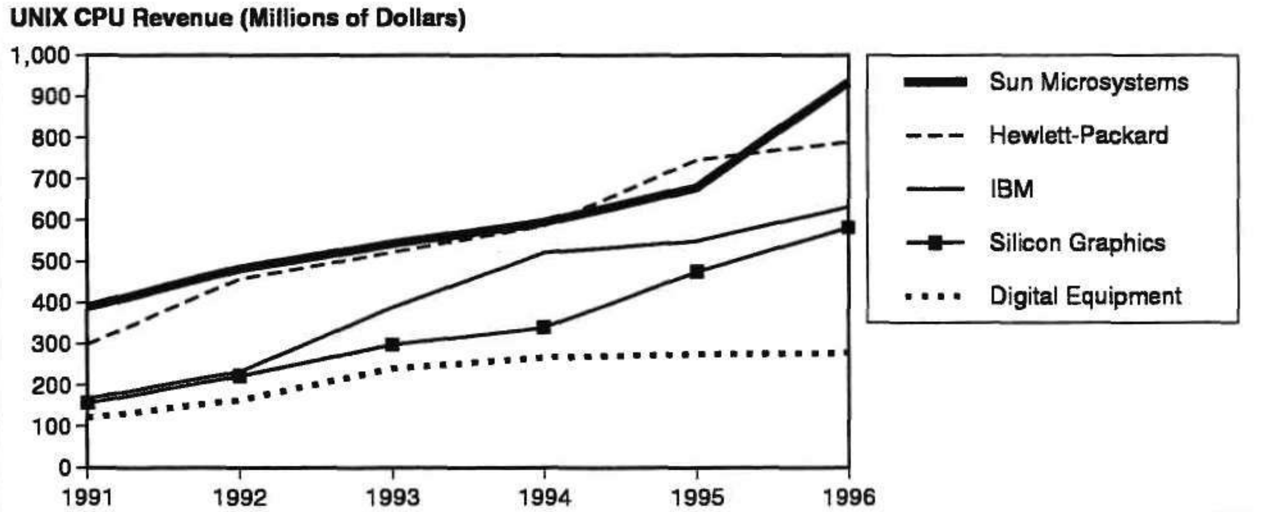


Source: Dataquest (September 1997)

The Hardware Vendors

No analysis of the mechanical CAD/CAM/CAE market would be complete without understanding fundamental shifts among the hardware vendors. For every dollar spent on mechanical applications software, nearly 1.4 times that amount is spent on computing hardware. The big four UNIX players—Hewlett-Packard, IBM, Silicon Graphics, and Sun Microsystems continue to battle it out for market leadership and growth leadership. Figure 3-3 shows UNIX hardware vendor performance for 1996.

Figure 3-3
UNIX Hardware Vendor Performance



Source: Dataquest (September 1997)

Chapter 4
Market Drivers

This chapter explores the trends that will most influence the mechanical CAD/CAM/CAE landscape over the next five years. Although the market is showing the first signs of slowing down from its 1995 and 1996 double-digit growth, many opportunities for vendors still exist in key regions of the world, with certain emerging technologies, and in specific market segments. The trends identified in the following paragraphs are a rich mixture of technology, vendor, and end-user factors.

The Ongoing UNIX—NT Debate

This section discusses the effect of Windows NT on the mechanical CAD/CAM/CAE landscape from a number of different perspectives.

A Software Perspective

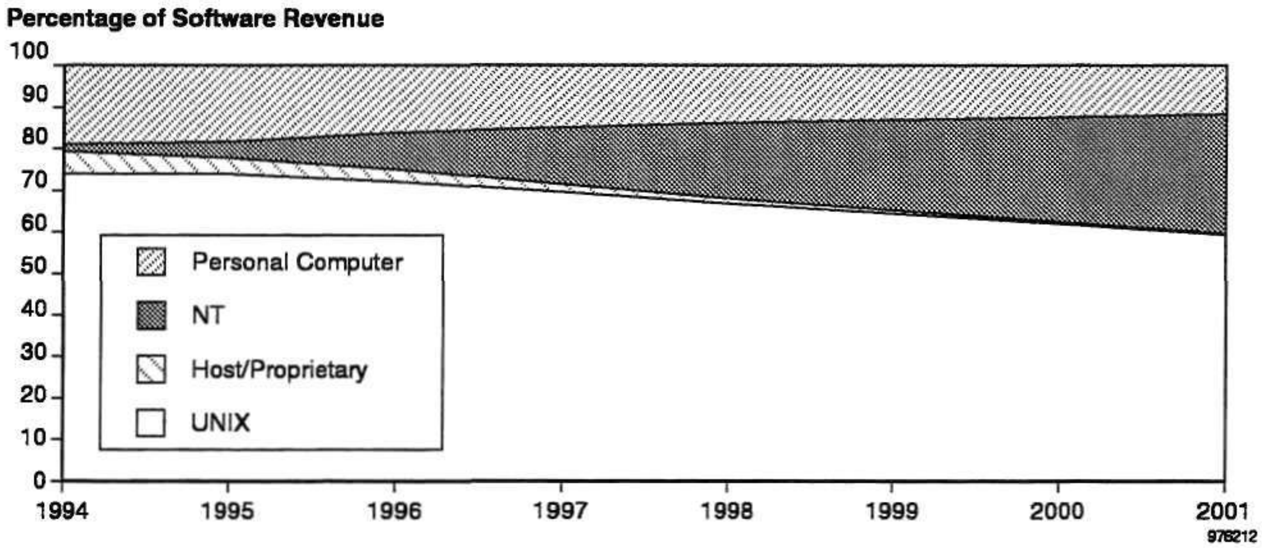
Since 1994, sales of Windows NT-based mechanical applications have grown from $42 million to $295 million in 1996. Despite the fast growth of NT-based mechanical software, it really has not begun to affect the revenue generated from UNIX-based mechanical application sales. The overall mechanical market has grown enough to accommodate increased sales by both operating systems. It is important to keep in mind that the top vendor in the mechanical market today, IBM, still has yet to port its full CATIA product line to the NT platform. Further, nine of the top 10 mechanical CAD/CAM/CAE vendors generate the bulk of their revenue from UNIX-based sales, and an NT-based offering by these vendors is, at best, a port of their existing UNIX code to NT rather than a ground-up design of new software aimed at taking advantage of specific features of the NT operating system. With a port, these vendors, too, can join the "we have an NT solution" bandwagon. Figure 4-1 shows Dataquest's mechanical applications software forecast by operating system through the year 2001.

All signs are pointing to the fact that NT will not eat into the UNIX *installed* base for at least a few more years. Where NT will have its biggest impact in the near term is in the high-growth midrange CAD market, discussed later in this chapter.

A Hardware Perspective

As indicated earlier, the mechanical applications market is expected to remain dominated by UNIX-based software sales in the future, at least from a revenue perspective, much as it is today. Nevertheless, it is important to examine what is happening on the Windows NT hardware vendor front. In the past 18 months, three of the top five established workstation vendors—Digital, Hewlett-Packard, and IBM—have released Intel and Windows NT-based workstation product families alongside their UNIX-based systems. Only Silicon Graphics and Sun Microsystems are staying solidly in the UNIX camp. Other vendors, such as Intergraph and NeTpower, have adopted an exclusively Intel/Microsoft strategy, and new players have entered the market, most notably Compaq Computer Corporation.

Figure 4-1
Mechanical CAD/CAM/CAE Forecast by Operating System



Source: Dataquest (September 1997)

Since the introduction of Windows NT, some high-end PC configurations have been sold into some mechanical applications traditionally considered to be the domain of RISC/UNIX workstation vendors, blurring the boundaries between the two market segments. The biggest threat to the strong foothold of the UNIX hardware vendors in mechanical CAD/CAM/CAE is the introduction of Intel's Pentium Pro. Here, Intel-based systems could compete on equal footing with entry-level RISC systems, accelerating the penetration of Windows NT into the UNIX-dominated workstation market. Nevertheless, the mechanical CAD/CAM/CAE market moves slowly, and toppling the entrenched market leader for mechanical applications, UNIX, will be a long, arduous process for any operating system.

A User's Perspective

The speed at which NT-based software becomes a standard in mechanical design depends on end-user purchases and interest. In early 1997, Dataquest asked 198 users what their main CAD operating system will be in 1999 and in 2001. According to end users, UNIX will indeed cede some ground to Windows NT in mechanical CAD; over the next two years, 18 percent of users plan to move to the Windows NT operating system, and by 2001, 28 percent expect NT to be their primary mechanical CAD operating system. However, the overall numbers do not give the whole picture. According to end users, NT will make its greatest gains in electrical and electronic machinery and aerospace, and those respondents in automotive tend to be more guarded about their transition to NT.

It is important to keep in mind that the survey respondents identified UNIX as their main CAD operating system today, so these results start from a base of 100 percent UNIX users, and that these responses are from end users and are not a Dataquest forecast of mechanical CAD operating systems. Previous end-user surveys have shown that users tend to be much more optimistic about change than in reality. Expect actual movement to NT to be slower than the numbers cited above.

Emergence of the Midrange

There is no shortage of midrange mechanical design packages on the market today—Autodesk's Mechanical Desktop, Bentley Systems' MicroStation Modeler, EDS Unigraphics' UG/Creator Bundle, Intergraph's Solid Edge, Parametric Technology's PT/Modeler, SDRC's Artisan Series, and SolidWorks' SolidWorks. This section identifies the issues facing expansion of the midrange market.

Understanding the Two Tiers

At this time last year, the midrange market was too immature to clearly define. What will develop over the next year is a midrange market with two distinct tiers. The first tier consists of those users who are looking to move from 2-D design to 3-D design. This group perhaps uses one of the various versions of AutoCAD and is looking to move up to solid modeling for some of its design work. The second tier consists of those users who are looking to extend CAD into the enterprise. For instance, an automotive company may be using a full-blown UNIX-based system for their primary design package and a midrange package (with a common solid modeling engine) among its suppliers.

Selling mechanical CAD systems to the first tier is different from selling to the second tier. The first tier of users, those moving from 2-D to 3-D, have the following characteristics:

- Lack budgets for more expensive UNIX-based CAD systems
- Lack a lot of investment in historical, legacy data that would make switching CAD systems something to be avoided
- Have limited needs in analysis and CAM, at least today
- Work in smaller groups or teams of designers
- Rely on value-added resellers (VARs) and dealers for their CAD needs and training

In contrast, those in the second tier, who are looking to extend CAD further into the enterprise, have:

- Lack budgets for more UNIX-based CAD systems, but have budgets that are larger than the first tier
- Have investments in historical and legacy data that must be preserved
- Are looking for seamless data transfer among CAD systems and downstream and upstream applications
- Purchase CAD systems via direct sales as part of a larger companywide CAD or information technology (IT) strategy

Clearly, among the midrange products mentioned earlier, some fit more naturally among the first tier than among the second tier. In particular, EDS Unigraphics, Parametric Technology, and SDRC all offer midrange and higher-end packages that are based on a common, proprietary solid modeling engine, making data transfer seamless, both upstream and downstream. On the other hand, Autodesk, Bentley Systems, Intergraph, and SolidWorks sell midrange products today almost exclusively through the indirect channel and typically in smaller two- to five-seat deals.

Indirect Channel; Qualified Dealers

Growth of the midrange mechanical CAD market, as well as any one vendor's success in that market, will depend heavily on the distribution channels and strength of the VARs. For years, mechanical VARs and dealers have taken a back seat in the UNIX-dominated mechanical CAD/CAM/CAE market that has relied heavily on direct sales. Given the number of midrange mechanical design packages being sold through dealers and VARs today, software vendors are undoubtedly having to work to attract and retain qualified dealers. Nevertheless, CAD VARs today are becoming more sophisticated, either offering software products themselves (like Visionary Design Systems is doing) or expanding their network through acquisition (like Rand Technologies). At the same time, mechanical CAD users will become more sophisticated and demanding in their needs, as well. Keeping up with technology is a challenge to all, and VARs and designers are no exception.

Interoperability—A Never-Ending Story

Truly seamless interoperability among CAD/CAM/CAE applications is an elusive proposition. The concept of interoperability has been bandied about for years, as have the so-called solutions to interoperability—direct translators, data exchange standards like IGES, STEP, and OLE for D&M. Interoperability is less of an issue for those companies that use one single CAD/CAM/CAE package from art to part. But, with the exception of a few industries like aerospace and automotive, art-to-part software supplied by one vendor is becoming less of a reality. Further, interoperability issues hang like a dark cloud over the midrange market, especially for those midrange packages that are focused on just design today.

Because the entire world of CAD users does not use identical geometry engines, interoperability problems stand out like sore thumbs. Proprietary solid modeling engines are the traditional mainstay of the mechanical CAD/CAM/CAE market. In past years, there has been an influx of solid modeling kernels (Spatial Technology's ACIS, EDS Unigraphics' Parasolid, and Ricoh's DesignBase) for which their respective developers have set up OEM deals. Users have different modeling needs, and the various modeling kernels all have different functionalities and capabilities.

Unfortunately, Dataquest does not envision standardization around one particular modeling kernel at any time in the near or far future, if at all. Thus said, vendors and users have no choice but to attack interoperability issues via standards. STEP and OLE for D&M are two solutions to interoperability that appear to be moving forward, albeit slowly at times.

The STEP Standard

STEP is a collection of international standards being developed in smaller pieces via worldwide committees. One of STEP's original visions was to have various systems accept and use standard product data so that suppliers, vendors, and manufacturers could receive and supply information about product parts and the interrelationships of parts and materials. The initial focus of STEP was on mechanical parts; however, this is not the only focus today. There are STEP development efforts in process plant design and electrical design as well. STEP is viewed not necessarily as a successor to IGES, but as a broader exchange standard because it incorporates manufacturing information on product features such as size, materials, properties, and part relationships. In a nutshell, STEP consists of application protocols that govern the technicalities of how files and data are represented and transferred.

STEP has always shown stronger backing in Europe than in the rest of the world, though there are STEP-related initiatives in North America, Japan, and Asia/Pacific. Because STEP is such a comprehensive standard, it is expected that no one vendor will develop software that is fully compliant with every aspect of STEP. Instead, vendors will implement those aspects of STEP that are pertinent to their customers' lines of business or product applications. At this point in time, the major mechanical CAD/CAM/CAE vendors have been supporting STEP as far as it has gone, making available the ability to create a STEP file from their proprietary data models.

The problem for the users today is that even the STEP processors available right now do not yet exchange data perfectly. ProSTEP e.V. recently announced the results of a benchmark it did with 10 STEP interfaces from various vendors exchanging solid modeling data. The quality of the interfaces has certainly improved, but by no means can a user expect seamless data transfer yet. At heart of the issue are the demands of the users, who can't afford to fiddle around with exchange standards that are close, but not quite right. Even with the strong vendor support that STEP is receiving, particularly in Europe, the bottom line is that designers and engineers are paid for designing products and manufacturing them. They do not have the time to rework CAD model imports and try to figure out where the errors are.

OLE for Design and Modeling

OLE for D&M specifies a standard set of geometry and topology interfaces for mechanical applications. It is a set of component object model (also known as COM from Microsoft) interface specifications developed specifically for the mechanical design industry. OLE for D&M has received strong backing from a number of mechanical CAD/CAM/CAE vendors with products on the PC or NT platforms.

The organization facilitating the development of OLE for D&M is the Design & Modeling Application Council (DMAC), established in early 1995 and pioneered by Intergraph. The DMAC held a major demonstration of CAD/CAM/CAE application interoperability using OLE for D&M earlier this year.

Because of the common interfaces, software that supports OLE for D&M allows for data exchange *without translation* (for example, no IGES translations are needed), thus making geometry exchange neater and more seamless. The breadth of OLE for D&M is being extended to include such things as support for nonmanifold topology, interchange of product structure data, and features interface (something akin to smart CAD objects). If OLE for D&M can be expanded to include these additional functionalities as well as others, it will become a very plausible mechanism for seamless interoperability among CAD, CAM, and CAE applications.

Opportunities in Asia/Pacific

Dataquest expects the Asia/Pacific region to grow faster than any other region of the world over the next five years (see Table 4-1). A mixture of local government, multinational companies, and industry initiatives is driving mechanical applications software growth in this region. While we can produce a market share table showing a market leader in Asia/Pacific, it appears as if no single software vendor has a dominant position in every country. Dataquest also has found that success in one country doesn't necessarily translate to success in another country, and good growth by a vendor one year doesn't ensure good growth in the following year. The Asia/Pacific CAD market can accommodate many vendors and dealers that keep the following factors in mind:

- Particularly in Southeast Asia, mechanical designers are not as advanced in their use of CAD as are their counterparts worldwide. There exists a large number of 2-D users who can be migrated to 3-D design methodologies. Here, midrange solutions will do well.
- In regions where labor is cheap, corporations believe it is more cost-effective to hire more workers than to automate portions of the design and manufacturing processes.
- Local and national governments play a heavy role in development of IT in many Southeast Asian countries, and strong initiatives for jump-starting or growing a country's IT infrastructure have begun. These initiatives typically will include CAD as part of the strategy.
- The growing automotive industries in Indonesia, Korea, Malaysia, and Thailand, as well as aerospace initiatives in China and Indonesia, all bode well for future mechanical CAD sales.
- Users will need implementation and consulting services to get the most from their CAD systems. Typically, there is no CAD guru who fully understands CAD/CAM/CAE technology and can oversee its deployment.

Table 4-1
Forecast Asia/Pacific Growth by Country, Mechanical CAD/CAM/CAE

Country	1996 Revenue ($M)	1996-2001 CAGR (%)
China	24.5	27.7
Hong Kong	16.5	14.6
Korea	43.9	18.7
Singapore	13.9	15.3
Taiwan	30.1	15.3
Rest of Asia	51.8	25.5
Total Asia/Pacific	**180.7**	**21.1**

Note: Rest of Asia includes Australia, Brunei, Cambodia, India, Indonesia, Laos, Malaysia, Maldives, Myanmar, Nepal, New Zealand, Pakistan, Philippines, Sri Lanka, Thailand, and Vietnam.
Source: Dataquest (September 1997)

Product Data Management—Time for a New Focus

Despite the hype, PDM as it stands today has not exploded into a vast market opportunity for vendors. Although the problems that PDM addresses are very real, the methods by which PDM has tackled these problems are less than ideal. Many of the solutions on the market have focused heavily on vaulting/engineering document management first and product structure second. Workflow capabilities have been available, but these solutions required that processes be predefined in a rigid structure. This methodology may fit products once they are released from engineering to manufacturing, but it does not facilitate the less structured engineering design process.

Last year, Dataquest could have said that integration of PDM with manufacturing resource planning (MRP) solutions from companies like SAP and Baan was the trendy thing to do. This year, it has been Web-enabling the PDM solution (that is, creating a Web-based interface for the PDM client). Neither trend will create explosive growth in the market. The PDM vision must be revisited to incorporate elements of collaborative engineering (discussed later) within an intranet or Internet environment—and even then, it will still be a missionary sale. On a positive note, some of the vendors understand this need and are beginning to roll out products that are more than just Web-enabled solutions of their old PDM solutions. PDM market and players are discussed in greater detail in Chapter 5.

Collaborative Engineering

Only a few years ago, collaborative engineering meant electronic whiteboarding, a technology that few designers were interested in because it wasn't connected tightly to the CAD model; there was no efficient way to take those marked-up whiteboarding changes and link them directly to CAD geometry. That has changed with the advent of Internet and intranet technology. The race to collaborative engineering is on again, with both PDM and CAD/CAM/CAE vendors sprinting to offer something that fits under that rubric.

Right now, vendors have nothing to lose and everything to gain by putting some sort of Web spin on their products, as users today are not really sure of what they need or want in terms of Internet/intranet/Web capabilities in their automation tools. What is certain is that the collaborative engineering solutions today have greater potential than anything in the past 10 years to bring engineering design out of its traditional silo.

Clearly, collaborative engineering, or what used to be called concurrent engineering, is reinventing itself. Although no single definition has emerged yet, Dataquest believes there needs to be some element of CAD, data management, and workflow for the designer, customer, and supplier (that is, the extended enterprise). Solutions that are making headway at defining the potential of collaborative engineering include Bentley Systems' Engineering Back Office suite of products, CoCreate's concept of shared-space design, Computervision's EPD.Connect, Dassault Systemes/IBM focus on process-centric users, and Parametric Technology's Pro/INTRALINK.

Mechanical and Electrical Co-design

In the past few years, there have been two opportunities for mechanical and electrical design tools and methodologies to merge. One is with system-level design. True system-level design automation (SDA) tools are still years ahead. Much of the SDA work today is project-oriented, and these programs are funding some new tool development. Two well-known SDA programs are the Ford 2000 program and the European AIT consortium; a well-known precursor to SDA (before the term SDA became popular) was the Boeing 777 project.

Only a few SDA tools are commercially available today. They are primarily high-level architectural system design and modeling tools and tend to be academic in their approach to SDA. There is still a disconnect between translating those system requirements to actual design requirements, whether they are electrical or mechanical. There is a System Level Design Language Working Group, whose goal is to come up with an electronic/mechanical systems language by the year 2006.

The second opportunity for mechanical and electrical disciplines to merge is with mechanical and electrical co-design tools. Electromechanical systems have their own set of design problems beyond just mechanical ones—signal integrity, electromagnetic radiation, and thermal issues can all affect a product's intended function. Most of the tools that fall into this emerging category are cabling tools. True, companies like Computervision have had cabling and wire harness solutions for years. But today, a handful of vendors, mostly from the electrical side, is addressing the mechanical/electrical co-design issue. This group includes Mentor Graphics, Viewlogic, and Mechtronix. For these electronic design automation vendors to succeed in this category, they will have to offer tools that give mechanical designers the precise geometry modeling that they need—ones that have the ability to do simulations and are priced lower than the typical electrical designer's seat.

The Promise of Objects—If and When

Beginning in 1995 and continuing through 1997, CAD vendors began unveiling products or architectures based on object-oriented technology, including Autodesk (ObjectARX), Bentley Systems (MicroStation/J), Computervision (Pelorus), Intergraph (Jupiter), and Matra Datavision (CAS.CADE). The promise of objects and object-oriented technology in CAD is moving slowly ahead, albeit faster in AEC and more slowly in mechanical CAD/CAM/CAE.

The discussion that follows is extracted from a Dataquest Perspective sent to our worldwide AEC CAD clients—"Smart Objects in CAD Software: How Far, How Fast?" (CAEC-WW-DP-9708), dated August 18, 1997. Although the extracted text focuses on CAD in general and AEC users in particular, we feel that readers of this report will find the discussion of interest, as many of the object-based developments in AEC may one day filter over to the mechanical applications side.

The Confusion about Object Technology

The object-oriented world promised to help software vendors bring products to market faster by exploiting reusable code while dramatically reducing user design time by increasing certainty of design outcome and freeing users from the worries of data translation and integration with other CAD programs. The dividing lines among objects, object-oriented architectures, component technology, and object-oriented programming are not easy to ascertain. Adding to the confusion, some CAD vendors have taken the liberty of calling their software object-oriented, even though the amount of "object-orientation" in their software might actually be quite small. This has given vendors the freedom to market their products as being object-oriented even if the software has only a few smart objects or only has portions of the code written using an object-oriented programming language like C++.

Today, object-oriented CAD applications seem to be divided in two camps. At one end, there are those applications that are built using object-oriented programming languages. Benefits to the end user are limited, but benefits to the application developers are theoretically greater (in terms of code reuse and faster application development). At the other end, there are those applications that actually allow the user to place smart objects within their CAD drawings. (First, a definition: Objects seek to represent real world entities by encapsulating their attributes and behavior. The term "smart" is used to denote that the objects carry all the knowledge about themselves with them. This knowledge can include business rules, design rules, or manufacturing processes. For instance, a smart door object is more than just a collection of lines and arcs. It knows that it can't be placed on a window or in a firewall.) Here is where end users begin to see the benefits of object technology. The user begins designing less with lines, arcs, and circles and more with doors, windows, and walls. Of course, this is a very simplified view of where vendors are coming from today in marketing object technology to the CAD world.

The Bottom Line

The bottom line is that users are less concerned with the object orientation of a solution as compared with its ability to address their design needs. They would also like software solutions that can be extended with ease, instead of having to invest in programming resources to develop a custom solution and to be able to access objects or CAD applications across platforms without having to work around interoperability issues. To date, the object-based architectures and solutions being offered by vendors in the CAD world still do not solve the ever-important user concerns of proprietary data models, data exchange, and interoperability. The promise of objects in CAD will have reached its promise once smart objects are able to carry knowledge from one application to another and users will be able to operate in a hybrid environment where legacy (nonsmart) data is involved.

Objects in CAD are not quite here yet, but over the next five years there will be a slow but steady infiltration of software that is increasingly populated by smart objects. This infiltration will first take place in AEC and will eventually filter over to the mechanical world. The uptake of objects in CAD would go faster if vendors would focus more on the interoperability of objects and solutions. One can only hope that the OLE for D&M committee is beginning to think about smart objects like smart screws, bolts, and motors.

Interactive Product Simulation

Although rapid prototyping may be a reality in CAD today, what has been called virtual prototyping has not been widely embraced by the design community. CAD vendors have ventured in this direction of designing and visualizing assemblies in a virtual environment (for example, Computervision's electronic product definition strategy). Hardware vendors like Silicon Graphics and IBM have seen its customers use its workstations to complete virtual tasks, such as fly-throughs of complex product assemblies to simulations of a manufacturing plant. And there has been the occasional animation-based software vendor eyeing a piece of the virtual prototyping market. But "virtual prototyping" has never been clearly defined, resulting in a mix of hardware and software solutions looking for a market and a group of users. The ambiguity of this market's definition has made sizing this market a challenge for Dataquest.

Dataquest believes we have finally stumbled on a term that may better describe this market (and enable us to eventually size the market opportunity)—interactive product simulation (IPS). As Division Inc. describes IPS, it is the ability to create, interact with, manipulate, share, and analyze a virtual product in real time. We feel that this term and definition fit more closely with the mechanical design process. With this definition, we can include such companies as Engineering Animation (with VisMockUp and VisFly), Division Inc. (with its dVise family of products), and Tecnomatix Technologies (with DYNAMO), and we can exclude such companies as Transom Technologies Inc. (with its Jack software). Dataquest will be looking at IPS more closely in 1998, refining the boundaries of IPS and defining the market players.

Chapter 5
Mechanical Market by Subapplication

Chapter 2 provided a definition of Dataquest's mechanical subapplication structure. This chapter provides a detailed look at the market by subapplication. For the convenience of our readers, here we reprint Figure 2-2, our subapplication outline, as Figure 5-1. Table 5-1 gives the 1996 market size by subapplication and the five-year CAGR forecast.

There are two important points to be made about Dataquest's subapplication database. First, while we report a vendor's market share and revenue based on *company software revenue*, or the sum of direct, indirect, OEM, and reseller revenue, we report a vendor's *subapplication revenue* based on *software product revenue*, or the sum of direct and indirect revenue. Thus, for some companies, in particular IBM, the sum of all subapplication revenue will be lower than what we normally report in our standard market share tables (because of the exclusion of OEM and reseller revenue in the subapplication database).

Secondly, this year, Dataquest is reporting less detailed subapplications than in previous years under the Computer-Aided Design heading. Because the boundaries among functional design, conceptual design, and tool and fixture design are not that distinct, we are reporting those three subapplications under the heading Design Applications.

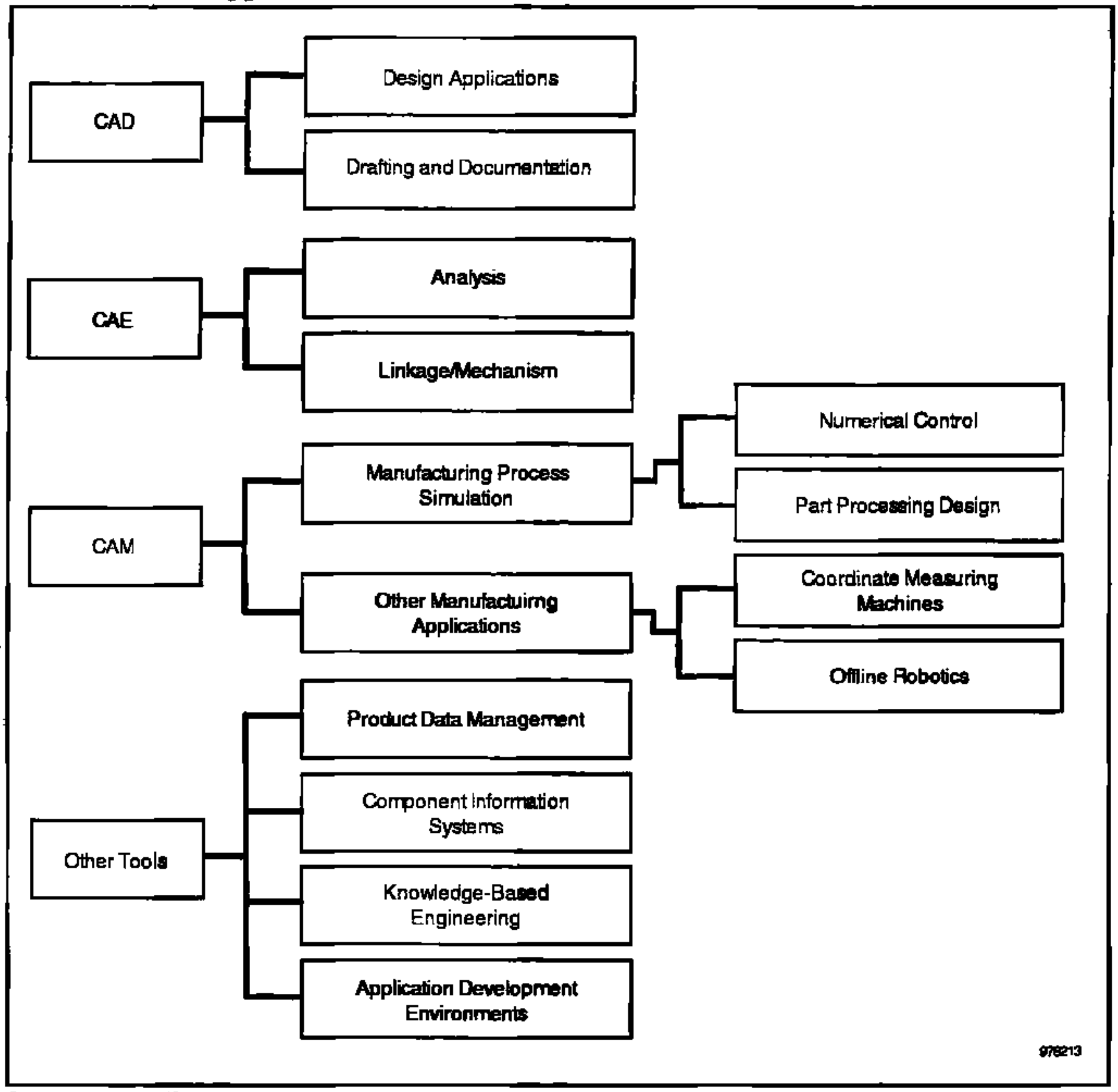
Computer-Aided Design

Design Applications

Design applications are the mainstay of the mechanical CAD/CAM/CAE market. Investment in basic CAD tools by end users is reflected in the high growth rate of this subapplication in both 1996 and 1995 (17 and 32 percent, respectively). Vendor penetration into the untapped Asia/Pacific region and reinvestment/rethinking of CAD strategy by a large number of European automotive and aerospace firms have re-energized this subapplication over the past few years. Outstanding performance by perennial market players Parametric Technology, IBM, EDS Unigraphics, Computervision, and MICROCADAM in 1996 also have helped to boost this segment. Figure 5-2 shows the 1996 software market share of the leaders in design applications.

This subapplication will continue to grow, albeit more slowly, over the next five years. It is expected to show a five-year CAGR of 11 percent until 2001, slightly above the total market CAGR of 10 percent over that same time period. Better modeling tools will be needed to drive downstream applications like CAM and rapid prototyping, and users are beginning to design increasingly complex assemblies. The midrange vendors will become strong factors in driving this subapplication beginning in mid-to-late 1998, especially in sales for manufacturing tool and fixture design.

Figure 5-1
Mechanical Subapplications



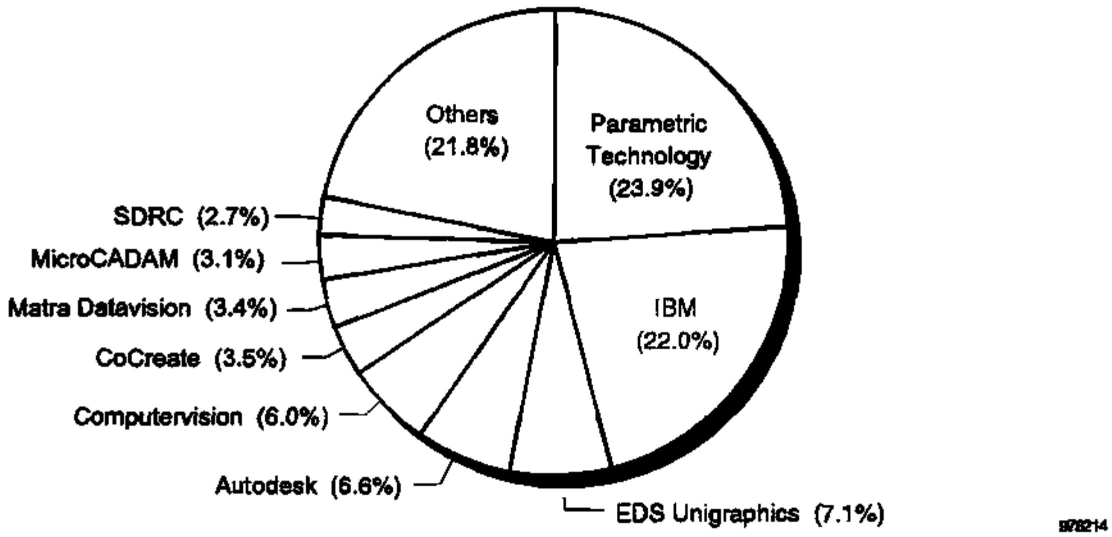
Source: Dataquest (September 1997)

Table 5-1
Mechanical Subapplications Market Size and Forecast

	1996 Software Revenue ($M)	1995-1996 Growth (%)	1996-2001 CAGR (%)
Computer-Aided Design	2,108.9	10.4	8.3
Design Applications	1,382.6	17.2	10.9
Drafting and Documentation	726.3	-0.6	2.4
Computer-Aided Engineering	553.6	15.9	11.8
Analysis	507.4	15.1	11.7
Linkage/Mechanism	46.2	25.5	12.5
Computer-Aided Manufacturing	393.8	18.7	11.6
NC Part Programming	322.7	16.3	10.8
Part Processing Design	32.5	42.4	15.9
Other Manufacturing Applications	38.5	22.6	14.0
Other Tools	287.9	19.9	13.5
Knowledge-Based Engineering Tools	22.3	43.1	11.5
Application Development Environments	23.8	13.0	14.7
Product Data Management	236.2	17.1	12.2
Component Information Systems	5.7	235.7	45.3
All Subapplications	**3,344.6**	**12.9**	**9.8**

Note: Revenue does not add to $3,344.6 million because of rounding
Source: Dataquest (September 1997)

Figure 5-2
1996 Design Applications Market Share



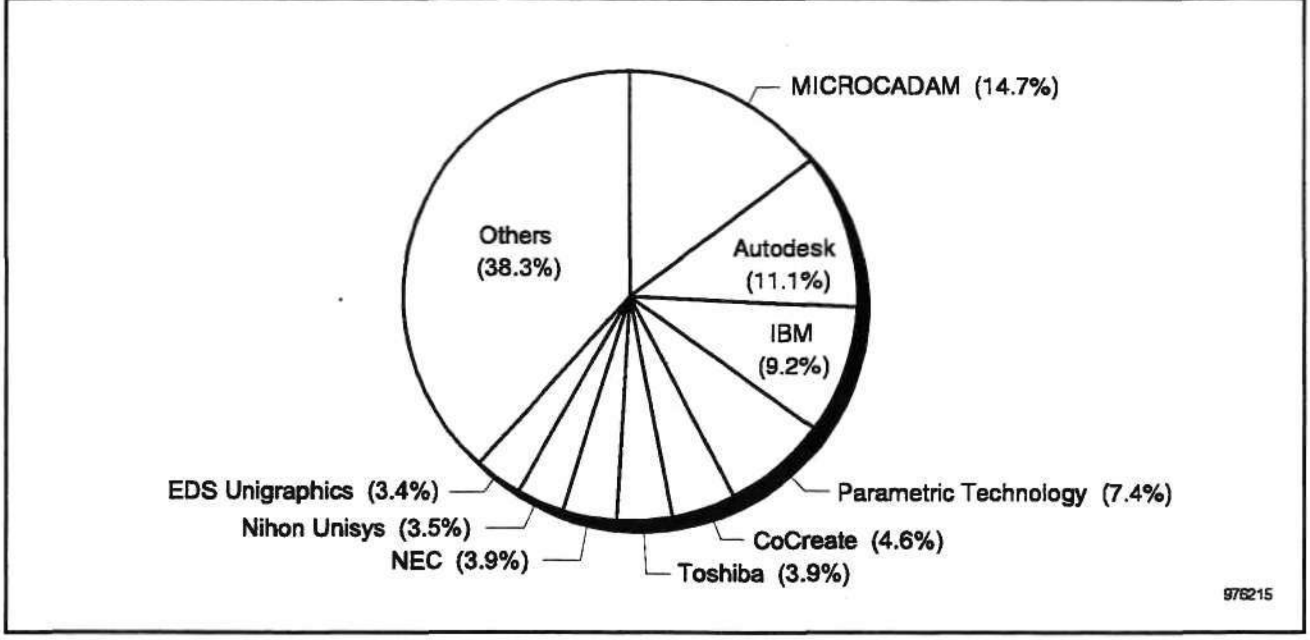
Source: Dataquest (September 1997)

Drafting and Documentation

Similar to design applications, drafting and documentation is the bread and butter of the mechanical CAD/CAM/CAE market; in fact, in the earliest days of CAD, drafting was the only subapplication in the market. This subapplication has continued to be one of the largest (comprising more than 20 percent of the 1996 mechanical CAD/CAM/CAE software revenue). Despite its size, it is also one of the slowest-growing subapplications. In 1996, it reached $726 million; in 2001, it is expected to reach only $818 million. Figure 5-3 gives the market share of the top players in this subapplication.

Although drafting is not an area of rapid change or innovation, drafting's large market size confirms that, even after 25 years of mechanical CAD development, this subapplication is still essential to the design process. A new crop of players, like Visio and 3D/Eye (now part of Visionary Design Systems), could shake up this sleepy application in the near term, though they will not drive huge expansion here. Instead, they have the potential to take market share away from established players, particularly those with largely standalone drafting-only packages. Looking further out, however, 3-D and solid models are becoming more common in the design process, and these models are being sent directly to downstream manufacturing applications, leaving out the intermediate drafting and drawing step.

Figure 5-3
1996 Drafting and Documentation Market Share



Source: Dataquest (September 1997)

Computer-Aided Engineering

Analysis

Dataquest has been waiting for years for the analysis market to take off—so far, it still hasn't happened. Instead, revenue from this subapplication have hovered around the average mechanical CAD/CAM/CAE market growth rate, performing neither well above nor well below the average growth. Although MacNeal-Schwendler and SDRC still lead this market (see Figure 5-4), no single vendor is growing largely at the expense of another. This is one subapplication that features a host of small players and specialty analysis vendors.

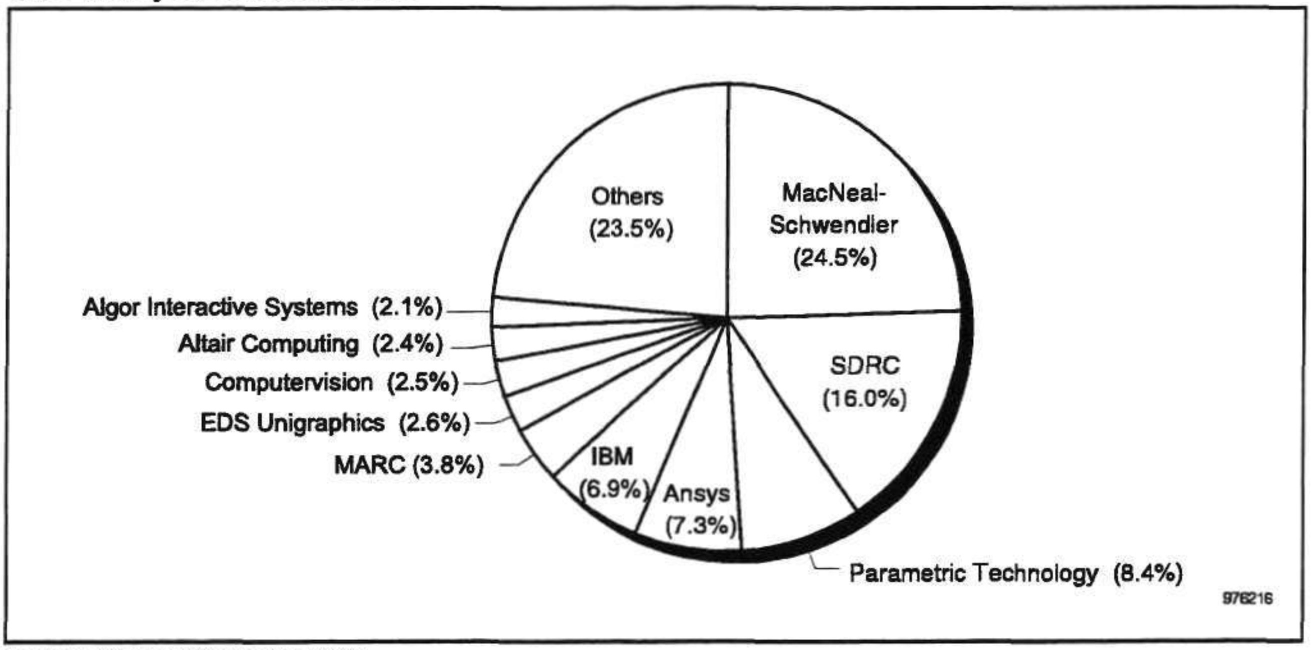
Analysis vendors have been responding to designers' needs by developing better user interfaces, error-checking codes, and automatic mesh generators and healers The next step is to pursue tighter integration of these analysis packages with solid modelers, something Ansys is already doing. Additionally there are still untapped areas within this market to pursue, such as nonlinear analysis, and nontraditional industries, such as in electronic packaging (though Dataquest can no longer consider this area "untapped"). The analysis market is badly in need of a visionary to spearhead this subapplication's next big step forward—to date, Ansys is the only company that has attempted to do just that. For the most part, many of the vendors in this market have been busy pursuing some of these untapped opportunities rather than putting forth a vision of what analysis should be in the next five years.

Linkage/Mechanism

Linkage/mechanism reached $46 million in 1996, up 26 percent from the previous year. While Mechanical Dynamics was one of the pioneers of this market, Parametric Technology's overall robust growth have given it the No. 1 spot (see Figure 5-5).

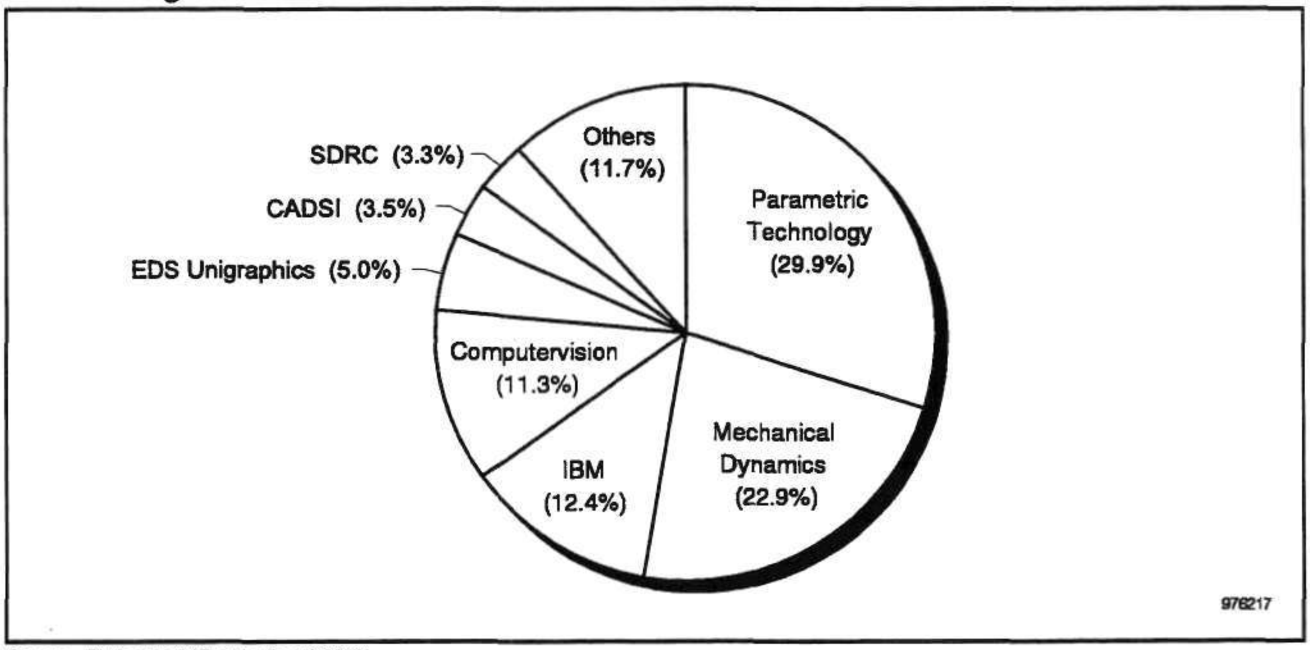
Dataquest sees this subapplication growing at about the same rate as the analysis market until 1999, at which point we predict that it will grow faster than analysis until the year 2001. We see real benefits in an engineer's ability to do quick simulations, what-if scenarios, and analysis of designs before the design and any associated problems move further downstream. The one limiting factors to good growth in this subapplication is the lack of tight integration with CAD software. Right now, the integration is primarily with analysis packages. Linkage/mechanism, similar to analysis, will not become "mainstream" until that integration with CAD occurs.

Figure 5-4
1996 Analysis Market Share



Source: Dataquest (September 1997)

Figure 5-5
1996 Linkage/Mechanism Market Share



Source: Dataquest (September 1997)

Computer-Aided Manufacturing

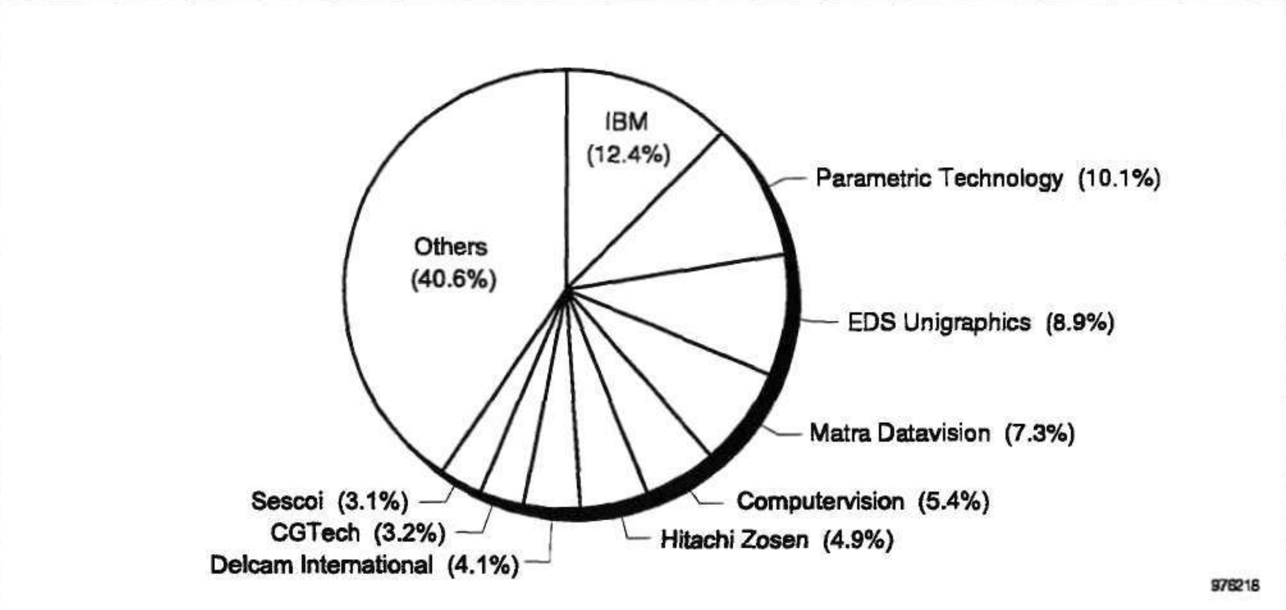
Manufacturing Process Simulation

Numerical Control

Figure 5-6 shows the 1996 software revenue market share of the leading vendors. Nearly all of the leading mechanical applications vendors play in this subapplication, including several Japanese companies (like Hitachi Zosen and Nihon Unisys) with their own products developed in-house as well as a number of NC-only vendors (like CGTech, Pathtrace, CNC Software, and Surfware). Despite the continuing fragmented nature of this subapplication, Dataquest does not expect a shakeout anytime soon.

It can be expected that increased sales in CAD software translate to increased sales in numerical control (NC) software. Dataquest has found that growth of NC software typically lag that of CAD software, but not by much. We expect NC sales to show a five-year CAGR of 11 percent, nearly the same as the forecast sales growth of design applications.

Figure 5-6
1996 Numerical Control Market Share



Source: Dataquest (September 1997)

The key factor for growth in this market will come from the ability of these tools to close the gap between design and manufacturing. More specifically, a key driver will be the ability to extract information from design data and bring that intelligent information to the manufacturing process, and vice versa. This is one area where new software, in the form of intelligent or smart objects as discussed earlier in Chapter 4, could really find a niche in the mechanical CAD/CAM/CAE market. (Such systems could include feature recognition knowledge for machining user-defined and standard features.) Dataquest is already seeing steps in more tightly integrated in-house knowledge, business practices design activities, and manufacturing with software packages that incorporate manufacturing rule-checking and design rule-checking, as well as generative machining principles (closely linked to part processing design, discussed in the next section).

Part Processing Design

Part processing design is concerned with the design of a series of manufacturing steps needed to manufacture a part, which can include tool path optimization, material speed and feed rates, machine tool definitions, and machining operations. Few vendors actually offer tools that can be considered in this subapplication; hence, Dataquest is not showing market share of the part processing design players. This subapplication is expected to grow faster than average over the next five years. Today's players and products include IBM's Prismatic Machining Assistant, Matra Datavision's Euclid Machinist, SDRC's I-DEAS Generative Machining, and Tecnomatix Technologies PART.

Dataquest believes this is one area poised to grow well over the next five years, as much of this work is still done manually or with a patchwork of different programs. The real impediment to growth will be capturing mind share in the fragmented collection of job shops and manufacturing outfits, particularly in the United States, that are accustomed to a lot of manual processes.

Other Manufacturing Applications

Coordinate measuring machines and offline robotics round out the CAM subapplications. Because of the small size of these subapplications, Dataquest has chosen not to show market share of the vendors. We do not expect to see any large growth opportunity in coordinate measuring machine software as it exists today.

On the other hand, offline robotics technology presents some real opportunities for vendors. Currently, Deneb Robotics, IBM, and Tecnomatix Technologies compete in this space. Revenue for this subapplication was at $36 million in 1996, but the real market opportunity today is slightly larger than that, as Dataquest currently does not track all players (such as SILMA). Although the initial investment required for offline robotics applications is high, the potential benefits in time and production cost savings are huge. And, the big CAD spenders—those in automotive, aerospace, and industrial machinery—are fueling growth in this subapplication.

Other Tools

Knowledge-Based Engineering

Generative technologies, expert systems, and knowledge- or rule-based engineering (RBE) have existed for quite some time, and vendors have come and gone in this market. Today, the way Dataquest has defined knowledge-based engineering, the market has two mainstay players—Concentra and Stone & Webster—and a handful of small players offering knowledge-based engines or larger players (like Trilogy) building applications on top of knowledge-based engineering technology. The only player that we track in this market today is Concentra. Thus, we will not show market share or a growth forecast for this subapplication.

RBE can be best envisioned as a technology to automate repetitive portions of the engineering design process. For instance, a company can use an RBE system to develop a model that captures the full spectrum of engineering rules, industry standards, manufacturing constraints, cost information, and scheduling constraints. As a result of capturing these processes and knowledge, new designs can be generated directly from functional specifications.

The major benefit to the end user is a reduction in product development time and, consequently, cost. RBE requires a significant amount of programming, typically in a vendor-proprietary language, and a fair amount of consulting work, to develop a usable application for the end user. Dataquest expects growth in the rule-based engineering subapplication to come when the task of building (which today means programming) applications becomes easier or more robust applications are developed based on the technology. Nevertheless, the line is blurring between rule-based engineering, which is really a technology and not a market, and related areas like salesforce automation. Concentra has already had some success in this area with its salesforce automation tool introduced in 1995. We expect our definition of this subapplication to evolve as the technology and its applications change over the next few years.

Application Development Environments

Application development environments are the programming tools used to aid in the generation of user-defined, custom programs. These tools include CAD customization tools like EDS Unigraphics' UG/GRIP and Parametric Technology's Pro/DEVELOP. It also includes some of the new architectures announced over the past few years, like Matra Datavision's CAS.CADE, Computervision's Pelorus (though sales here are negligible), and Bentley Systems' MicroStation/J (announced in June). Again, because of the small size of this market ($24 million in 1996), Dataquest has chosen not to show any market share information.

The newer application development environments are closely aligned with object-oriented software and architectures for CAD applications. As the concept of object-oriented technology and component software technology for CAD takes off, so will this new breed of application development environments.

Product Data Management

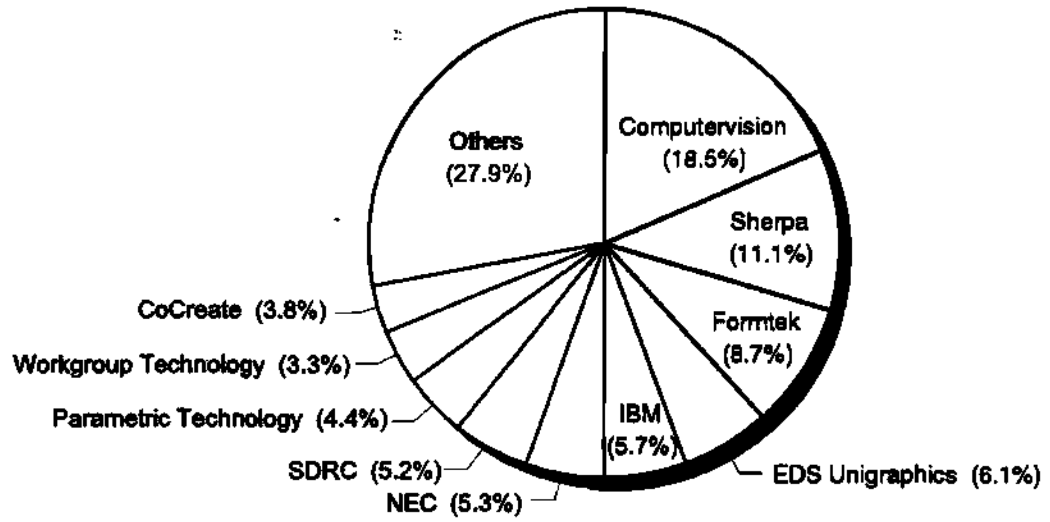
In following the PDM market, Dataquest tracks only those vendors that specifically offer PDM functionality—that is, a combination of vault, workflow, and product structure. We do not track systems integrators, consultants, companies offering conversion services, companies offering redlining/markup software, or hardware providers (for example, companies offering scanning devices). Nor do we track those companies that are primarily document management vendors (like Documentum and Cimage). As a result, our market size of $236 million in PDM software (excluding services) is smaller than what is typically quoted by other market research firms.

Of course, as some of these vendors become more PDM-focused and less document management-focused, we will begin to include those vendors in our PDM subapplication. Since last year, new players have entered the market, most notably Agile Software, ConsenSys, Right Angle, and Smart Solutions. When these companies show revenue streams greater than $2 million, we will add them to our database.

Figure 5-7 shows the 1996 market share of the leading PDM vendors. Computervision has led this market for the past three years, followed by Sherpa and Formtek. The market as a whole grew 17 percent in 1996. PDM purchases are still largely being made by discrete manufacturing companies, and a sizable chunk of the revenue generated in this market is still going to the mechanical CAD vendors.

Product data management has never exploded as many have hoped, and Dataquest continues to be conservative in our growth estimates. We expect PDM's software growth to remain slightly above the overall mechanical applications growth rate, especially from 1999 and beyond (prior to that time, it will show more growth compared to the average). Interestingly, one of the big factors inhibiting growth in this market is CAD to PDM integration, according to a PDM end-user survey we conducted in early 1997. Users rated CAD to PDM integration the most important in a series of PDM features. Further, the difference between their importance ratings and their satisfaction ratings for CAD to PDM integration was the greatest of all the features (meaning users were most dissatisfied with that area).

Figure 5-7
1996 Product Data Management Market Share



Source: Dataquest (September 1997)

PDM systems are also fighting the same organizational/cultural barriers they have fought since the beginning. We also asked our survey respondents to identify the single greatest impediment to expanded use of PDM in their companies, and 29 percent said the company's structure and culture was the biggest roadblock to expansion.

To date, few vendors have ventured out beyond the discrete manufacturing umbrella, although there is always talk of moving into the process industries like pharmaceuticals and insurance. Those companies eyeing new places for PDM to go have targeted two areas: electronic design and process plant design. This year, vendors announced either data management solutions that interface to electronic design automation software or wholly new software being developed to target the unique PDM requirements of the electronic designer. The other area of vendor attention, plant design, is an industry that could benefit from a standards-based approach to PDM. Plant design can be characterized as large, one-design/one-build projects with a need for standards and persistent data. Nevertheless, PDM cannot simply be brought into new markets or industries without understanding what end-user needs and industry-specific processes are. Until that changes, PDM will largely be a solution that resides in with discrete manufacturers.

Dataquest asks readers to refer to our PDM and collaborative engineering discussions in Chapter 4 for other growth/impediment opportunities for PDM.

Component Information Systems

Component information systems (CIS) is a unique subapplication that straddles mechanical, electrical, and architectural design/construction. Currently, Dataquest defines this subapplication as it applies to discrete manufacturing. Dataquest tracks only two mechanical-oriented CIS players—CADIS and Autodesk—but we will be adding CenTOR later this year. If we were to include CIS vendors geared toward electronic design, the market would expand to include Aspect Development and Information Handling Systems (IHS). If we were to expand the market to architectural/construction vendors, we would add The Sweets Group, other Autodesk products, and numerous smaller players with electronic catalogs. Because of the small size of this subapplication the way we track it today, we are not reporting market share information at this time.

The CIS players differentiate themselves from one another based on a number of factors, including the following:

- Electrical, mechanical, or materials component emphasis
- Revenue generated from legacy data conversion services, content or subscription services, and search/retrieval engines
- Search/retrieval capabilities
- Interfaces to PDM, CAD, or MRP systems
- Web/Internet/intranet capabilities

This subapplication will be a rising star over the next five years, with growth much greater than any other mechanical subapplication Dataquest currently tracks. Both low-end and high-end CIS applications are expected to do well. On one hand, there is still a lot of component and part selection done manually (with the engineer searching through paper-based catalogs). We expect much of this to be automated over the next five years, provided the price of these lower-end CIS systems stays low. On the other hand, high-end CIS deployments that involve corporate re-engineering and a significant amount of database development will also show healthy growth. Here, particularly in discrete manufacturing environments, the rising interest in corporate intranets as a delivery vehicle for information will further advance the market. The only limit to growth at the high end is the fact that these high-end CIS systems are often competing for dollars with PDM deployment and MRP systems.

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Market Statistics

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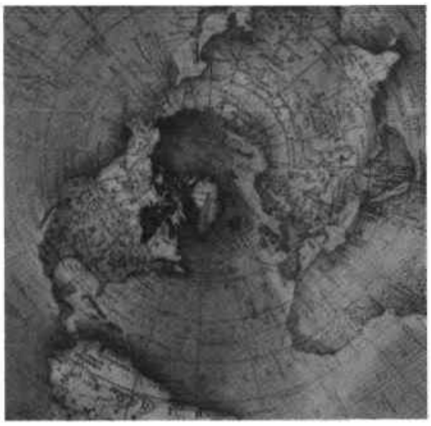

Dataquest

1997 European Mechanical CAD/CAM/CAE Forecast Update

Market Statistics

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Filing: Market Statistics

1997 European Mechanical CAD/CAM/CAE Forecast Update

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Chapter 1
1997 European Mechanical CAD/CAM/CAE Forecast Update

About This Document

This document contains Dataquest's detailed forecast information on the Mechanical CAD/CAM/CAE markets at the country level. This report is meant to supplement the worldwide Mechanical CAD/CAM/CAE forecast book by providing forecast detail for European countries.

Although Dataquest does not forecast currency exchange rates, we do forecast with the best 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 July 1997 exchange rate will remain stable in the future (see Tables 1 and 2).

Additional market statistics publications for Dataquest's Mechanical CAD/CAM/CAE service for 1997 are as follows:

- Dataquest's 1996 market share document (published as CMEC-WW-MS-9701) was sent to our clients in March.
- Dataquest's 1996 forecast document was released in May (published as CMEC-WW-MS-9702).
- Dataquest's 1996 market share data was verified, updated, and sent to our clients in August as a market share update report (published as CMEC-WW-MS-9703). Country-level data was also made available at this time.

This document is an updated forecast that has been expanded to include country-level information and in-depth analysis.

Worldwide Forecast Assumptions

The following sections describe the main forces driving the CAD/CAM/CAE, AEC and GIS, and EDA worldwide software forecasts.

All Applications

As CAD/CAM/CAE, AEC and GIS, and EDA becomes more of a replacement market, market leaders would appear to have the upper hand—the cost of switching is high. However, software that lets users get a better product to market faster and helps eliminate business risks will always be in demand, regardless of market share. Thus, there is always an opportunity for new vendors in technical markets.

The primary trend in design software function is toward operating at a higher level of abstraction. In all applications, Dataquest has seen an evolution of focus from electronic paper to component modeling and now to system modeling, with the eventual goal being to fully simulate, evaluate, redesign, and test the design inside the computer before manufacture. Meanwhile, increased computing power is allowing the nature of design to evolve to include constituencies in manufacturing, product support, and from users themselves. Thus the engineering process is being expanded to include input from a broader base.

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

	1995	1996	2001	Growth (%) 1995-1996	CAGR (%) 1996-2001
Europe (U.S.$M)					
Software Revenue	2,045.51	2,248.57	3,463.83	9.9	9.0
Hardware Revenue	2,816.50	2,861.37	3,682.31	1.6	5.2
Service Revenue	1,121.38	1,271.20	2,085.22	13.4	10.4
Total Factory Revenue	**5,983.39**	**6,381.13**	**9,228.66**	**6.6**	**7.7**
ECU/U.S.$ Exchange Rate*	**0.77**	**0.80**	**0.91**	**3.9**	**2.6**
Europe (ECU Million)					
Software Revenue	1,575.04	1,798.86	3,152.09	14.2	11.9
Hardware Revenue	2,168.70	2,289.09	3,350.91	5.6	7.9
Service Revenue	863.46	1,016.96	1,897.55	17.8	13.3
Total Factory Revenue	**4,607.21**	**5,104.91**	**8,398.08**	**10.8**	**10.5**
Japan (U.S.$M)					
Software Revenue	1,637.45	1,772.40	2,905.45	8.2	10.4
Hardware Revenue	2,772.38	2,793.91	3,723.95	0.8	5.9
Service Revenue	1,175.93	1,246.04	2,226.79	6.0	12.3
Total Factory Revenue	**5,585.76**	**5,812.35**	**8,856.19**	**4.1**	**8.8**
Japan/U.S.$ Exchange Rate*	**93.90**	**108.81**	**115.38**	**15.9**	**1.2**
Japan (Yen Million)					
Software Revenue	153,756.13	192,855.17	335,231.16	25.4	11.7
Hardware Revenue	260,326.42	304,005.04	429,669.19	16.8	7.2
Service Revenue	110,420.25	135,581.93	256,927.31	22.8	13.6
Total Factory Revenue	**524,502.80**	**632,442.14**	**1,021,827.66**	**20.6**	**10.1**
North America (U.S.$M)					
Software Revenue	2,138.08	2,531.06	5,162.27	18.4	15.3
Hardware Revenue	2,774.01	2,998.23	5,751.18	8.1	13.9
Service Revenue	1,230.68	1,483.94	3,056.50	20.6	15.5
Total Factory Revenue	**6,142.76**	**7,013.23**	**13,969.95**	**14.2**	**14.8**
Worldwide (U.S.$M)					
Software Revenue	6,306.82	7,159.11	13,265.95	13.5	13.1
Hardware Revenue	9,050.96	9,440.39	15,190.53	4.3	10.0
Service Revenue	3,801.12	4,352.20	8,412.34	14.5	14.1
Total Factory Revenue	**19,158.90**	**20,951.70**	**36,866.13**	**9.4**	**12.0**

*Assuming a stable currency, the 2001 exchange rate is the same as the July 1997 exchange rate.
Source: Dataquest (August 1997)

Table 2
Foreign Currency/U.S. Dollar

		Actual				Current			Year-to-Year Change (%)					
Country	Currency	1992	1993	1994	1995	1996	1997	1998	1992-1993	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998
Austria	Schilling	10.95	11.65	11.40	10.06	10.59	11.43	12.62	6.4	-2.1	-11.8	5.3	7.9	10.4
Belgium	Franc	32.02	34.67	33.66	29.42	30.96	33.50	37.04	8.3	-2.9	-12.6	5.2	8.2	10.6
Denmark	Krone	6.02	6.49	6.35	5.59	5.81	6.21	6.83	7.8	-2.2	-12.0	3.9	6.9	10.0
Finland	Markka	4.45	5.73	5.21	4.37	4.59	4.86	5.32	28.8	-9.1	-16.1	5.0	5.9	9.5
France	Franc	5.27	5.67	5.54	4.97	5.12	5.49	6.05	7.6	-2.3	-10.3	3.0	7.2	10.2
Germany	D-Mark	1.56	1.66	1.62	1.43	1.50	1.63	1.79	6.4	-2.4	-11.7	4.9	8.7	9.8
Italy	Lira	1,227.75	1,577.85	1,609.34	1,628.21	1,542.72	1,611.40	1,745.91	28.5	2.0	1.2	-5.3	4.5	8.3
Netherlands	Guilder	1.75	1.86	1.82	1.60	1.69	1.83	2.02	6.3	-2.2	-12.1	5.6	8.3	10.4
Norway	Krone	6.18	7.11	7.04	6.33	6.46	6.73	7.45	15.0	-1.0	-10.1	2.1	4.2	10.7
Spain	Peseta	101.90	127.87	133.48	124.40	126.68	137.12	151.33	25.5	4.4	-6.8	1.8	8.2	10.4
Sweden	Krona	5.81	7.82	7.70	7.14	6.71	7.20	7.81	34.6	-1.5	-7.3	-6.0	7.3	8.5
Switzerland	Franc	1.40	1.48	1.37	1.18	1.24	1.37	1.48	5.7	-7.4	-13.9	5.1	10.5	8.0
United Kingdom	Pound	0.57	0.67	0.65	0.63	0.64	0.62	0.60	17.5	-3.0	-3.1	1.6	-3.1	-3.2
Europe Average	ECU	0.77	0.86	0.84	0.77	0.80	0.84	0.91	11.4	-1.5	-8.7	3.9	5.0	8.3
China	Renminbi	5.51	5.76	8.54	8.32	8.34	8.33	8.32	4.5	48.3	-2.6	0.2	-0.1	-0.1
Hong Kong	Dollar	7.74	7.74	7.73	7.74	7.73	7.74	7.75	0	-0.1	0.1	-0.1	0.1	0.1
Japan	Yen	126.34	110.85	101.56	93.90	108.81	116.22	115.38	-12.3	-8.4	-7.5	15.9	6.8	-0.7
Korea	Won	782.41	799.42	805.80	770.57	805.16	860.04	893.09	2.2	0.8	-4.4	4.5	6.8	3.8
Singapore	Dollar	1.63	1.62	1.53	1.43	1.41	1.42	1.45	-0.9	-5.3	-6.5	-1.4	0.7	2.1
Taiwan	Dollar	24.93	26.15	26.45	26.48	27.47	27.62	28.03	4.9	1.1	0.1	3.7	0.5	1.5

Source: Dataquest (September 1997)

At the same time, the nature of design data itself is expanding from a focus on geometry to include multiple data types, making the challenge of system modeling even more complex. Also, the World Wide Web holds the potential to expand the nature of collaborative design by harnessing the joint power of anticipated increases in both computing power and communications bandwidth. Thus, there is little limit to the problems that design or GIS software can tackle. The primary challenge will continue to be to develop robust, leading-edge software ahead of competitors. During the forecast period, Dataquest anticipates significant, but not revolutionary, advances in the ability of the existing programmer pool to produce new software.

In addition to technology trends, it is also necessary to consider exchange rate fluctuations, especially as the dollar has continued to strengthen against most major currencies of the world, such as the deutsche mark and the yen, over the past year. Growth rates in countries where the dollar has strengthened against the local currency are likely to be adversely affected when considered in dollar-denominated terms.

Mechanical Forecast Assumptions

The following factors will promote expansion of the mechanical CAD/CAM/CAE market.

Renewed Investment in Mechanical CAD Technology

Over the past two years, Dataquest has seen renewed investment in mechanical CAD/CAM/CAE technology among the major aerospace and automotive companies, particularly in North America and Europe. Now that these companies have completed their investment cycles, we expect to see corresponding investment by their supplier bases as a key driver of the market going forward. Furthermore, many of these major companies that reinvested in base CAD technology will be looking to further invest in design automation. Add-on, niche applications should be pushing the market toward higher growth over our forecast period.

At the regional level, the outlook for Europe continues to be positive. The weakening of major European currencies against the dollar has helped the export of manufactured goods in countries like Germany, France, Italy, and Spain, and this is creating a more favorable climate for business investment and industrial production. The dollar has also strengthened against the Japanese yen over the past year, and indications are for an economic upturn in Japan, as well, in the near term.

New Software, New Platforms, New Users

Despite the fact that it is still a UNIX-based world out there, there is a very strong interest in NT-based mechanical design solutions. Vendors spent 1995 and 1996 making solutions available on the NT platform, and, finally, designers and engineers have a number of packages to choose from. The prospects of lower-cost software on lower-cost platforms have sparked renewed interest in CAD technology among designers who have not been purchasing CAD systems in recent years.

NT is beginning to encroach on the installed base for DOS/Windows and Windows 95 at the low end and UNIX at the high end. The move to replace UNIX will take longer than the replacement at the low end, especially for industries that need surfacing technologies. For example, today it is not possible to model the surface of a complete car using NT machines. These tasks still depend on high-end UNIX workstations. Also, a large proportion of 3-D CAD software packages are still on UNIX. But 3-D CAD software is becoming less expensive and easier to use and is moving to NT in a big way.

Untapped Users Eager for Technology

While CAD investment in Europe and North America will begin to slow down over our forecast period, the Asia/Pacific region is just beginning to take off, fueled by CAD investments from local and national governments (such as Indonesia's IPTN) and multinational companies. As manufacturing continues to move offshore into the Asia/Pacific region, Dataquest expects to see an increased level of CAD sophistication among the users. Similarly, mechanical CAD/CAM/CAE growth in Japan is expected to undergo major reinvestment over our forecast period. The UNIX platform dominates the mechanical sector in Japan today, and the Japanese mechanical market still places a heavy emphasis on 2-D design rather than solid modeling. We expect to see a movement of many Japanese CAD users from 2-D and proprietary systems to 3-D commercial systems over our forecast period.

The following trends will slow growth in the mechanical CAD/CAM/CAE market.

CAD Investments Are Cyclical

The major aerospace and automotive companies, particularly in Europe, have been significant drivers of the double-digit mechanical CAD/CAM/CAE growth Dataquest has seen over the last two years. However, these companies have now completed their investment cycles in CAD technology for the next four to six years. Investment in CAD by these companies will slow significantly until the next investment cycle begins, bringing down the overall market growth.

Meeting User Needs Beyond Design

In order for the mechanical CAD/CAM/CAE market to maintain the high growth that it has experienced in recent years, designers need applications that do more than just design. Design needs to become more tightly integrated with manufacturing and analysis, and beyond that, the whole process of bringing a product to market cannot continue to live in isolation within the engineering walls. Vendors are beginning to address this issue today, but it will take some time before users as well as vendors determine exactly what is needed and how it can work within the business processes of a company.

AEC Forecast Assumptions

The following factors will contribute to the long-term expansion of the AEC CAD industry.

CAD Is Becoming a Business Requirement

Large design firms are growing at the expense of smaller firms, and 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.

AEC Market Penetration

A significant pool of untapped users still exists, and the relatively low market penetration of AEC CAD systems should allow steady worldwide growth during the next five years, despite constant volatility in demand for the buildings and infrastructure to be designed.

New Features in AEC CAD Products Are Achievable

Better, lower-cost visualization tools will be in increasing demand as sales and communication tools. Data and database functions are growing in importance in AEC design, creating opportunities to sell users significant new functionality. Some vendors will create products that foster communications in the entire design, construction, and maintenance process—products that will increase the payoff in CAD investments.

The following trends will inhibit growth in AEC.

Design Is Only Part of the Problem

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 not well-addressed by AEC systems today. Design tools can only thrive in the AEC structure when they support more of the entire business problem. Commitment to and cooperation on the problem from multiple vendors will allow Dataquest to increase the forecast growth rate further.

GIS/Mapping Forecast Assumptions

The following sections identify those factors that will promote growth in the worldwide GIS market.

Impact of Windows NT

Intergraph's move to Windows NT at the expense of UNIX will quickly make PC-based operating systems the dominant revenue stream in North America. In the long term, the GIS UNIX market is highly subject to erosion by Windows NT because of the appealing prospects of better integration of GIS and Windows-based productivity tools.

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 or have only entry-level systems in terms of value delivered.

New Technologies

Faster, less expensive 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, and laser range finders are making it possible to create GISs that are significantly less expensive, 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. Finally, database companies themselves are gaining a better understanding of spatial analysis, a key factor in spreading use of GIS systems more broadly.

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

Long-term expansion of the GIS market will be constrained by the following factors.

High Cost of Entry Remains a Barrier

There will remain an uncertain, but certainly high, cost of creating a working GIS 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."

Price Pressures Inhibit Growth

Price pressure will hold down total revenue in the GIS market. Innovation is the only way to maintain prices in any software industry, and GIS vendors will struggle in their attempt to create compelling new applications and improved investment payoff for customers.

Electronic Design Automation Forecast Assumptions

It is fairly obvious that the EDA industry is not used to this level of prosperity. This market's 1996 estimates were almost 1 percent below the 1996 actual figures. This has been driven by an almost unprecedented seat count growth. Companies can no longer afford the level of tool sharing seen in the past. Mainstream companies have started re-engineering their engineering groups. Dataquest's lowest estimate of a week lost in the design cycle is $155,000, and that isn't counting lost market opportunity and so on. This makes the decision to by a new toolset fairly easy. The bad news is that sales in CAE are still primarily in the older tools. Only in the two CAD applications, IC CAD and PCB Design, is there the impact of a new generation of tools. Dataquest continues to expect a slowdown after the second design cycle is completed in early 1999. The only way to grow through that dip would be to get the new register transfer level (RTL) methodology tools on the market by the end of next year—unfortunately, that doesn't look very likely at this point.

Electronic CAE

CAE was the one area that came in below the preliminary numbers. By operation system, it was apparent that NT is growing faster than expected. This is mirrored by UNIX sales being almost 3 percent lower than reported in the preliminary numbers. North America came in as expected, but Japan reported lower numbers, which was the cause of the miss. Europe came in higher, showing a lot more life than most people expected.

IC Layout

IC Layout was where the industry showed its reluctance to believe its own reports. Although the preliminary numbers came in below Dataquest's expectations, the final numbers blew the Dataquest forecast out of the water. IC CAD grew more than 38 percent.

The general explanation from IC CAD suppliers was that they just didn't believe their preliminary numbers and therefore lowballed their response until they got the actual figures from their regions. Europe was the big surprise, coming in at almost 28 percent more than the preliminary numbers.

PCB Design

The PCB design market came in about 1 percent higher than the preliminary numbers, and here the UNIX-to NT-migration is really evident. Not unexpectedly, UNIX is all but finished as the platform of choice for PCB design. What wasn't taken into account was the decrease in the "swap-out" rate. Basically, the PCB world is upgrading hardware almost two years faster than in the past. This was another surprisingly strong market in Europe.

History and Forecast for All Applications and Operating Systems

Table 3 shows the history and forecast of all applications.

Table 3
Top Level Worldwide CAD/CAM/CAE/GIS Software History and Forecast, All Applications and Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Software Revenue ($M)									
Worldwide, All Operating Systems	**5,296**	**6,313**	**7,134**	**8,071**	**9,180**	**10,098**	**11,397**	**12,968**	**12.7**
UNIX	3,713	4,277	4,815	5,302	5,803	6,168	6,608	7,105	8.1
Windows NT	118	352	624	1,080	1,645	2,143	2,941	3,946	44.6
Personal Computer	1,270	1,502	1,531	1,567	1,645	1,730	1,812	1,893	4.3
Host/Proprietary	194	182	165	122	87	56	36	24	-31.8
All Operating Systems									
North America	1,855	2,140	2,498	2,889	3,321	3,667	4,216	4,854	14.2
Europe	1,691	2,080	2,261	2,455	2,713	2,964	3,247	3,593	9.7
Japan	1,398	1,627	1,827	2,061	2,334	2,522	2,812	3,168	11.6
Asia/Pacific	265	356	432	537	667	786	946	1,155	21.7
Rest of World	87	110	117	130	145	158	177	198	11.2
Year-to-Year Software Revenue Growth Rate (%)									
Worldwide, All Operating Systems	-	**19.2**	**13.0**	**13.1**	**13.7**	**10.0**	**12.9**	**13.8**	-
UNIX	-	15.2	12.6	10.1	9.4	6.3	7.1	7.5	-
Windows NT	-	199.0	77.1	73.1	52.3	30.3	37.2	34.2	-
Personal Computer	-	18.2	1.9	2.3	5.0	5.2	4.7	4.5	-
Host/Proprietary	-	-6.3	-9.7	-25.7	-29.0	-34.9	-35.8	-33.0	-
All Operating Systems									
North America	-	15.4	16.7	15.7	15.0	10.4	15.0	15.1	-
Europe	-	23.0	8.7	8.6	10.5	9.3	9.5	10.7	-
Japan	-	16.4	12.3	12.8	13.3	8.1	11.5	12.7	-
Asia/Pacific	-	34.3	21.5	24.3	24.1	18.0	20.3	22.1	-
Rest of World	-	26.8	5.9	11.3	12.0	9.2	11.5	11.9	-

Source: Dataquest (September 1997)

Forecast Methodology

Fundamental to the way Dataquest conducts its research is the underlying philosophy that the best data and analyses come from a well-balanced program. This program includes the following: balance between primary and secondary collection techniques; balance between supply-side and demand-side analysis; balance between focused, industry-specific research and coordinated, "big-picture" analysis aided by integration of data from the more than 25 separate high-technology industries Dataquest covers; and balance between the perspectives of experienced industry professionals and rigorous, disciplined techniques of seasoned market researchers.

Dataquest also analyzes trends in the macroenvironment, which can have major influences on both supply-side and demand-side forecasting. In addition to demographics, analysts look at gross national product (GNP) growth, interest rate fluctuation, business expectations, and capital spending plans. In the geopolitical arena, the group looks at trade issues, political stability or lack thereof, tariffs, nontariff barriers, and such factors as the effect on Europe of the events of 1996.

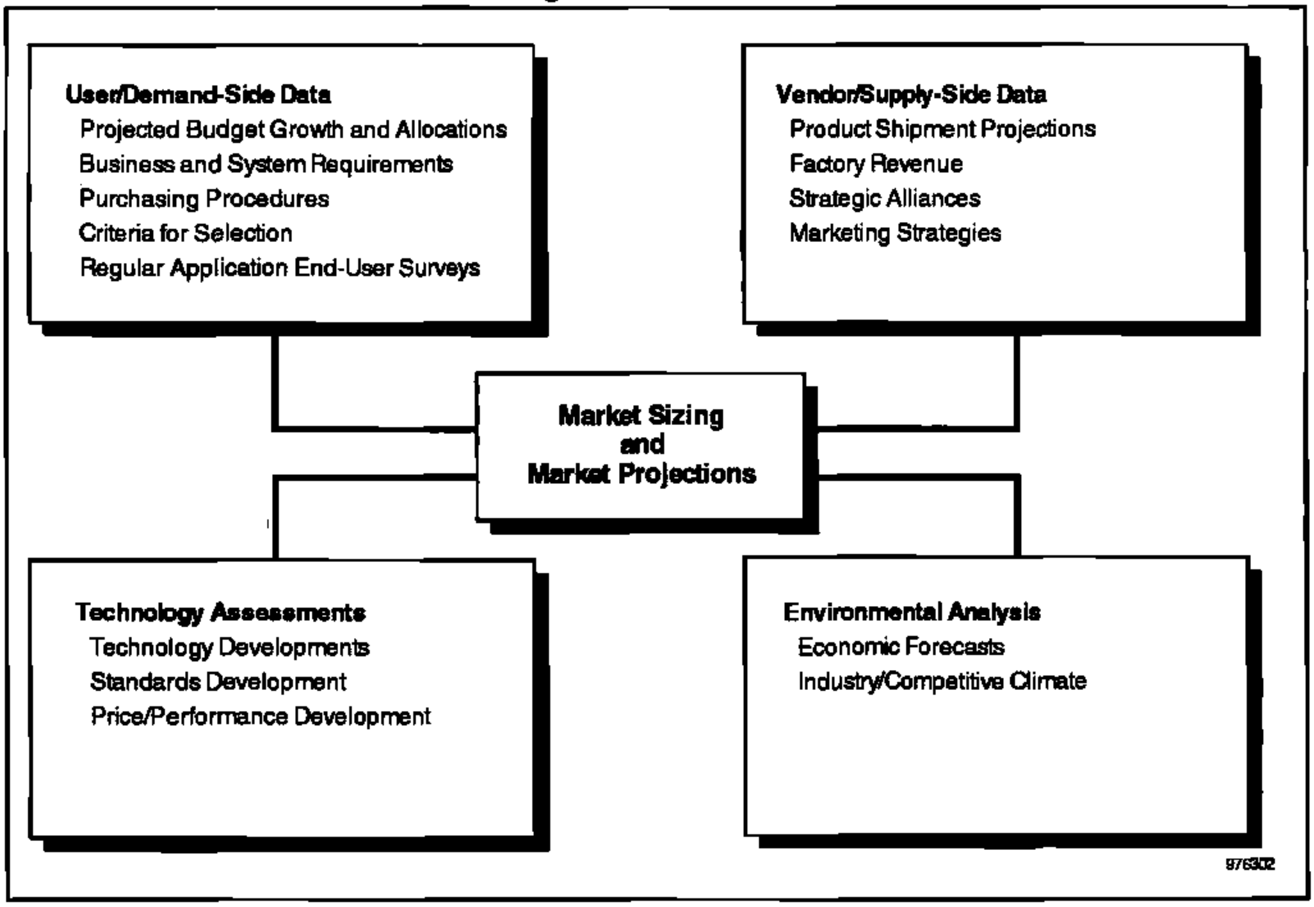
Figure 1 shows the CAD/CAM/CAE, AEC and GIS, and EDA forecasting model. The overall forecasting process uses a combination of techniques such as time series and technological modeling. Market estimates and forecasts are derived using the following research techniques:

- Segment forecasting—Individual forecasts are derived for each application segment tracked by the CAD/CAM/CAE, AEC and GIS, and EDA groups. Specifically, each application, segmented by region and platform, is forecast and rolled up. In this way, each application segment incorporates its own set of unique assumptions.
- Demand-based analysis—Market growth is tracked and forecast in terms of the present and anticipated demand of current and future users. This requires the development of a total available market model and a satisfied available market figure to assess the levels of penetration accurately. Dataquest analysts also factor in the acceptance or ability for users to consume new technology.
- Capacity-based analysis—This method involves identifying future shipment volume constraints. These constraints, or "ceilings," can be the result of component availability, manufacturing capacity, or distribution capacity. In any case, capacity limitations are capable of keeping shipments below the demand level.

Changes to the Forecast Database

Within this forecasting model, Dataquest has made numerous assumption changes that better reflect the reality in the changing the mechanical CAD/CAM/CAE, AEC and GIS, and EDA worlds. These changes include updating the hardware retirement model and altering the average selling prices (ASPs) for software, service, and hardware.

Figure 1
CAD/CAM/CAE and GIS Forecasting Model



Source: Dataquest (September 1997)

Segmentation Definitions

Operating Systems

The following defines the operating systems:

- UNIX—Includes all UNIX variants and older workstation operating systems.
- Host—Includes minicomputer and mainframe operating systems in which external workstationsõ functions are dependent on a host computer.
- Windows NT—The Microsoft operating system.
- PC—Includes DOS, Windows, Windows 95, OS/2, and Apple operating systems.

Line Items

Line item definitions are as follows:

- Average selling price (ASP) is defined as the average price of a product, inclusive of any discounts.
- CPU revenue is the portion of revenue derived from a system sale that is related to the value of the CPU.
- CPU shipment is defined as the number of CPUs delivered.
- CPU installed base is defined as the total number of CPUs in active, day-to-day use.
- Unit shipment is defined as the number of products delivered (that is, seats).
- Seats are defined as the number of possible simultaneous users.
- Installed seats are defined as the total number of seats in active, day-to-day use.
- Hardware revenue is defined as the sum of the revenue from the hardware system components: CPU revenue, terminal revenue, and peripherals revenue.
- Peripherals revenue is defined as the value of all the peripherals from turnkey sale. (Peripherals in this category typically are input and output devices.)
- Terminal revenue is defined as revenue derived from the sale of terminals used to graphically create, analyze, or manipulate designs. The term is applicable only to the host systems.
- Software revenue is revenue derived from the sale of application software.
- Service revenue is defined as revenue derived from the service and support of CAD/CAM/CAE, AEC and GIS, or EDA systems. Service is followed as software service and hardware service.
- Total factory revenue is defined as the amount of money received for goods measured in U.S. dollars and is the sum of hardware, software, and service revenue.

Regions

Europe

- Western Europe—Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, and the United Kingdom
- Rest of Western Europe—Andorra, Cyprus, Faeroe Islands, Gibraltar, Greenland, Guernsey, Iceland, Jersey, Liechtenstein, Malta, Republic of Monaco, San Marino, and Vatican City
- Central and Eastern Europe—Albania, Armenia, Azerbaijan, Belarus, Bosnia, Bulgaria, Croatia, Czech Republic, Estonia, Federal Republic of Yugoslavia (including Serbia and Montenegro), Georgia, Hungary, Kazakhstan, Krygyzstan, Latvia, Lithuania, Macedonia, Moldova, Poland, Romania, Russia (as far as the Urals), Slovakia, Slovenia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan

Chapter 2

Market Statistics Tables

Table A-1
Top Level Mechanical Forecast, Worldwide, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Software Revenue ($M)									
Worldwide, All Operating Systems	**2,436**	**2,963**	**3,345**	**3,689**	**4,108**	**4,502**	**4,893**	**5,332**	**9.8**
Worldwide									
UNIX	1,804	2,190	2,412	2,566	2,745	2,903	3,037	3,168	5.6
Windows NT	42	115	295	507	744	980	1,229	1,526	38.9
Personal Computer	460	540	538	546	567	585	604	621	2.9
Host/Proprietary	131	117	100	69	52	34	23	16	-30.4
All Operating Systems									
North America	730	859	1,009	1,139	1,265	1,400	1,540	1,689	10.9
Europe	825	1,024	1,149	1,197	1,317	1,419	1,534	1,683	7.9
Japan	753	902	970	1,081	1,194	1,283	1,359	1,440	8.2
Asia/Pacific	99	141	181	233	291	356	413	470	21.1
Rest of World	28	36	36	38	41	44	47	49	6.5
Year-to-Year Software Revenue Growth Rate (%)									
Worldwide, All Operating Systems	**-**	**21.6**	**12.9**	**10.3**	**11.4**	**9.6**	**8.7**	**9.0**	**-**
Worldwide									
UNIX	-	21.4	10.1	6.4	7.0	5.8	4.6	4.3	-
Windows NT	-	176.2	155.3	72.1	46.6	31.8	25.4	24.1	-
Personal Computer	-	17.4	-0.4	1.5	3.9	3.1	3.2	2.9	-
Host/Proprietary	-	-10.4	-14.6	-31.0	-24.6	-34.6	-31.8	-29.7	-
All Operating Systems									
North America	-	17.7	17.4	12.9	11.1	10.6	10.0	9.7	-
Europe	-	24.1	12.2	4.2	10.0	7.8	8.1	9.7	-
Japan	-	19.7	7.6	11.4	10.4	7.5	5.9	6.0	-
Asia/Pacific	-	42.2	28.0	28.9	25.0	22.3	16.0	13.8	-
Rest of World	-	29.3	-0.5	6.8	6.8	7.2	6.6	5.2	-

Source: Dataquest (August 1997)

Table B-1
Detail Mechanical Forecast, Europe, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	93,421	108,211	108,499	106,400	111,700	115,600	121,000	127,600	3
Seats	97,482	111,876	112,092	109,100	113,800	117,200	122,100	128,400	3
Year-to-Year Increase (%)	3	15	0	-3	4	3	4	5	-
Installed Base									
CPUs	286,677	312,132	332,527	342,500	354,600	371,000	391,100	414,800	5
Seats	310,428	332,599	350,580	358,200	367,900	381,900	399,800	421,500	4
Year-to-Year Increase (%)	5	7	5	2	3	4	5	5	-
Revenue Data ($M)									
CPU Revenue	1,163	1,313	1,377	1,411	1,451	1,474	1,539	1,619	3
Terminal Revenue	84	58	49	62	48	29	18	11	-26
Peripheral Revenue	61	91	105	102	98	92	88	85	-4
Hardware Revenue	**1,308**	**1,462**	**1,530**	**1,575**	**1,597**	**1,595**	**1,644**	**1,715**	**2**
Year-to-Year Increase (%)	6	12	5	3	1	0	3	4	-
Software Revenue	**825**	**1,024**	**1,149**	**1,197**	**1,317**	**1,419**	**1,534**	**1,683**	**8**
Year-to-Year Increase (%)	6	24	12	4	10	8	8	10	-
Software Service	333	315	389	481	525	562	603	653	11
Hardware Service	244	281	312	356	371	378	397	420	6
Service Revenue	**578**	**596**	**701**	**837**	**896**	**939**	**1,000**	**1,073**	**9**
Year-to-Year Increase (%)	12	3	18	19	7	5	6	7	-
Total Factory Revenue	**2,711**	**3,083**	**3,380**	**3,609**	**3,810**	**3,954**	**4,178**	**4,471**	**6**
Year-to-Year Increase (%)	7	14	10	7	6	4	6	7	-

Source: Dataquest (August 1997)

Table B-2
Detail Mechanical Forecast, Benelux, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	4,081	4,404	4,696	4,400	4,600	4,700	4,800	5,000	1
Seats	4,192	4,538	4,806	4,500	4,600	4,700	4,800	5,000	1
Year-to-Year Increase (%)	6	8	6	-6	3	1	3	4	-
Installed Base									
CPUs	12,439	13,138	13,948	14,400	14,900	15,500	16,200	17,000	4
Seats	13,600	14,030	14,649	14,900	15,400	15,900	16,500	17,200	3
Year-to-Year Increase (%)	2	3	4	2	3	3	4	4	-
Revenue Data ($M)									
CPU Revenue	55	62	69	69	69	68	70	72	1
Terminal Revenue	4	3	2	3	2	1	1	0	-29
Peripheral Revenue	2	3	3	3	3	3	2	2	-7
Hardware Revenue	**60**	**68**	**74**	**75**	**74**	**72**	**73**	**75**	**0**
Year-to-Year Increase (%)	15	13	10	0	-1	-3	2	2	-
Software Revenue	**35**	**46**	**56**	**57**	**62**	**67**	**72**	**78**	**7**
Year-to-Year Increase (%)	17	31	21	2	9	7	7	9	-
Software Service	11	13	16	20	21	23	25	27	11
Hardware Service	12	14	16	18	18	18	18	19	2
Service Revenue	**23**	**27**	**32**	**38**	**40**	**41**	**43**	**45**	**7**
Year-to-Year Increase (%)	25	16	21	18	5	3	5	6	-
Total Factory Revenue	**118**	**141**	**163**	**170**	**176**	**179**	**188**	**198**	**4**
Year-to-Year Increase (%)	17	19	16	4	4	2	5	6	-

Source: Dataquest (August 1997)

Table B-3
Detail Mechanical Forecast, France, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	15,007	17,300	16,542	15,600	17,500	18,900	20,200	21,300	5
Seats	15,744	18,071	17,237	16,100	18,000	19,300	20,400	21,500	4
Year-to-Year Increase (%)	10	15	-5	-7	12	7	6	5	-
Installed Base									
CPUs	42,185	48,023	51,628	52,800	55,400	59,500	64,600	70,000	6
Seats	46,234	51,644	54,913	55,700	57,900	61,700	66,300	71,400	5
Year-to-Year Increase (%)	10	12	6	1	4	6	8	8	-
Revenue Data ($M)									
CPU Revenue	215	247	243	243	268	283	300	316	5
Terminal Revenue	15	11	9	11	9	6	4	2	-25
Peripheral Revenue	8	17	16	15	16	15	14	13	-4
Hardware Revenue	**238**	**276**	**267**	**270**	**293**	**304**	**318**	**332**	**4**
Year-to-Year Increase (%)	14	16	-3	1	9	4	5	4	-
Software Revenue	**153**	**193**	**199**	**200**	**236**	**264**	**290**	**318**	**10**
Year-to-Year Increase (%)	14	26	3	1	18	12	10	9	-
Software Service	65	60	69	83	98	108	118	128	13
Hardware Service	46	54	57	63	71	74	79	83	8
Service Revenue	**111**	**114**	**126**	**147**	**168**	**183**	**197**	**211**	**11**
Year-to-Year Increase (%)	23	3	10	17	15	9	8	7	-
Total Factory Revenue	**502**	**583**	**592**	**617**	**697**	**750**	**805**	**860**	**8**
Year-to-Year Increase (%)	16	16	2	4	13	8	7	7	-

Source: Dataquest (August 1997)

Table B-4
Detail Mechanical Forecast, Germany, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	33,025	40,134	38,796	36,600	38,100	38,900	40,300	42,600	2
Seats	34,835	41,966	40,543	37,900	39,200	39,700	40,800	42,900	1
Year-to-Year Increase (%)	3	20	-3	-7	4	1	3	5	-
Installed Base									
CPUs	101,710	112,374	119,016	121,100	123,600	127,500	132,800	139,900	3
Seats	110,519	120,574	126,745	128,100	129,800	132,700	136,900	143,100	2
Year-to-Year Increase (%)	5	9	5	1	1	2	3	5	-
Revenue Data ($M)									
CPU Revenue	420	494	491	490	496	492	505	530	2
Terminal Revenue	35	28	23	29	22	13	8	5	-27
Peripheral Revenue	27	43	45	44	42	39	36	35	-5
Hardware Revenue	**482**	**565**	**559**	**563**	**560**	**544**	**549**	**569**	**0**
Year-to-Year Increase (%)	4	17	-1	1	-1	-3	1	4	-
Software Revenue	**297**	**382**	**406**	**409**	**444**	**470**	**503**	**553**	**6**
Year-to-Year Increase (%)	1	29	6	1	9	6	7	10	-
Software Service	116	127	141	167	179	186	195	210	8
Hardware Service	88	106	112	127	131	131	136	144	5
Service Revenue	**204**	**233**	**253**	**294**	**310**	**317**	**331**	**354**	**7**
Year-to-Year Increase (%)	6	14	8	16	5	2	5	7	-
Total Factory Revenue	**983**	**1,180**	**1,218**	**1,266**	**1,314**	**1,331**	**1,383**	**1,476**	**4**
Year-to-Year Increase (%)	4	20	3	4	4	1	4	7	-

Source: Dataquest (August 1997)

Table B-5
Detail Mechanical Forecast, Italy, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	8,221	10,404	10,943	11,700	12,200	12,600	13,400	14,400	6
Seats	8,467	10,438	11,076	11,800	12,000	12,700	13,500	14,400	5
Year-to-Year Increase (%)	-8	23	6	6	2	6	6	7	-
Installed Base									
CPUs	28,683	31,765	35,722	37,200	38,400	39,700	41,500	44,100	4
Seats	31,065	33,468	36,950	38,100	38,800	39,900	41,700	44,200	4
Year-to-Year Increase (%)	0	8	10	3	2	3	4	6	-
Revenue Data ($M)									
CPU Revenue	99	104	122	120	122	129	137	148	4
Terminal Revenue	5	1	1	1	1	1	0	0	-31
Peripheral Revenue	7	7	14	11	11	11	11	12	-4
Hardware Revenue	**111**	**112**	**137**	**133**	**134**	**140**	**149**	**160**	**3**
Year-to-Year Increase (%)	-6	0	23	-3	1	5	6	7	-
Software Revenue	**69**	**80**	**101**	**108**	**118**	**126**	**136**	**148**	**8**
Year-to-Year Increase (%)	-8	15	27	7	9	6	8	9	-
Software Service	31	25	37	43	46	50	55	61	11
Hardware Service	20	20	25	26	27	29	32	35	7
Service Revenue	**51**	**45**	**62**	**69**	**73**	**79**	**87**	**96**	**9**
Year-to-Year Increase (%)	0	-12	37	12	6	9	9	10	-
Total Factory Revenue	**232**	**237**	**300**	**310**	**325**	**345**	**371**	**403**	**6**
Year-to-Year Increase (%)	-5	2	27	3	5	6	8	9	-

Source: Dataquest (August 1997)

Table B-6
Detail Mechanical Forecast, Scandanavia, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	5,611	7,317	7,476	7,100	7,300	7,500	7,900	8,300	2
Seats	5,878	7,549	7,725	7,300	7,400	7,600	8,000	8,400	2
Year-to-Year Increase (%)	11	28	2	-6	3	3	5	5	-
Installed Base									
CPUs	16,688	18,937	21,026	22,200	23,100	24,100	25,300	26,800	5
Seats	18,478	20,406	22,287	23,200	24,000	24,800	25,900	27,200	4
Year-to-Year Increase (%)	2	10	9	4	3	4	4	5	-
Revenue Data ($M)									
CPU Revenue	70	79	90	91	91	91	95	100	2
Terminal Revenue	5	4	4	5	3	2	1	1	-27
Peripheral Revenue	4	5	6	6	5	5	5	4	-6
Hardware Revenue	**80**	**88**	**100**	**101**	**100**	**98**	**101**	**105**	**1**
Year-to-Year Increase (%)	21	11	13	1	-1	-2	3	4	-
Software Revenue	**48**	**62**	**74**	**75**	**82**	**88**	**96**	**106**	**7**
Year-to-Year Increase (%)	27	30	21	2	8	8	9	10	-
Software Service	21	17	26	32	34	37	40	44	11
Hardware Service	15	17	21	23	24	24	25	26	5
Service Revenue	**36**	**34**	**46**	**55**	**58**	**61**	**65**	**70**	**9**
Year-to-Year Increase (%)	44	-5	37	19	5	5	7	8	-
Total Factory Revenue	**163**	**183**	**220**	**232**	**239**	**247**	**262**	**280**	**5**
Year-to-Year Increase (%)	28	13	20	5	3	3	6	7	-

Source: Dataquest (August 1997)

Table B-7
Detail Mechanical Forecast, Spain, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	3,062	3,149	4,086	4,400	4,800	5,200	5,400	5,600	7
Seats	3,182	3,274	4,212	4,500	4,900	5,200	5,400	5,700	6
Year-to-Year Increase (%)	4	3	29	7	9	6	4	4	-
Installed Base									
CPUs	10,199	9,959	10,795	12,000	13,600	15,100	16,500	17,700	10
Seats	10,852	10,561	11,366	12,600	14,100	15,500	16,800	17,900	10
Year-to-Year Increase (%)	-2	-3	8	11	12	11	8	7	-
Revenue Data ($M)									
CPU Revenue	32	36	42	49	53	56	58	61	8
Terminal Revenue	2	2	1	2	2	1	1	0	-23
Peripheral Revenue	2	3	6	6	6	6	6	6	1
Hardware Revenue	**36**	**40**	**49**	**57**	**61**	**63**	**65**	**67**	**6**
Year-to-Year Increase (%)	24	12	22	15	7	4	3	3	-
Software Revenue	**25**	**29**	**37**	**43**	**49**	**55**	**59**	**64**	**12**
Year-to-Year Increase (%)	26	18	28	15	15	11	8	9	-
Software Service	10	10	14	19	22	24	26	28	14
Hardware Service	7	8	9	12	13	14	14	15	11
Service Revenue	**16**	**18**	**24**	**31**	**35**	**38**	**40**	**43**	**13**
Year-to-Year Increase (%)	23	9	32	32	12	9	6	6	-
Total Factory Revenue	**77**	**87**	**110**	**131**	**145**	**156**	**164**	**174**	**10**
Year-to-Year Increase (%)	24	13	26	19	11	8	6	6	-

Source: Dataquest (August 1997)

Table B-8
Detail Mechanical Forecast, United Kingdom, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	15,596	16,036	17,974	19,100	19,500	20,000	21,000	22,300	4
Seats	16,061	16,525	18,451	19,500	19,800	20,200	21,100	22,400	4
Year-to-Year Increase (%)	6	3	12	6	2	2	5	6	-
Installed Base									
CPUs	46,408	48,876	52,421	56,300	59,900	63,700	67,700	72,100	7
Seats	49,449	51,457	54,705	58,300	61,700	65,200	68,900	73,000	6
Year-to-Year Increase (%)	5	4	6	7	6	6	6	6	-
Revenue Data ($M)									
CPU Revenue	187	192	224	254	255	257	271	288	5
Terminal Revenue	11	9	8	11	8	5	3	2	-26
Peripheral Revenue	7	9	10	11	11	10	9	9	-2
Hardware Revenue	**206**	**210**	**242**	**276**	**273**	**272**	**283**	**299**	**4**
Year-to-Year Increase (%)	9	2	15	14	-1	-1	4	6	-
Software Revenue	**136**	**151**	**190**	**217**	**232**	**249**	**271**	**301**	**10**
Year-to-Year Increase (%)	12	11	26	14	7	7	9	11	-
Software Service	59	41	65	89	96	103	112	123	14
Hardware Service	41	43	51	64	66	66	70	75	8
Service Revenue	**100**	**84**	**116**	**154**	**161**	**169**	**182**	**198**	**11**
Year-to-Year Increase (%)	15	-16	38	33	5	5	8	9	-
Total Factory Revenue	**442**	**445**	**548**	**647**	**667**	**690**	**736**	**799**	**8**
Year-to-Year Increase (%)	11	1	23	18	3	3	7	8	-

Source: Dataquest (August 1997)

Table B-9
Detail Mechanical Forecast, Austria/Switzerland, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	2,548	4,732	3,601	3,500	3,700	3,700	3,800	3,900	1
Seats	2,568	4,755	3,629	3,500	3,700	3,700	3,800	3,900	1
Year-to-Year Increase (%)	137	85	-24	-3	4	2	2	1	-
Installed Base									
CPUs	3,963	8,062	10,158	11,100	11,500	11,900	12,300	12,700	5
Seats	4,156	8,223	10,297	11,200	11,600	12,000	12,400	12,800	4
Year-to-Year Increase (%)	121	98	25	9	4	3	3	3	-
Revenue Data ($M)									
CPU Revenue	24	40	42	43	45	45	47	48	3
Terminal Revenue	0	0	0	0	0	0	0	0	-30
Peripheral Revenue	1	2	2	2	2	2	1	1	-7
Hardware Revenue	**26**	**42**	**44**	**46**	**47**	**47**	**48**	**49**	**2**
Year-to-Year Increase (%)	31	63	5	3	3	1	3	1	-
Software Revenue	**17**	**33**	**38**	**40**	**45**	**49**	**53**	**57**	**8**
Year-to-Year Increase (%)	40	96	15	7	12	9	7	7	-
Software Service	7	9	11	14	14	15	16	16	8
Hardware Service	5	7	9	10	10	9	10	9	2
Service Revenue	**12**	**16**	**20**	**23**	**24**	**24**	**25**	**26**	**5**
Year-to-Year Increase (%)	21	34	27	17	4	2	3	1	-
Total Factory Revenue	**54**	**90**	**102**	**109**	**116**	**121**	**127**	**132**	**5**
Year-to-Year Increase (%)	31	67	12	7	6	4	5	4	-

Source: Dataquest (August 1997)

Table B-10
Detail Mechanical Forecast, Russia, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	117	509	418	400	500	500	500	600	6
Seats	117	509	418	400	500	500	500	600	6
Year-to-Year Increase (%)	388	336	-18	6	8	6	5	5	-
Installed Base									
CPUs	139	637	982	1,200	1,400	1,500	1,700	1,800	13
Seats	139	637	982	1,200	1,400	1,500	1,700	1,800	13
Year-to-Year Increase (%)	482	357	54	25	14	10	8	7	-
Revenue Data ($M)									
CPU Revenue	2	4	5	5	6	6	7	7	9
Terminal Revenue	-	-	-	-	-	-	-	-	NA
Peripheral Revenue	0	0	0	0	0	0	0	0	3
Hardware Revenue	**2**	**5**	**5**	**5**	**6**	**6**	**7**	**7**	**9**
Year-to-Year Increase (%)	262	113	4	14	9	7	7	7	-
Software Revenue	**1**	**4**	**4**	**5**	**6**	**6**	**7**	**8**	**13**
Year-to-Year Increase (%)	1,321	146	18	17	15	12	10	11	-
Software Service	1	2	1	2	2	3	3	3	17
Hardware Service	0	1	1	1	1	1	1	2	10
Service Revenue	**1**	**3**	**2**	**3**	**4**	**4**	**4**	**5**	**14**
Year-to-Year Increase (%)	126	94	-6	34	12	10	9	9	-
Total Factory Revenue	**5**	**11**	**11**	**14**	**15**	**17**	**18**	**20**	**12**
Year-to-Year Increase (%)	284	117	6	19	12	10	9	9	-

NA = Not applicable
Source: Dataquest (August 1997)

Table B-11
Detail Mechanical Forecast, Central Europe*, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	1,162	1,981	2,091	2,200	2,300	2,400	2,500	2,600	4
Seats	1,148	2,008	2,122	2,200	2,300	2,400	2,500	2,600	4
Year-to-Year Increase (%)	11	75	6	3	5	4	5	4	-
Installed Base									
CPUs	2,708	4,161	5,396	6,300	7,000	7,500	8,000	8,600	10
Seats	2,797	4,245	5,489	6,400	7,100	7,600	8,100	8,600	9
Year-to-Year Increase (%)	43	52	29	16	11	8	7	6	-
Revenue Data ($M)									
CPU Revenue	18	27	27	30	31	32	34	36	6
Terminal Revenue	-	0	0	0	0	0	0	0	-25
Peripheral Revenue	1	1	2	2	2	2	2	2	-1
Hardware Revenue	**18**	**28**	**29**	**32**	**33**	**34**	**36**	**37**	**5**
Year-to-Year Increase (%)	-5	52	3	11	3	3	5	5	-
Software Revenue	**13**	**21**	**23**	**25**	**28**	**31**	**33**	**36**	**10**
Year-to-Year Increase (%)	-10	66	10	11	10	9	8	9	-
Software Service	4	5	6	7	8	8	9	9	11
Hardware Service	4	6	6	7	8	8	8	9	8
Service Revenue	**8**	**11**	**12**	**15**	**16**	**16**	**17**	**18**	**9**
Year-to-Year Increase (%)	-17	39	5	26	6	5	6	6	-
Total Factory Revenue	**39**	**60**	**64**	**72**	**77**	**81**	**86**	**92**	**8**
Year-to-Year Increase (%)	-9	54	6	14	6	5	6	6	-

*Not including Russia
Source: Dataquest (August 1997)

Table B-12
Detail Mechanical Forecast, Rest of Europe, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	4,991	2,245	1,875	1,400	1,300	1,200	1,100	1,100	-10
Seats	5,288	2,242	1,872	1,400	1,300	1,200	1,100	1,100	-10
Year-to-Year Increase (%)	-32	-58	-17	-24	-11	-8	-3	-2	-
Installed Base									
CPUs	21,553	16,202	11,436	7,900	5,900	4,800	4,400	4,200	-18
Seats	23,138	17,353	12,198	8,400	6,100	5,000	4,500	4,200	-19
Year-to-Year Increase (%)	-10	-25	-30	-31	-27	-18	-10	-6	-
Revenue Data ($M)									
CPU Revenue	40	29	22	17	16	14	14	14	-9
Terminal Revenue	6	0	-	-	-	-	-	-	NA
Peripheral Revenue	2	0	0	0	0	0	0	0	-12
Hardware Revenue	**48**	**29**	**22**	**18**	**16**	**15**	**14**	**14**	**-9**
Year-to-Year Increase (%)	-28	-40	-23	-21	-10	-8	-2	-1	-
Software Revenue	**32**	**24**	**20**	**16**	**15**	**14**	**14**	**14**	**-6**
Year-to-Year Increase (%)	-30	-24	-18	-19	-7	-5	0	2	-
Software Service	9	6	4	4	4	4	4	5	3
Hardware Service	7	6	5	4	4	3	3	3	-7
Service Revenue	**15**	**12**	**9**	**8**	**8**	**8**	**8**	**8**	**-2**
Year-to-Year Increase (%)	-26	-22	-26	-6	-6	-3	2	3	-
Total Factory Revenue	**95**	**65**	**51**	**42**	**39**	**37**	**36**	**37**	**-6**
Year-to-Year Increase (%)	-28	-32	-21	-18	-8	-6	0	1	-

NA = Not applicable
Source: Dataquest (August 1997)

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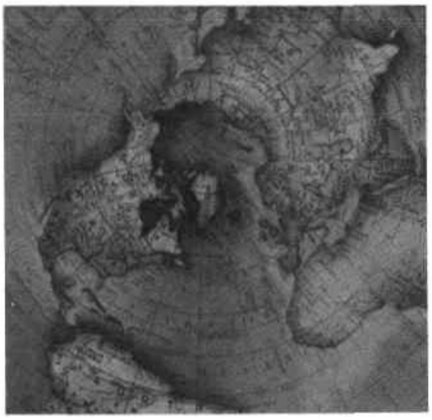

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1996 Mechanical CAD/CAM/CAE Asia/Pacific Market Share Update

Market Statistics

Program: Mechanical CAD/CAM/CAE Applications Asia/Pacific
Product Code: CMEC-AP-MS-9701
Publication Date: September 1, 1997
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Chapter 1
Introduction

About This Document

This Market Statistics report contains Dataquest's detailed market share information on the mechanical CAD/DAM/CAE industry at the country level. This document is meant to supplement the worldwide mechanical CAD/CAM/CAE market share book by providing mechanical CAD/CAM/CAE market share detail for Asia/Pacific countries.

Definitions

This section lists the definitions specific to this document. For other definitions, please see the worldwide market statistics book.

Asia/Pacific

Includes Australia, Bangladesh, Brunei, Cambodia, China, Hong Kong, India, Indonesia, Korea, Laos, Malaysia, Maldives, Myanmar, Nepal, New Zealand, Pakistan, Philippines, Singapore, Sri Lanka, Taiwan, Thailand, and Vietnam

Publishing Schedule

Dataquest publishes market share and forecasting at the country level once each year. Our delivery schedule is as follows:

- Asia/Pacific country-level market share tables for 1996, based on data collection and analysis beginning in January 1997, are presented in this report. At this point, the market share database is frozen and will not be changed until the end of 1997.
- Forecast tables will be available electronically by September 5, and books will be shipped by September 26. These forecast tables will contain country-level information for the Asia/Pacific region.

A Final Note

Dataquest's policy is to continually update its market information for current and past years with any new data received in order to arrive at the most accurate market representation possible. Our ongoing commitment is to maintain an accurate and complete model of the entire CAD/CAM/CAE, AEC and GIS, and EDA worldwide markets, and we welcome your input. Please feel free to contact any member of the CAD/CAM/CAE, AEC and GIS, or EDA team if you have any questions or concerns.

Chapter 2
Market Statistics Tables

Table A-1
Top 30 Mechanical Software Companies, Worldwide, All Operating Systems
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	IBM	368.3	494.5	579.7	17.2	17.3
2	Parametric Technology	209.8	321.2	495.0	54.1	14.8
3	Dassault	154.2	190.6	228.6	19.9	6.8
4	EDS Unigraphics	140.5	155.5	191.3	23.0	5.7
5	Autodesk	166.8	189.6	176.5	-6.9	5.3
6	Computervision	148.2	149.0	174.4	17.1	5.2
7	Structural Dynamics Research Corporation	115.4	144.8	153.0	5.7	4.6
8	MICROCADAM	91.7	129.2	152.0	17.7	4.5
9	MacNeal-Schwendler	90.8	114.0	124.3	9.0	3.7
10	Info. Services Int'l. Dentsu*	66.0	85.2	117.2	37.6	3.5
11	Fujitsu	83.7	97.0	107.3	10.7	3.2
12	Matra Datavision	75.6	87.4	91.8	4.9	2.7
13	CoCreate	74.5	79.0	90.2	14.2	2.7
14	Hitachi	66.7	70.9	79.9	12.7	2.4
15	NEC	61.7	72.9	62.9	-13.7	1.9
16	Toshiba*	54.5	66.7	62.5	-6.3	1.9
17	Nihon Unisys	48.1	52.8	54.4	3.0	1.6
18	Hitachi Zosen Info Systems	34.5	38.7	39.3	1.4	1.2
19	ANSYS	32.5	32.6	37.0	13.6	1.1
20	Hakuto*	23.6	29.8	34.0	14.0	1.0
21	C. Itoh Techno-Science*	34.6	30.8	30.8	0	0.9
22	Intergraph	61.1	54.0	27.1	-49.8	0.8
23	Tecnomatix Technology	13.0	20.1	26.3	31.1	0.8
24	Sherpa Corporation	18.8	20.6	26.2	27.2	0.8
25	Marubeni Hytech*	18.3	19.9	23.0	15.3	0.7
26	ISD Software	10.5	14.5	22.7	56.5	0.7
27	Delcam International	11.6	16.7	21.9	31.1	0.7
28	Applicon	19.3	21.5	21.8	1.3	0.7
29	Sumisho Electronics*	18.4	18.8	21.6	14.5	0.6
30	Adra Systems	18.0	19.0	21.1	11.2	0.6
	All North American Companies	1,720.6	2,140.9	2,500.8	16.8	74.8
	All European Companies	288.2	342.0	352.2	3.0	10.5
	All Asian Companies	428.4	481.5	491.5	2.1	14.7
	All Companies	**2,437.2**	**2,964.4**	**3,344.6**	**12.8**	**100.0**

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-2
Top 30 Mechanical Software Companies, Asia/Pacific, All Operating Systems
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	IBM	29.0	38.8	42.3	9.1	23.4
2	Parametric Technology	0.1	9.6	32.9	241.1	18.2
3	Autodesk	16.7	20.9	22.9	10.0	12.7
4	EDS Unigraphics	12.6	15.6	17.2	10.7	9.5
5	Dassault	10.8	13.3	14.6	9.6	8.1
6	Structural Dynamics Research Corporation	7.6	6.5	10.9	67.9	6.0
7	Computervision	2.8	10.3	10.1	-1.6	5.6
8	MacNeal-Schwendler	1.8	2.4	7.5	212.1	4.1
9	Matra Datavision	2.6	7.0	4.6	-34.4	2.5
10	MICROCADAM	3.0	3.9	4.6	17.9	2.5
11	Delcam International	2.3	2.8	3.1	7.8	1.7
12	Intergraph	2.4	2.1	2.8	33.3	1.5
13	FORMTEK	0.7	0.8	2.1	172.8	1.1
14	Sharp*	1.5	2.1	1.9	-10.2	1.0
15	Cimatron	1.1	1.7	1.8	9.3	1.0
16	ANSYS	1.3	1.9	1.8	-5.4	1.0
17	Design Automation	0.9	1.6	1.8	14.4	1.0
18	MCS	1.3	1.8	1.8	-0.7	1.0
19	Alias Research	-	1.7	1.7	-	1.0
20	Gerber Systems	1.1	1.2	1.5	21.0	0.8
21	Straessle Informationssysteme	1.1	1.6	1.4	-14.2	0.8
22	Adra Systems	0.7	1.1	1.4	19.3	0.8
23	Concentra	0.1	0.3	1.2	372.3	0.7
24	Bentley Systems	0.3	0.8	1.0	14.6	0.5
25	Mechanical Dynamics	1.0	1.0	1.0	-3.1	0.5
26	Pafec	-	-	1.0	NA	0.5
27	Investronica SA	3.8	3.9	0.8	-79.5	0.4
28	MARC	-	-	0.8	NA	0.4
29	Vero International Software	0.2	0.3	0.7	115.4	0.4
30	CNC Software	0.5	0.6	0.7	16.8	0.4
	All North American Companies	85.0	120.6	162.8	35.0	90.1
	All European Companies	12.3	17.8	14.1	-20.6	7.8
	All Asian Companies	2.9	4.1	3.8	-7.4	2.1
	All Companies	**100.2**	**142.4**	**180.7**	**26.8**	**100.0**

NA = Not applicable
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-3
Top Mechanical Software Companies, China, All Operating Systems
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	EDS Unigraphics	2.3	4.9	6.5	33.5	26.7
2	IBM	3.5	5.0	5.6	11.6	23.0
3	Parametric Technology	-	0.8	4.2	421.9	17.0
4	Dassault	1.5	1.7	1.9	12.2	7.9
5	Structural Dynamics Research Corporation	1.1	0.8	1.6	87.1	6.5
6	Computervision	0.4	1.5	1.5	-1.6	5.9
7	MacNeal-Schwendler	0.6	0.8	1.2	48.6	5.1
8	MICROCADAM	0.5	0.7	0.8	17.9	3.4
9	Autodesk	0.5	0.6	0.7	15.1	2.7
10	ANSYS	0.4	0.5	0.6	16.9	2.5
11	Gerber Systems	0.4	0.4	0.5	38.3	2.2
12	Cimatron	0.2	0.3	0.3	9.3	1.3
13	Matra Datavision	0.4	0.5	0.3	-34.4	1.2
14	Intergraph	0.2	0.2	0.2	33.3	0.8
15	Delcam International	0.1	0.2	0.2	7.8	0.7
16	B.A. Intelligence Networks	0.1	0.1	0.1	78.8	0.6
17	Mechanical Dynamics	0.5	0.1	0.1	-3.1	0.6
18	Investronica SA	-	-	0.1	NA	0.5
19	Spatial Technology	0.1	0.2	0.1	-45.4	0.3
20	Applicon	0.1	0.1	0.1	5.5	0.3
21	CAD Centre	0.1	0.1	0	-66.7	0.1
22	Bentley Systems	-	-	0	NA	0.1
23	Pacific Numerix	-	-	0	NA	0
24	Engineered Software	-	-	0	NA	0
	Other Companies	1.1	1.1	0.6	-44.6	2.5
	All North American Companies	9.8	16.0	23.0	43.4	93.7
	All European Companies	0.8	1.0	1.0	-7.2	3.9
	All Asian Companies	-	-	-	NA	-
	All Companies	**11.7**	**18.1**	**24.5**	**35.2**	**100.0**

NA = Not applicable
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (July 1997)

Table A-4
Top Mechanical Software Companies, Hong Kong, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	Parametric Technology	-	1.4	4.2	203.4	25.7
2	IBM	2.3	3.1	3.0	-1.0	18.5
3	Computervision	0.5	1.7	1.7	-1.6	10.3
4	Structural Dynamics Research Corporation	1.2	1.0	1.7	73.2	10.1
5	EDS Unigraphics	0.3	0.8	1.2	52.5	7.4
6	Dassault	-	1.1	1.1	-0.5	6.4
7	Autodesk	0.7	0.8	0.9	15.6	5.7
8	MICROCADAM	0.5	0.7	0.8	17.9	5.0
9	Pafec	-	-	0.7	NA	4.4
10	Investronica SA	-	-	0.6	NA	3.9
11	Intergraph	0.4	0.3	0.5	33.3	2.7
12	Vero International Software	0.2	0.1	0.3	115.4	1.9
13	Matra Datavision	0.4	0.5	0.3	-34.4	1.9
14	Gerber Systems	0.2	0.2	0.3	11.1	1.7
15	Cimatron	0.1	0.1	0.1	9.3	0.7
16	Just In Time Systems	-	-	0.1	NA	0.6
17	CNC Software	0.1	0.1	0.1	8.7	0.6
18	CIMLINC	-	0.1	0.1	8.1	0.4
19	Bentley Systems	-	-	0	NA	0.3
20	Gibbs and Associates	-	-	0	NA	0.2
21	MacNeal-Schwendler	0.6	0.7	-	-100.0	-
22	MCS	0.3	0.3	-	-100.0	-
	Other Companies	0.9	0.7	0.4	-49.7	2.3
	All North American Companies	6.7	10.8	14.0	29.9	84.7
	All European Companies	0.8	0.7	2.2	202.4	13.0
	All Asian Companies	-	-	-	NA	-
	All Companies	**8.4**	**12.2**	**16.5**	**35.1**	**100.0**

NA = Not applicable
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (July 1997)

Table A-5
Top 30 Mechanical Software Companies, Korea, All Operating Systems
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	IBM	5.4	8.5	9.6	12.6	21.9
2	Parametric Technology	-	2.2	8.1	266.5	18.3
3	Autodesk	4.3	5.1	5.3	4.1	12.1
4	MacNeal-Schwendler	-	-	3.7	NA	8.5
5	Structural Dynamics Research Corporation	1.8	1.9	3.4	81.9	7.7
6	Dassault	7.7	2.9	3.3	13.1	7.6
7	FORMTEK	-	-	2.1	NA	4.7
8	Computervision	0.5	1.7	1.7	-1.6	3.9
9	Delcam International	0.7	1.5	1.6	7.8	3.7
10	Adra Systems	0.6	0.9	1.1	16.1	2.5
11	Straessle Informationssysteme	0.9	1.1	1.0	-14.2	2.2
12	MICROCADAM	0.5	0.7	0.8	17.9	1.9
13	MCS	-	0.4	0.7	65.5	1.7
14	ANSYS	0.4	0.5	0.6	12.7	1.4
15	Matra Datavision	0.4	0.9	0.6	-34.4	1.4
16	Altair Computing	-	-	0.6	NA	1.4
17	EDS Unigraphics	0.6	3.2	0.5	-85.6	1.0
18	Intergraph	0.4	0.3	0.5	33.3	1.0
19	Concentra	0.1	0.1	0.4	228.3	0.9
20	Mechanical Dynamics	0.5	0.3	0.4	45.3	0.9
21	Bentley Systems	-	-	0.2	NA	0.6
22	CIMLINC	-	0.2	0.2	8.1	0.5
23	Cimatron	0.1	0.2	0.2	9.3	0.5
24	Gerber Systems	0.1	0.2	0.2	16.7	0.5
25	Vero International Software	-	0.1	0.2	115.4	0.4
26	Applicon	0.1	0.1	0.1	5.5	0.3
27	Pafec	-	-	0.1	NA	0.3
28	CAD Lab	-	-	0.1	NA	0.3
29	CNC Software	0.1	0.1	0.1	14.3	0.2
30	Just In Time Systems	-	-	0.1	NA	0.2
	Other Companies	3.1	3.3	1.0	-69.3	2.3
	All North American Companies	14.5	25.5	38.8	52.0	88.4
	All European Companies	2.5	3.8	4.1	6.2	9.2
	All Asian Companies	0.1	0.1	-	-100.0	-
	All Companies	**20.2**	**32.8**	**43.9**	**33.7**	**100.0**

NA = Not applicable
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (July 1997)

Table A-6
Top Mechanical Software Companies, Singapore, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	Parametric Technology	-	1.3	3.1	135.0	22.1
2	IBM	1.9	2.6	2.5	-1.0	18.3
3	EDS Unigraphics	2.8	1.5	2.4	62.7	17.6
4	Structural Dynamics Research Corporation	1.6	1.3	2.0	49.6	14.3
5	Dassault	-	0.9	0.9	-0.5	6.3
6	MICROCADAM	0.5	0.7	0.8	17.9	6.0
7	Autodesk	0.5	0.6	0.7	13.5	5.3
8	Computervision	0.2	0.7	0.7	-1.6	5.3
9	Concentra	0.1	0.1	0.4	228.3	3.0
10	B.A. Intelligence Networks	0.2	0.2	0.2	43.6	1.7
11	Vero International Software	0	0.1	0.2	115.4	1.3
12	Delcam International	0.6	0.2	0.2	7.8	1.3
13	Intergraph	0.1	0.1	0.2	33.3	1.1
14	Cimatron	0.1	0.1	0.1	9.3	0.8
15	Just In Time Systems	-	-	0.1	NA	0.7
16	CNC Software	0.1	0.1	0.1	8.7	0.7
17	DP Technology	0	0.1	0.1	37.1	0.5
18	CAD Centre	-	0	0	265.8	0.2
19	Bentley Systems	-	-	0	NA	0.2
20	Gibbs and Associates	-	-	0	NA	0.2
21	Applicon	0	0	0	5.5	0.2
22	ISD Software	-	-	0	NA	0.1
23	Pacific Numerix	-	-	0	NA	0.1
24	ANSYS	0.1	0.1	-	-100.0	-
	Other Companies	1.2	0.6	0.3	-38.8	2.4
	All North American Companies	7.8	9.1	12.9	41.8	93.2
	All European Companies	1.1	0.4	0.6	65.3	4.4
	All Asian Companies	-	-	-	NA	-
	All Companies	**10.1**	**10.0**	**13.9**	**38.2**	**100.0**

NA = Not applicable
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (July 1997)

Table A-7
Top Mechanical Software Companies, Taiwan, All Operating Systems
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	Parametric Technology	-	2.0	5.2	160.7	17.4
2	Autodesk	3.6	4.5	4.8	5.9	15.9
3	IBM	3.1	4.5	4.5	1.5	15.1
4	Structural Dynamics Research Corporation	1.9	1.5	2.2	52.0	7.4
5	Dassault	1.5	1.5	1.6	2.0	5.2
6	EDS Unigraphics	0.6	1.0	1.5	52.0	5.1
7	MacNeal-Schwendler	-	-	1.2	NA	4.1
8	Computervision	0.3	1.2	1.2	-1.6	4.0
9	MCS	1.0	1.0	1.0	-0.7	3.4
10	Cimatron	0.6	0.9	1.0	9.3	3.2
11	MICROCADAM	0.5	0.7	0.8	17.9	2.7
12	Delcam International	0.4	0.5	0.5	7.8	1.8
13	Gerber Systems	0.3	0.4	0.5	12.2	1.6
14	Hitachi Zosen Info Systems	0.3	0.4	0.4	1.4	1.3
15	Intergraph	0.3	0.3	0.4	33.3	1.2
16	ANSYS	0.3	0.4	0.3	-28.3	1.0
17	DP Technology	0.1	0.2	0.3	38.5	0.8
18	B.A. Intelligence Networks	0.2	0.2	0.2	45.1	0.8
19	Bentley Systems	-	-	0.2	NA	0.7
20	Straessle Informationssysteme	0.2	0.2	0.2	-14.2	0.6
21	CNC Software	0.2	0.2	0.2	9.8	0.6
22	Spatial Technology	0.1	0.2	0.1	-45.4	0.3
23	Livermore Software Laboratories	0	0.1	0.1	-27.1	0.2
24	Vero International Software	-	0	0	115.4	0.1
25	Ricoh	-	-	0	NA	0.1
26	ISD Software	-	-	0	NA	0.1
27	CAD Centre	-	-	0	NA	0.1
28	Diehl Graphsoft Inc.	-	0	-	-100.0	-
	Other Companies	3.5	4.0	4.0	0.5	13.4
	All North American Companies	12.1	17.6	23.9	35.9	79.3
	All European Companies	1.5	1.8	1.8	1.7	6.0
	All Asian Companies	0.3	0.4	0.4	3.5	1.3
	All Companies	**17.5**	**23.7**	**30.1**	**26.8**	**100.0**

NA = Not applicable
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (July 1997)

Table A-8
Top 30 Mechanical Software Companies, Rest of Asia/Pacific, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	IBM	12.9	15.1	17.0	12.3	32.8
2	Autodesk	7.1	9.2	10.5	14.1	20.3
3	Parametric Technology	-	1.9	8.1	319.1	15.7
4	Dassault	-	5.2	5.9	12.9	11.3
5	EDS Unigraphics	6.1	4.2	5.0	20.9	9.7
6	Matra Datavision	0.5	5.1	3.4	-34.4	6.5
7	Computervision	0.9	3.4	3.3	-1.6	6.4
8	MacNeal-Schwendler	0.6	0.8	1.2	51.2	2.4
9	Intergraph	1.0	0.9	1.2	33.3	2.2
10	Delcam International	0.4	0.5	0.5	7.8	1.0
11	MICROCADAM	0.3	0.4	0.4	17.9	0.8
12	Mechanical Dynamics	-	0.6	0.4	-27.3	0.8
13	Bentley Systems	-	-	0.4	NA	0.8
14	Concentra	-	-	0.4	NA	0.7
15	ANSYS	0.2	0.3	0.3	-7.2	0.6
16	Adra Systems	0.1	0.2	0.3	35.2	0.5
17	CNC Software	0.2	0.2	0.2	33.1	0.4
18	Straessle Informationssysteme	-	0.2	0.2	-14.2	0.4
19	Research Engineers—Civilsoft	0.1	0.1	0.1	56.7	0.2
20	Cimatron	0.1	0.1	0.1	9.3	0.2
21	CAD Centre	-	-	0.1	NA	0.2
22	Just In Time Systems	-	-	0.1	NA	0.2
23	DP Technology	0	0.1	0.1	67.8	0.2
24	Algor Interactive Systems	0	0.1	0.1	34.3	0.2
25	Pafec	-	-	0.1	NA	0.1
26	Gibbs and Associates	-	-	0.1	NA	0.1
27	RoboCAD Solutions	0	0	0	33.1	0.1
28	Diehl Graphsoft Inc.	-	0	0	24.2	0.1
29	FORMTEK	0.7	0.8	-	-100.0	-
30	Pathtrace Systems Inc.	0	0	-	-100.0	-
	Other Companies	2.6	3.5	1.2	-65.7	2.4
	All North American Companies	28.7	36.0	46.1	28.1	89.0
	All European Companies	1.1	6.0	4.5	-24.8	8.7
	All Asian Companies	-	-	-	NA	-
	All Companies	**32.3**	**45.5**	**51.8**	**13.9**	**100.0**

NA = Not applicable
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (July 1997)

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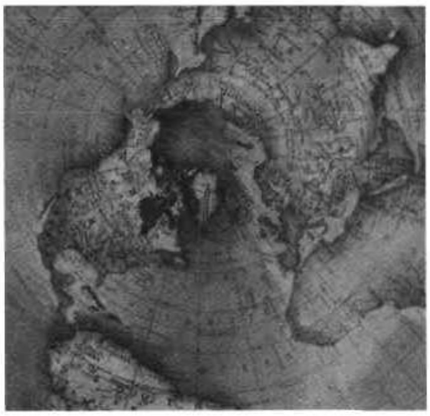

Dataquest

1997 Asia/Pacific Mechanical CAD/CAM/CAE Forecast Update

Market Statistics

Program: Mechanical CAD/CAM/CAE Asia/Pacific
Product Code: CMEC-AP-MS-9702
Publication Date: September 29, 1997
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Chapter 1

1997 Asia/Pacific Mechanical CAD/CAM/CAE Forecast Update

About This Document

This document contains Dataquest's detailed forecast information on the Mechanical CAD/CAM/CAE market at the country level. This report is meant to supplement the worldwide Mechanical CAD/CAM/CAE forecast book by providing forecast detail for Asia/Pacific countries.

Although Dataquest does not forecast currency exchange rates, we do forecast with the best 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 July 1997 exchange rate will remain stable in the future (see Tables 1 and 2).

Additional market statistics publications for Dataquest's Mechanical CAD/CAM/CAE service for 1997 are as follows:

- Dataquest's 1996 market share document (published as CMEC-WW-MS-9701) was sent to our clients in March.
- Dataquest's 1996 forecast document was released in May (published as CMEC-WW-MS-9702).
- Dataquest's 1996 market share data was verified, updated, and sent to our clients in August as a market share update report (published as CMEC-WW-MS-9703). Country-level data was also made available at this time.

This document is an updated forecast that has been expanded to include country-level information and in-depth analysis.

Worldwide Forecast Assumptions

The following sections describe the main forces driving the CAD/CAM/CAE, AEC and GIS, and EDA worldwide software forecasts.

All Applications

As CAD/CAM/CAE, AEC and GIS, and EDA becomes more of a replacement market, market leaders would appear to have the upper hand—the cost of switching is high. However, software that lets users get a better product to market faster and helps eliminate business risks will always be in demand, regardless of market share. Thus, there is always an opportunity for new vendors in technical markets.

The primary trend in design software function is toward operating at a higher level of abstraction. In all applications, Dataquest has seen an evolution of focus from electronic paper to component modeling and now to system modeling, with the eventual goal being to fully simulate, evaluate, redesign, and test the design inside the computer before manufacture. Meanwhile, increased computing power is allowing the nature of design to evolve to include constituencies in manufacturing, product support, and from users themselves. Thus the engineering process is being expanded to include input from a broader base.

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

	1995	1996	2001	Growth (%) 1995-1996	CAGR (%) 1996-2001
Europe (U.S.$M)					
Software Revenue	2,045.51	2,248.57	3,463.83	9.9	9.0
Hardware Revenue	2,816.50	2,861.37	3,682.31	1.6	5.2
Service Revenue	1,121.38	1,271.20	2,085.22	13.4	10.4
Total Factory Revenue	**5,983.39**	**6,381.13**	**9,228.66**	**6.6**	**7.7**
ECU/U.S.$ Exchange Rate*	**0.77**	**0.80**	**0.91**	**3.9**	**2.6**
Europe (ECU Million)					
Software Revenue	1,575.04	1,798.86	3,152.09	14.2	11.9
Hardware Revenue	2,168.70	2,289.09	3,350.91	5.6	7.9
Service Revenue	863.46	1,016.96	1,897.55	17.8	13.3
Total Factory Revenue	**4,607.21**	**5,104.91**	**8,398.08**	**10.8**	**10.5**
Japan (U.S.$M)					
Software Revenue	1,637.45	1,772.40	2,905.45	8.2	10.4
Hardware Revenue	2,772.38	2,793.91	3,723.95	0.8	5.9
Service Revenue	1,175.93	1,246.04	2,226.79	6.0	12.3
Total Factory Revenue	**5,585.76**	**5,812.35**	**8,856.19**	**4.1**	**8.8**
Japan/U.S.$ Exchange Rate*	**93.90**	**108.81**	**115.38**	**15.9**	**1.2**
Japan (Yen Million)					
Software Revenue	153,756.13	192,855.17	335,231.16	25.4	11.7
Hardware Revenue	260,326.42	304,005.04	429,669.19	16.8	7.2
Service Revenue	110,420.25	135,581.93	256,927.31	22.8	13.6
Total Factory Revenue	**524,502.80**	**632,442.14**	**1,021,827.66**	**20.6**	**10.1**
North America (U.S.$M)					
Software Revenue	2,138.08	2,531.06	5,162.27	18.4	15.3
Hardware Revenue	2,774.01	2,998.23	5,751.18	8.1	13.9
Service Revenue	1,230.68	1,483.94	3,056.50	20.6	15.5
Total Factory Revenue	**6,142.76**	**7,013.23**	**13,969.95**	**14.2**	**14.8**
Worldwide (U.S.$M)					
Software Revenue	6,306.82	7,159.11	13,265.95	13.5	13.1
Hardware Revenue	9,050.96	9,440.39	15,190.53	4.3	10.0
Service Revenue	3,801.12	4,352.20	8,412.34	14.5	14.1
Total Factory Revenue	**19,158.90**	**20,951.70**	**36,866.13**	**9.4**	**12.0**

*Assuming a stable currency, the 2001 exchange rate is the same as the July 1997 exchange rate.
Source: Dataquest (August 1997)

Table 2
Foreign Currency/U.S. Dollar

		Actual				Current			Year-to-Year Change (%)					
Country	Currency	1992	1993	1994	1995	1996	1997	1998	1992-1993	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998
Austria	Schilling	10.95	11.65	11.40	10.06	10.59	11.43	12.62	6.4	-2.1	-11.8	5.3	7.9	10.4
Belgium	Franc	32.02	34.67	33.66	29.42	30.96	33.50	37.04	8.3	-2.9	-12.6	5.2	8.2	10.6
Denmark	Krone	6.02	6.49	6.35	5.59	5.81	6.21	6.83	7.8	-2.2	-12.0	3.9	6.9	10.0
Finland	Markka	4.45	5.73	5.21	4.37	4.59	4.86	5.32	28.8	-9.1	-16.1	5.0	5.9	9.5
France	Franc	5.27	5.67	5.54	4.97	5.12	5.49	6.05	7.6	-2.3	-10.3	3.0	7.2	10.2
Germany	D-Mark	1.56	1.66	1.62	1.43	1.50	1.63	1.79	6.4	-2.4	-11.7	4.9	8.7	9.8
Italy	Lira	1,227.75	1,577.85	1,609.34	1,628.21	1,542.72	1,611.40	1,745.91	28.5	2.0	1.2	-5.3	4.5	8.3
Netherlands	Guilder	1.75	1.86	1.82	1.60	1.69	1.83	2.02	6.3	-2.2	-12.1	5.6	8.3	10.4
Norway	Krone	6.18	7.11	7.04	6.33	6.46	6.73	7.45	15.0	-1.0	-10.1	2.1	4.2	10.7
Spain	Peseta	101.90	127.87	133.48	124.40	126.68	137.12	151.33	25.5	4.4	-6.8	1.8	8.2	10.4
Sweden	Krona	5.81	7.82	7.70	7.14	6.71	7.20	7.81	34.6	-1.5	-7.3	-6.0	7.3	8.5
Switzerland	Franc	1.40	1.48	1.37	1.18	1.24	1.37	1.48	5.7	-7.4	-13.9	5.1	10.5	8.0
United Kingdom	Pound	0.57	0.67	0.65	0.63	0.64	0.62	0.60	17.5	-3.0	-3.1	1.6	-3.1	-3.2
Europe Average	ECU	0.77	0.86	0.84	0.77	0.80	0.84	0.91	11.4	-1.5	-8.7	3.9	5.0	8.3
China	Renminbi	5.51	5.76	8.54	8.32	8.34	8.33	8.32	4.5	48.3	-2.6	0.2	-0.1	-0.1
Hong Kong	Dollar	7.74	7.74	7.73	7.74	7.73	7.74	7.75	0	-0.1	0.1	-0.1	0.1	0.1
Japan	Yen	126.34	110.85	101.56	93.90	108.81	116.22	115.38	-12.3	-8.4	-7.5	15.9	6.8	-0.7
Korea	Won	782.41	799.42	805.80	770.57	805.16	860.04	893.09	2.2	0.8	-4.4	4.5	6.8	3.8
Singapore	Dollar	1.63	1.62	1.53	1.43	1.41	1.42	1.45	-0.9	-5.3	-6.5	-1.4	0.7	2.1
Taiwan	Dollar	24.93	26.15	26.45	26.48	27.47	27.62	28.03	4.9	1.1	0.1	3.7	0.5	1.5

Source: Dataquest (September 1997)

At the same time, the nature of design data itself is expanding from a focus on geometry to include multiple data types, making the challenge of system modeling even more complex. Also, the World Wide Web holds the potential to expand the nature of collaborative design by harnessing the joint power of anticipated increases in both computing power and communications bandwidth. Thus, there is little limit to the problems that design or GIS software can tackle. The primary challenge will continue to be to develop robust, leading-edge software ahead of competitors. During the forecast period, Dataquest anticipates significant, but not revolutionary, advances in the ability of the existing programmer pool to produce new software.

In addition to technology trends, it is also necessary to consider exchange rate fluctuations, especially as the dollar has continued to strengthen against most major currencies of the world, such as the deutsche mark and the yen, over the past year. Growth rates in countries where the dollar has strengthened against the local currency are likely to be adversely affected when considered in dollar-denominated terms.

Mechanical Forecast Assumptions

The following factors will promote expansion of the mechanical CAD/CAM/CAE market.

Renewed Investment in Mechanical CAD Technology

Over the past two years, Dataquest has seen renewed investment in mechanical CAD/CAM/CAE technology among the major aerospace and automotive companies, particularly in North America and Europe. Now that these companies have completed their investment cycles, we expect to see corresponding investment by their supplier bases as a key driver of the market going forward. Furthermore, many of these major companies that reinvested in base CAD technology will be looking to further invest in design automation. Add-on, niche applications should be pushing the market toward higher growth over our forecast period.

At the regional level, the outlook for Europe continues to be positive. The weakening of major European currencies against the dollar has helped the export of manufactured goods in countries like Germany, France, Italy, and Spain, and this is creating a more favorable climate for business investment and industrial production. The dollar has also strengthened against the Japanese yen over the past year, and indications are for an economic upturn in Japan, as well, in the near term.

New Software, New Platforms, New Users

Despite the fact that it is still a UNIX-based world out there, there is a very strong interest in NT-based mechanical design solutions. Vendors spent 1995 and 1996 making solutions available on the NT platform, and, finally, designers and engineers have a number of packages to choose from. The prospects of lower-cost software on lower-cost platforms have sparked renewed interest in CAD technology among designers who have not been purchasing CAD systems in recent years.

NT is beginning to encroach on the installed base for DOS/Windows and Windows 95 at the low end and UNIX at the high end. The move to replace UNIX will take longer than the replacement at the low end, especially for industries that need surfacing technologies. For example, today it is not possible to model the surface of a complete car using NT machines. These tasks still depend on high-end UNIX workstations. Also, a large proportion of 3-D CAD software packages are still on UNIX. But 3-D CAD software is becoming less expensive and easier to use and is moving to NT in a big way.

Untapped Users Eager for Technology

While CAD investment in Europe and North America will begin to slow down over our forecast period, the Asia/Pacific region is just beginning to take off, fueled by CAD investments from local and national governments (such as Indonesia's IPTN) and multinational companies. As manufacturing continues to move offshore into the Asia/Pacific region, Dataquest expects to see an increased level of CAD sophistication among the users. Similarly, mechanical CAD/CAM/CAE growth in Japan is expected to undergo major reinvestment over our forecast period. The UNIX platform dominates the mechanical sector in Japan today, and the Japanese mechanical market still places a heavy emphasis on 2-D design rather than solid modeling. We expect to see a movement of many Japanese CAD users from 2-D and proprietary systems to 3-D commercial systems over our forecast period.

The following trends will slow growth in the mechanical CAD/CAM/CAE market.

CAD Investments Are Cyclical

The major aerospace and automotive companies, particularly in Europe, have been significant drivers of the double-digit mechanical CAD/CAM/CAE growth Dataquest has seen over the last two years. However, these companies have now completed their investment cycles in CAD technology for the next four to six years. Investment in CAD by these companies will slow significantly until the next investment cycle begins, bringing down the overall market growth.

Meeting User Needs Beyond Design

In order for the mechanical CAD/CAM/CAE market to maintain the high growth that it has experienced in recent years, designers need applications that do more than just design. Design needs to become more tightly integrated with manufacturing and analysis, and beyond that, the whole process of bringing a product to market cannot continue to live in isolation within the engineering walls. Vendors are beginning to address this issue today, but it will take some time before users as well as vendors determine exactly what is needed and how it can work within the business processes of a company.

AEC Forecast Assumptions

The following factors will contribute to the long-term expansion of the AEC CAD industry.

CAD Is Becoming a Business Requirement

Large design firms are growing at the expense of smaller firms, and 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.

AEC Market Penetration

A significant pool of untapped users still exists, and the relatively low market penetration of AEC CAD systems should allow steady worldwide growth during the next five years, despite constant volatility in demand for the buildings and infrastructure to be designed.

New Features in AEC CAD Products Are Achievable

Better, lower-cost visualization tools will be in increasing demand as sales and communication tools. Data and database functions are growing in importance in AEC design, creating opportunities to sell users significant new functionality. Some vendors will create products that foster communications in the entire design, construction, and maintenance process—products that will increase the payoff in CAD investments.

The following trends will inhibit growth in AEC.

Design Is Only Part of the Problem

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 not well-addressed by AEC systems today. Design tools can only thrive in the AEC structure when they support more of the entire business problem. Commitment to and cooperation on the problem from multiple vendors will allow Dataquest to increase the forecast growth rate further.

GIS/Mapping Forecast Assumptions

The following sections identify those factors that will promote growth in the worldwide GIS market.

Impact of Windows NT

Intergraph's move to Windows NT at the expense of UNIX will quickly make PC-based operating systems the dominant revenue stream in North America. In the long term, the GIS UNIX market is highly subject to erosion by Windows NT because of the appealing prospects of better integration of GIS and Windows-based productivity tools.

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 or have only entry-level systems in terms of value delivered.

New Technologies

Faster, less expensive 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, and laser range finders are making it possible to create GISs that are significantly less expensive, 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. Finally, database companies themselves are gaining a better understanding of spatial analysis, a key factor in spreading use of GIS systems more broadly.

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

Long-term expansion of the GIS market will be constrained by the following factors.

High Cost of Entry Remains a Barrier

There will remain an uncertain, but certainly high, cost of creating a working GIS 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."

Price Pressures Inhibit Growth

Price pressure will hold down total revenue in the GIS market. Innovation is the only way to maintain prices in any software industry, and GIS vendors will struggle in their attempt to create compelling new applications and improved investment payoff for customers.

Electronic Design Automation Forecast Assumptions

It is fairly obvious that the EDA industry is not used to this level of prosperity. This market's 1996 estimates were almost 1 percent below the 1996 actual figures. This has been driven by an almost unprecedented seat count growth. Companies can no longer afford the level of tool sharing seen in the past. Mainstream companies have started re-engineering their engineering groups. Dataquest's lowest estimate of a week lost in the design cycle is $155,000, and that isn't counting lost market opportunity and so on. This makes the decision to by a new toolset fairly easy. The bad news is that sales in CAE are still primarily in the older tools. Only in the two CAD applications, IC CAD and PCB Design, is there the impact of a new generation of tools. Dataquest continues to expect a slowdown after the second design cycle is completed in early 1999. The only way to grow through that dip would be to get the new register transfer level (RTL) methodology tools on the market by the end of next year—unfortunately, that doesn't look very likely at this point.

Electronic CAE

CAE was the one area that came in below the preliminary numbers. By operation system, it was apparent that NT is growing faster than expected. This is mirrored by UNIX sales being almost 3 percent lower than reported in the preliminary numbers. North America came in as expected, but Japan reported lower numbers, which was the cause of the miss. Europe came in higher, showing a lot more life than most people expected.

IC Layout

IC Layout was where the industry showed its reluctance to believe its own reports. Although the preliminary numbers came in below Dataquest's expectations, the final numbers blew the Dataquest forecast out of the water. IC CAD grew more than 38 percent.

The general explanation from IC CAD suppliers was that they just didn't believe their preliminary numbers and therefore lowballed their response until they got the actual figures from their regions. Europe was the big surprise, coming in at almost 28 percent more than the preliminary numbers.

PCB Design

The PCB design market came in about 1 percent higher than the preliminary numbers, and here the UNIX-to-NT migration is really evident. Not unexpectedly, UNIX is all but finished as the platform of choice for PCB design. What wasn't taken into account was the decrease in the "swap-out" rate. Basically, the PCB world is upgrading hardware almost two years faster than in the past. This was another surprisingly strong market in Europe.

History and Forecast for All Applications and Operating Systems

Table 3 shows the history and forecast of all applications.

Table 3
Top Level Worldwide CAD/CAM/CAE/GIS Software History and Forecast, All Applications and Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Software Revenue ($M)									
Worldwide, All Operating Systems	**5,283**	**6,307**	**7,159**	**8,078**	**9,265**	**10,223**	**11,599**	**13,266**	**13.1**
Worldwide									
UNIX	3,708	4,275	4,789	5,237	5,758	6,103	6,556	7,098	8.2
Windows NT	118	351	736	1,239	1,867	2,424	3,290	4,361	42.7
Personal Computer	1,265	1,499	1,478	1,492	1,564	1,648	1,722	1,786	3.9
Host/Proprietary	192	181	155	109	76	49	31	21	-33.1
All Operating Systems									
North America	1,825	2,138	2,531	2,969	3,474	3,848	4,453	5,162	15.3
Europe	1,691	2,046	2,249	2,368	2,620	2,857	3,136	3,464	9.0
Japan	1,406	1,637	1,772	1,984	2,223	2,395	2,632	2,905	10.4
Asia/Pacific	277	376	483	612	770	918	1,125	1,401	23.7
Rest of World	84	109	124	145	178	206	254	334	21.9
Year-to-Year Software Revenue Growth Rate (%)									
Worldwide, All Operating Systems	-	**19.4**	**13.5**	**12.8**	**14.7**	**10.3**	**13.5**	**14.4**	-
Worldwide									
UNIX	-	15.3	12.0	9.3	9.9	6.0	7.4	8.3	-
Windows NT	-	196.9	109.6	68.4	50.6	29.9	35.7	32.6	-
Personal Computer	-	18.5	-1.4	0.9	4.8	5.4	4.5	3.7	-
Host/Proprietary	-	-5.9	-14.1	-29.6	-30.4	-36.3	-35.5	-33.5	-
All Operating Systems									
North America	-	17.2	18.4	17.3	17.0	10.8	15.7	15.9	-
Europe	-	21.0	9.9	5.3	10.6	9.0	9.8	10.4	-
Japan	-	16.4	8.2	11.9	12.0	7.7	9.9	10.4	-
Asia/Pacific	-	35.7	28.3	26.7	25.8	19.2	22.5	24.5	-
Rest of World	-	30.5	13.4	17.0	22.7	15.6	23.2	31.7	-

NA = Not applicable
Source. Dataquest (August 1997)

Forecast Methodology

Fundamental to the way Dataquest conducts its research is the underlying philosophy that the best data and analyses come from a well-balanced program. This program includes the following: balance between primary and secondary collection techniques; balance between supply-side and demand-side analysis; balance between focused, industry-specific research and coordinated, "big-picture" analysis aided by integration of data from the more than 25 separate high-technology industries Dataquest covers; and balance between the perspectives of experienced industry professionals and rigorous, disciplined techniques of seasoned market researchers.

Dataquest also analyzes trends in the macroenvironment, which can have major influences on both supply-side and demand-side forecasting. In addition to demographics, analysts look at gross national product (GNP) growth, interest rate fluctuation, business expectations, and capital spending plans. In the geopolitical arena, the group looks at trade issues, political stability or lack thereof, tariffs, nontariff barriers, and such factors as the effect on Europe of the events of 1996.

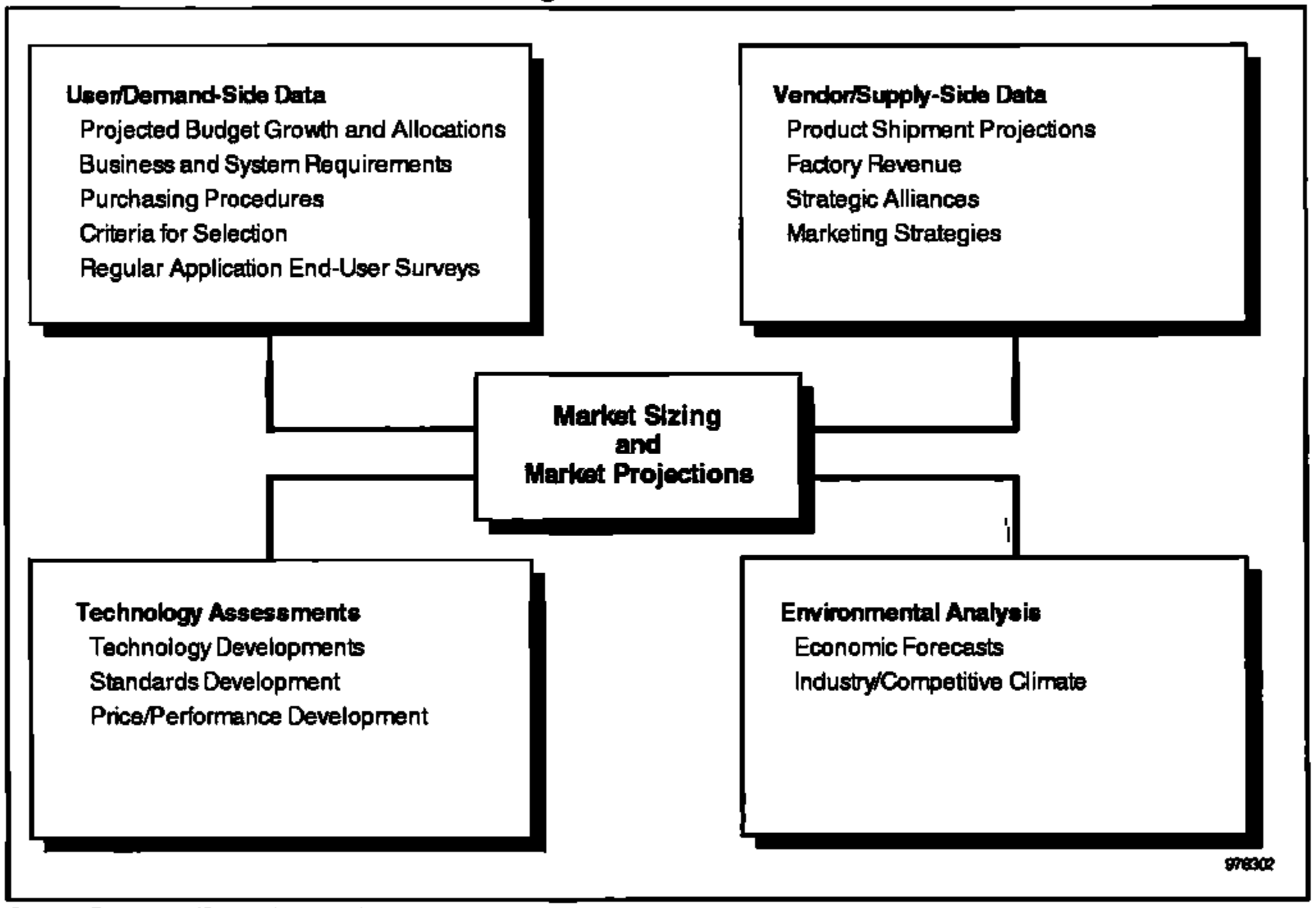
Figure 1 shows the CAD/CAM/CAE, AEC and GIS, and EDA forecasting model. The overall forecasting process uses a combination of techniques such as time series and technological modeling. Market estimates and forecasts are derived using the following research techniques:

- Segment forecasting—Individual forecasts are derived for each application segment tracked by the CAD/CAM/CAE, AEC and GIS, and EDA groups. Specifically, each application, segmented by region and platform, is forecast and rolled up. In this way, each application segment incorporates its own set of unique assumptions.
- Demand-based analysis—Market growth is tracked and forecast in terms of the present and anticipated demand of current and future users. This requires the development of a total available market model and a satisfied available market figure to assess the levels of penetration accurately. Dataquest analysts also factor in the acceptance or ability for users to consume new technology.
- Capacity-based analysis—This method involves identifying future shipment volume constraints. These constraints, or "ceilings," can be the result of component availability, manufacturing capacity, or distribution capacity. In any case, capacity limitations are capable of keeping shipments below the demand level.

Changes to the Forecast Database

Within this forecasting model, Dataquest has made numerous assumption changes that better reflect the reality in the changing the mechanical CAD/CAM/CAE, AEC and GIS, and EDA worlds. These changes include updating the hardware retirement model and altering the average selling prices (ASPs) for software, service, and hardware.

Figure 1
CAD/CAM/CAE and GIS Forecasting Model



Source: Dataquest (September 1997)

Segmentation Definitions

Operating Systems

The following defines the operating systems:

- UNIX—Includes all UNIX variants and older workstation operating systems.
- Host—Includes minicomputer and mainframe operating systems in which external workstationsõ functions are dependent on a host computer.
- Windows NT—The Microsoft operating system.
- PC—Includes DOS, Windows, Windows 95, OS/2, and Apple operating systems.

Line Items

Line item definitions are as follows:

- Average selling price (ASP) is defined as the average price of a product, inclusive of any discounts.
- CPU revenue is the portion of revenue derived from a system sale that is related to the value of the CPU.
- CPU shipment is defined as the number of CPUs delivered.
- CPU installed base is defined as the total number of CPUs in active, day-to-day use.
- Unit shipment is defined as the number of products delivered (that is, seats).
- Seats are defined as the number of possible simultaneous users.
- Installed seats are defined as the total number of seats in active, day-to-day use.
- Hardware revenue is defined as the sum of the revenue from the hardware system components: CPU revenue, terminal revenue, and peripherals revenue.
- Peripherals revenue is defined as the value of all the peripherals from turnkey sale. (Peripherals in this category typically are input and output devices.)
- Terminal revenue is defined as revenue derived from the sale of terminals used to graphically create, analyze, or manipulate designs. The term is applicable only to the host systems.
- Software revenue is revenue derived from the sale of application software.
- Service revenue is defined as revenue derived from the service and support of CAD/CAM/CAE, AEC and GIS, or EDA systems. Service is followed as software service and hardware service.
- Total factory revenue is defined as the amount of money received for goods measured in U.S. dollars and is the sum of hardware, software, and service revenue.

Regions

Asia/Pacific

Australia, Bangladesh, Brunei, Cambodia, China, Hong Kong, India, Indonesia, Korea, Laos, Malaysia, Maldives, Myanmar, Nepal, New Zealand, Pakistan, the Philippines, Singapore, Sri Lanka, Taiwan, Thailand, and Vietnam

Chapter 2
Market Statistics Tables

Table A-1
Top Level Mechanical Forecast, Asia/Pacific, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Software Revenue ($M)									
Worldwide, All Operating Systems	**2,436**	**2,963**	**3,345**	**3,689**	**4,108**	**4,502**	**4,893**	**5,332**	**9.8**
Worldwide									
UNIX	1,804	2,190	2,412	2,566	2,745	2,903	3,037	3,168	5.6
Windows NT	42	115	295	507	744	980	1,229	1,526	38.9
Personal Computer	460	540	538	546	567	585	604	621	2.9
Host/Proprietary	131	117	100	69	52	34	23	16	-30.4
All Operating Systems									
North America	730	859	1,009	1,139	1,265	1,400	1,540	1,689	10.9
Europe	825	1,024	1,149	1,197	1,317	1,419	1,534	1,683	7.9
Japan	753	902	970	1,081	1,194	1,283	1,359	1,440	8.2
Asia/Pacific	99	141	181	233	291	356	413	470	21.1
Rest of World	28	36	36	38	41	44	47	49	6.5
Year-to-Year Software Revenue Growth Rate (%)									
Worldwide, All Operating Systems	**-**	**21.6**	**12.9**	**10.3**	**11.4**	**9.6**	**8.7**	**9.0**	-
Worldwide									
UNIX	-	21.4	10.1	6.4	7.0	5.8	4.6	4.3	-
Windows NT	-	176.2	155.3	72.1	46.6	31.8	25.4	24.1	-
Personal Computer	-	17.4	-0.4	1.5	3.9	3.1	3.2	2.9	-
Host/Proprietary	-	-10.4	-14.6	-31.0	-24.6	-34.6	-31.8	-29.7	-
All Operating Systems									
North America	-	17.7	17.4	12.9	11.1	10.6	10.0	9.7	-
Europe	-	24.1	12.2	4.2	10.0	7.8	8.1	9.7	-
Japan	-	19.7	7.6	11.4	10.4	7.5	5.9	6.0	-
Asia/Pacific	-	42.2	28.0	28.9	25.0	22.3	16.0	13.8	-
Rest of World	-	29.3	-0.5	6.8	6.8	7.2	6.6	5.2	-

Source: Dataquest (August 1997)

Table B-1
Top Level Mechanical Forecast, Asia/Pacific, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	18,103	22,689	24,004	27,400	31,300	35,400	39,000	42,300	12
Seats	18,778	23,454	25,075	28,500	32,200	36,200	39,600	42,800	11
Year-to-Year Increase (%)	32	25	7	14	13	12	9	8	-
Installed Base									
CPUs	38,278	52,000	62,970	73,400	84,700	97,700	111,300	124,800	15
Seats	40,488	54,431	65,910	76,800	88,200	101,200	114,500	127,600	14
Year-to-Year Increase (%)	45	34	21	17	15	15	13	11	-
Revenue Data ($M)									
CPU Revenue	142	203	235	300	339	383	423	458	14
Terminal Revenue	12	14	18	31	23	18	12	8	-15
Peripheral Revenue	11	15	12	15	16	16	16	16	5
Hardware Revenue	**164**	**232**	**266**	**347**	**377**	**416**	**451**	**482**	**13**
Year-to-Year Increase (%)	46	41	15	30	9	10	8	7	-
Software Revenue	**99**	**141**	**181**	**233**	**291**	**356**	**413**	**470**	**21**
Year-to-Year Increase (%)	37	42	28	29	25	22	16	14	-
Software Service	35	39	54	85	106	129	150	170	26
Hardware Service	26	42	54	78	89	100	111	121	18
Service Revenue	**62**	**81**	**108**	**163**	**195**	**230**	**261**	**291**	**22**
Year-to-Year Increase (%)	36	31	34	51	19	18	14	12	-
Total Factory Revenue	**325**	**454**	**554**	**743**	**863**	**1,002**	**1,125**	**1,244**	**18**
Year-to-Year Increase (%)	41	40	22	34	16	16	12	11	-

Source: Dataquest (August 1997)

Table B-2
Top Level Mechanical Forecast, China, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	1,456	2,032	2,254	2,900	3,600	4,300	5,000	5,600	20
Seats	1,492	2,060	2,279	2,900	3,600	4,400	5,000	5,600	20
Year-to-Year Increase (%)	26	38	11	28	24	21	15	12	-
Installed Base									
CPUs	3,632	4,753	5,843	7,300	9,200	11,500	14,000	16,600	23
Seats	3,922	4,977	6,016	7,400	9,300	11,600	14,100	16,600	23
Year-to-Year Increase (%)	22	27	21	23	25	25	22	18	-
Revenue Data ($M)									
CPU Revenue	17	27	33	46	56	68	77	85	21
Terminal Revenue	0	0	0	1	1	1	0	0	-6
Peripheral Revenue	1	1	2	2	2	2	2	2	9
Hardware Revenue	**18**	**29**	**35**	**49**	**59**	**71**	**80**	**87**	**20**
Year-to-Year Increase (%)	15	60	21	41	21	19	13	10	-
Software Revenue	**12**	**18**	**25**	**35**	**47**	**61**	**73**	**83**	**28**
Year-to-Year Increase (%)	15	56	34	44	34	29	19	15	-
Software Service	4	5	7	13	18	23	27	32	33
Hardware Service	4	6	8	13	16	19	21	24	23
Service Revenue	**8**	**11**	**16**	**26**	**33**	**42**	**49**	**55**	**29**
Year-to-Year Increase (%)	12	44	39	66	29	25	17	13	-
Total Factory Revenue	**38**	**58**	**75**	**110**	**140**	**173**	**201**	**226**	**25**
Year-to-Year Increase (%)	14	55	29	47	27	24	16	12	-

Source: Dataquest (August 1997)

Table B-3
Top Level Mechanical Forecast, Hong Kong, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	1,481	1,767	2,231	2,400	2,600	2,800	3,000	3,200	8
Seats	1,505	1,775	2,233	2,400	2,600	2,800	3,000	3,200	8
Year-to-Year Increase (%)	-1	18	26	10	7	8	7	6	-
Installed Base									
CPUs	3,951	4,666	5,593	6,500	7,400	8,300	9,100	9,800	12
Seats	4,144	4,805	5,682	6,600	7,400	8,300	9,100	9,800	12
Year-to-Year Increase (%)	20	16	18	15	13	12	10	8	-
Revenue Data ($M)									
CPU Revenue	13	20	23	27	27	29	30	32	7
Terminal Revenue	0	0	0	0	0	0	0	0	-17
Peripheral Revenue	1	2	2	2	2	2	2	2	1
Hardware Revenue	**14**	**22**	**25**	**29**	**29**	**31**	**32**	**34**	**6**
Year-to-Year Increase (%)	-2	51	13	19	0	5	5	4	-
Software Revenue	**9**	**12**	**17**	**20**	**22**	**26**	**29**	**33**	**15**
Year-to-Year Increase (%)	-7	46	33	19	14	16	12	12	-
Software Service	3	3	6	8	9	11	12	14	18
Hardware Service	2	4	5	7	8	8	9	9	12
Service Revenue	**5**	**7**	**11**	**16**	**17**	**19**	**21**	**23**	**15**
Year-to-Year Increase (%)	-2	35	52	41	8	12	10	9	-
Total Factory Revenue	**28**	**41**	**52**	**65**	**69**	**76**	**82**	**89**	**11**
Year-to-Year Increase (%)	-4	47	26	23	6	11	9	8	-

Source: Dataquest (August 1997)

Table B-4
Top Level Mechanical Forecast, Korea, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	4,104	5,135	5,639	6,300	7,000	7,900	8,700	9,400	11
Seats	4,316	5,335	5,831	6,500	7,200	8,000	8,800	9,500	10
Year-to-Year Increase (%)	36	24	9	11	11	11	10	8	-
Installed Base									
CPUs	8,258	11,532	14,310	16,800	19,300	22,100	25,000	27,900	14
Seats	8,810	12,161	14,990	17,500	20,000	22,800	25,600	28,500	14
Year-to-Year Increase (%)	55	38	23	17	14	14	13	11	-
Revenue Data ($M)									
CPU Revenue	29	46	55	67	74	83	92	100	13
Terminal Revenue	4	4	3	5	4	3	2	2	-12
Peripheral Revenue	4	4	3	3	3	3	3	3	3
Hardware Revenue	**37**	**53**	**61**	**75**	**82**	**89**	**98**	**104**	**11**
Year-to-Year Increase (%)	63	42	15	24	8	9	9	7	-
Software Revenue	**20**	**32**	**44**	**54**	**65**	**78**	**91**	**103**	**19**
Year-to-Year Increase (%)	47	62	37	22	22	20	17	13	-
Software Service	9	10	13	20	24	29	34	39	24
Hardware Service	5	9	13	17	19	21	24	26	15
Service Revenue	**14**	**19**	**26**	**37**	**44**	**51**	**58**	**64**	**20**
Year-to-Year Increase (%)	39	40	37	43	17	16	15	11	-
Total Factory Revenue	**71**	**104**	**131**	**166**	**191**	**218**	**247**	**272**	**16**
Year-to-Year Increase (%)	53	47	26	27	15	15	13	10	-

Source: Dataquest (August 1997)

Table B-5
Top Level Mechanical Forecast, Singapore, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	1,299	1,430	1,558	1,700	1,900	2,100	2,200	2,400	9
Seats	1,413	1,638	1,952	2,100	2,200	2,300	2,400	2,500	5
Year-to-Year Increase (%)	11	16	19	9	3	5	4	5	-
Installed Base									
CPUs	3,227	3,882	4,420	4,900	5,400	6,100	6,700	7,300	11
Seats	3,525	4,327	5,183	6,000	6,600	7,300	7,800	8,300	10
Year-to-Year Increase (%)	32	23	20	15	11	9	7	6	-
Revenue Data ($M)									
CPU Revenue	15	16	20	24	24	25	26	28	7
Terminal Revenue	2	4	7	12	9	6	4	3	-17
Peripheral Revenue	1	1	1	1	1	1	1	1	-3
Hardware Revenue	**18**	**21**	**28**	**36**	**33**	**32**	**31**	**31**	**3**
Year-to-Year Increase (%)	26	17	32	32	-9	-4	-2	0	-
Software Revenue	**10**	**10**	**14**	**17**	**19**	**22**	**25**	**28**	**15**
Year-to-Year Increase (%)	11	4	35	20	14	17	13	12	-
Software Service	3	3	5	7	8	9	10	11	20
Hardware Service	3	3	5	6	6	6	7	7	8
Service Revenue	**6**	**6**	**9**	**13**	**14**	**15**	**17**	**18**	**15**
Year-to-Year Increase (%)	3	0	42	41	7	10	9	9	-
Total Factory Revenue	**34**	**37**	**51**	**66**	**66**	**69**	**73**	**78**	**9**
Year-to-Year Increase (%)	17	10	35	30	0	5	5	6	-

Source: Dataquest (August 1997)

Table B-6
Top Level Mechanical Forecast, Taiwan, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	3,971	4,958	5,074	5,500	5,900	6,400	6,900	7,200	7
Seats	4,098	5,160	5,410	5,900	6,200	6,600	7,000	7,400	6
Year-to-Year Increase (%)	21	26	5	9	5	7	6	5	-
Installed Base									
CPUs	8,062	11,241	13,474	15,200	16,700	18,200	19,800	21,400	10
Seats	8,421	11,719	14,195	16,100	17,700	19,300	20,800	22,200	9
Year-to-Year Increase (%)	59	39	21	14	10	9	8	7	-
Revenue Data ($M)									
CPU Revenue	23	33	39	46	47	51	55	58	8
Terminal Revenue	3	4	6	10	7	6	4	3	-16
Peripheral Revenue	1	2	1	2	1	1	1	1	-1
Hardware Revenue	**27**	**38**	**46**	**58**	**56**	**58**	**60**	**62**	**6**
Year-to-Year Increase (%)	20	45	21	26	-4	3	4	3	-
Software Revenue	**17**	**24**	**30**	**36**	**41**	**48**	**55**	**61**	**15**
Year-to-Year Increase (%)	17	40	26	19	15	17	14	12	-
Software Service	6	7	8	12	14	16	18	21	21
Hardware Service	4	6	8	11	11	12	12	13	10
Service Revenue	**10**	**13**	**16**	**23**	**25**	**28**	**31**	**34**	**16**
Year-to-Year Increase (%)	25	35	21	42	8	13	11	10	-
Total Factory Revenue	**54**	**76**	**92**	**117**	**122**	**134**	**146**	**157**	**11**
Year-to-Year Increase (%)	20	41	22	26	4	10	9	8	-

Source: Dataquest (August 1997)

Table B-7
Top Level Mechanical Forecast, Rest of Asia/Pacific, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	5,792	7,367	7,247	8,500	10,300	11,900	13,200	14,500	15
Seats	5,955	7,486	7,371	8,700	10,400	12,000	13,300	14,600	15
Year-to-Year Increase (%)	63	26	-2	18	20	16	11	10	-
Installed Base									
CPUs	11,148	15,925	19,330	22,700	26,700	31,500	36,700	41,800	17
Seats	11,665	16,440	19,844	23,200	27,200	32,000	37,100	42,200	16
Year-to-Year Increase (%)	53	41	21	17	17	18	16	14	-
Revenue Data ($M)									
CPU Revenue	45	62	66	91	110	128	142	157	19
Terminal Revenue	2	1	1	2	2	1	1	1	-7
Peripheral Revenue	3	5	4	6	6	7	7	7	9
Hardware Revenue	**50**	**69**	**71**	**99**	**118**	**136**	**150**	**164**	**18**
Year-to-Year Increase (%)	115	38	3	38	19	15	11	9	-
Software Revenue	**32**	**44**	**52**	**72**	**96**	**121**	**140**	**161**	**26**
Year-to-Year Increase (%)	103	37	17	39	33	25	16	15	-
Software Service	10	11	15	25	33	41	48	54	29
Hardware Service	9	12	15	24	29	34	38	42	23
Service Revenue	**18**	**23**	**30**	**49**	**62**	**75**	**85**	**96**	**26**
Year-to-Year Increase (%)	112	27	28	64	27	21	14	13	-
Total Factory Revenue	**101**	**137**	**153**	**219**	**276**	**331**	**376**	**422**	**22**
Year-to-Year Increase (%)	110	35	12	43	26	20	13	12	-

Source: Dataquest (August 1997)

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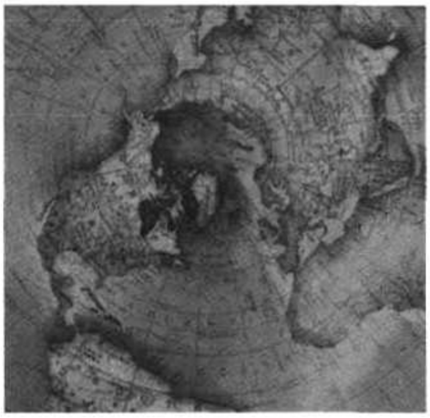

Dataquest

1997 Mechanical CAD/CAM/CAE Forecast Update

Market Statistics

Program: Mechanical CAD/CAM/CAE Worldwide
Product Code: CMEC-WW-MS-9704
Publication Date: September 29, 1997
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Chapter 1
1997 Mechanical CAD/CAM/CAE Forecast Update

Introduction

Dataquest's CAD/CAM/CAE, AEC and GIS, and EDA forecasts are based upon market share software revenue gathered primarily during the first quarter of 1997. Dataquest's software forecast for all applications includes:

- Three-year historical software and hardware revenue by region and operating system
- Five-year forecast of software, hardware, and service revenue by region and operating system
- Three-year history and five-year forecast of hardware shipments and installed base data

Although Dataquest does not forecast currency exchange rates, we do forecast with the best 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 July 1997 exchange rate will remain stable in the future (see Tables 1 and 2).

Dataquest's 1996 market share update documents for these markets (published as CAEC-WW-MS-9703, CEDA-WW-MS-9703, and CMEC-WW-MS-9703) were published and sent to our clients in August.

Worldwide Forecast Assumptions

The following sections describe the main forces driving the CAD/CAM/CAE, AEC and GIS, and EDA worldwide software forecasts.

All Applications

As CAD/CAM/CAE, AEC and GIS, and EDA becomes more of a replacement market, market leaders would appear to have the upper hand—the cost of switching is high. However, software that lets users get a better product to market faster and helps eliminate business risks will always be in demand, regardless of market share. Thus, there is always an opportunity for new vendors in technical markets.

The primary trend in design software function is toward operating at a higher level of abstraction. In all applications, Dataquest has seen an evolution of focus from electronic paper to component modeling and now to system modeling, with the eventual goal being to fully simulate, evaluate, redesign, and test the design inside the computer before manufacture. Meanwhile, increased computing power is allowing the nature of design to evolve to include constituencies in manufacturing, product support, and from users themselves. Thus the engineering process is being expanded to include input from a broader base.

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

	1995	1996	2001	Growth (%) 1995-1996	CAGR (%) 1996-2001
Europe (U.S.$M)					
Software Revenue	2,045.51	2,248.57	3,463.83	9.9	9.0
Hardware Revenue	2,816.50	2,861.37	3,682.31	1.6	5.2
Service Revenue	1,121.38	1,271.20	2,085.22	13.4	10.4
Total Factory Revenue	**5,983.39**	**6,381.13**	**9,228.66**	**6.6**	**7.7**
ECU/U.S.$ Exchange Rate*	**0.77**	**0.80**	**0.91**	**3.9**	**2.6**
Europe (ECU Million)					
Software Revenue	1,575.04	1,798.86	3,152.09	14.2	11.9
Hardware Revenue	2,168.70	2,289.09	3,350.91	5.6	7.9
Service Revenue	863.46	1,016.96	1,897.55	17.8	13.3
Total Factory Revenue	**4,607.21**	**5,104.91**	**8,398.08**	**10.8**	**10.5**
Japan (U.S.$M)					
Software Revenue	1,637.45	1,772.40	2,905.45	8.2	10.4
Hardware Revenue	2,772.38	2,793.91	3,723.95	0.8	5.9
Service Revenue	1,175.93	1,246.04	2,226.79	6.0	12.3
Total Factory Revenue	**5,585.76**	**5,812.35**	**8,856.19**	**4.1**	**8.8**
Japan/U.S.$ Exchange Rate*	**93.90**	**108.81**	**115.38**	**15.9**	**1.2**
Japan (Yen Million)					
Software Revenue	153,756.13	192,855.17	335,231.16	25.4	11.7
Hardware Revenue	260,326.42	304,005.04	429,669.19	16.8	7.2
Service Revenue	110,420.25	135,581.93	256,927.31	22.8	13.6
Total Factory Revenue	**524,502.80**	**632,442.14**	**1,021,827.66**	**20.6**	**10.1**
North America (U.S.$M)					
Software Revenue	2,138.08	2,531.06	5,162.27	18.4	15.3
Hardware Revenue	2,774.01	2,998.23	5,751.18	8.1	13.9
Service Revenue	1,230.68	1,483.94	3,056.50	20.6	15.5
Total Factory Revenue	**6,142.76**	**7,013.23**	**13,969.95**	**14.2**	**14.8**
Worldwide (U.S.$M)					
Software Revenue	6,306.82	7,159.11	13,265.95	13.5	13.1
Hardware Revenue	9,050.96	9,440.39	15,190.53	4.3	10.0
Service Revenue	3,801.12	4,352.20	8,412.34	14.5	14.1
Total Factory Revenue	**19,158.90**	**20,951.70**	**36,866.13**	**9.4**	**12.0**

*Assuming a stable currency, the 2001 exchange rate is the same as the July 1997 exchange rate.
Source: Dataquest (August 1997)

Table 2
Foreign Currency/U.S. Dollar

		Actual					Current		Year-to-Year Change (%)					
Country	Currency	1992	1993	1994	1995	1996	1997	1998	1992-1993	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998
Austria	Schilling	10.95	11.65	11.40	10.06	10.59	11.43	12.62	6.4	-2.1	-11.8	5.3	7.9	10.4
Belgium	Franc	32.02	34.67	33.66	29.42	30.96	33.50	37.04	8.3	-2.9	-12.6	5.2	8.2	10.6
Denmark	Krone	6.02	6.49	6.35	5.59	5.81	6.21	6.83	7.8	-2.2	-12.0	3.9	6.9	10.0
Finland	Markka	4.45	5.73	5.21	4.37	4.59	4.86	5.32	28.8	-9.1	-16.1	5.0	5.9	9.5
France	Franc	5.27	5.67	5.54	4.97	5.12	5.49	6.05	7.6	-2.3	-10.3	3.0	7.2	10.2
Germany	D-Mark	1.56	1.66	1.62	1.43	1.50	1.63	1.79	6.4	-2.4	-11.7	4.9	8.7	9.8
Italy	Lira	1,227.75	1,577.85	1,609.34	1,628.21	1,542.72	1,611.40	1,745.91	28.5	2.0	1.2	-5.3	4.5	8.3
Netherlands	Guilder	1.75	1.86	1.82	1.60	1.69	1.83	2.02	6.3	-2.2	-12.1	5.6	8.3	10.4
Norway	Krone	6.18	7.11	7.04	6.33	6.46	6.73	7.45	15.0	-1.0	-10.1	2.1	4.2	10.7
Spain	Peseta	101.90	127.87	133.48	124.40	126.68	137.12	151.33	25.5	4.4	-6.8	1.8	8.2	10.4
Sweden	Krona	5.81	7.82	7.70	7.14	6.71	7.20	7.81	34.6	-1.5	-7.3	-6.0	7.3	8.5
Switzerland	Franc	1.40	1.48	1.37	1.18	1.24	1.37	1.48	5.7	-7.4	-13.9	5.1	10.5	8.0
United Kingdom	Pound	0.57	0.67	0.65	0.63	0.64	0.62	0.60	17.5	-3.0	-3.1	1.6	-3.1	-3.2
Europe Average	ECU	0.77	0.86	0.84	0.77	0.80	0.84	0.91	11.4	-1.5	-8.7	3.9	5.0	8.3
China	Renminbi	5.51	5.76	8.54	8.32	8.34	8.33	8.32	4.5	48.3	-2.6	0.2	-0.1	-0.1
Hong Kong	Dollar	7.74	7.74	7.73	7.74	7.73	7.74	7.75	0	-0.1	0.1	-0.1	0.1	0.1
Japan	Yen	126.34	110.85	101.56	93.90	108.81	116.22	115.38	-12.3	-8.4	-7.5	15.9	6.8	-0.7
Korea	Won	782.41	799.42	805.80	770.57	805.16	860.04	893.09	2.2	0.8	-4.4	4.5	6.8	3.8
Singapore	Dollar	1.63	1.62	1.53	1.43	1.41	1.42	1.45	-0.9	-5.3	-6.5	-1.4	0.7	2.1
Taiwan	Dollar	24.93	26.15	26.45	26.48	27.47	27.62	28.03	4.9	1.1	0.1	3.7	0.5	1.5

Source: Dataquest (September 1997)

At the same time, the nature of design data itself is expanding from a focus on geometry to include multiple data types, making the challenge of system modeling even more complex. Also, the World Wide Web holds the potential to expand the nature of collaborative design by harnessing the joint power of anticipated increases in both computing power and communications bandwidth. Thus, there is little limit to the problems that design or GIS software can tackle. The primary challenge will continue to be to develop robust, leading-edge software ahead of competitors. During the forecast period, Dataquest anticipates significant, but not revolutionary, advances in the ability of the existing programmer pool to produce new software.

In addition to technology trends, it is also necessary to consider exchange rate fluctuations, especially as the dollar has continued to strengthen against most major currencies of the world, such as the deutsche mark and the yen, over the past year. Growth rates in countries where the dollar has strengthened against the local currency are likely to be adversely affected when considered in dollar-denominated terms.

Mechanical Forecast Assumptions

The following factors will promote expansion of the mechanical CAD/CAM/CAE market.

Renewed Investment in Mechanical CAD Technology

Over the past two years, Dataquest has seen renewed investment in mechanical CAD/CAM/CAE technology among the major aerospace and automotive companies, particularly in North America and Europe. Now that these companies have completed their investment cycles, we expect to see corresponding investment by their supplier bases as a key driver of the market going forward. Furthermore, many of these major companies that reinvested in base CAD technology will be looking to further invest in design automation. Add-on, niche applications should be pushing the market toward higher growth over our forecast period.

At the regional level, the outlook for Europe continues to be positive. The weakening of major European currencies against the dollar has helped the export of manufactured goods in countries like Germany, France, Italy, and Spain, and this is creating a more favorable climate for business investment and industrial production. The dollar has also strengthened against the Japanese yen over the past year, and indications are for an economic upturn in Japan, as well, in the near term.

New Software, New Platforms, New Users

Despite the fact that it is still a UNIX-based world out there, there is a very strong interest in NT-based mechanical design solutions. Vendors spent 1995 and 1996 making solutions available on the NT platform, and, finally, designers and engineers have a number of packages to choose from. The prospects of lower-cost software on lower-cost platforms have sparked renewed interest in CAD technology among designers who have not been purchasing CAD systems in recent years.

NT is beginning to encroach on the installed base for DOS/Windows and Windows 95 at the low end and UNIX at the high end. The move to replace UNIX will take longer than the replacement at the low end, especially for industries that need surfacing technologies. For example, today it is not possible to model the surface of a complete car using NT machines. These tasks still depend on high-end UNIX workstations. Also, a large proportion of 3-D CAD software packages are still on UNIX. But 3-D CAD software is becoming less expensive and easier to use and is moving to NT in a big way.

Untapped Users Eager for Technology

While CAD investment in Europe and North America will begin to slow down over our forecast period, the Asia/Pacific region is just beginning to take off, fueled by CAD investments from local and national governments (such as Indonesia's IPTN) and multinational companies. As manufacturing continues to move offshore into the Asia/Pacific region, Dataquest expects to see an increased level of CAD sophistication among the users. Similarly, mechanical CAD/CAM/CAE growth in Japan is expected to undergo major reinvestment over our forecast period. The UNIX platform dominates the mechanical sector in Japan today, and the Japanese mechanical market still places a heavy emphasis on 2-D design rather than solid modeling. We expect to see a movement of many Japanese CAD users from 2-D and proprietary systems to 3-D commercial systems over our forecast period.

The following trends will slow growth in the mechanical CAD/CAM/CAE market.

CAD Investments Are Cyclical

The major aerospace and automotive companies, particularly in Europe, have been significant drivers of the double-digit mechanical CAD/CAM/CAE growth Dataquest has seen over the last two years. However, these companies have now completed their investment cycles in CAD technology for the next four to six years. Investment in CAD by these companies will slow significantly until the next investment cycle begins, bringing down the overall market growth.

Meeting User Needs Beyond Design

In order for the mechanical CAD/CAM/CAE market to maintain the high growth that it has experienced in recent years, designers need applications that do more than just design. Design needs to become more tightly integrated with manufacturing and analysis, and beyond that, the whole process of bringing a product to market cannot continue to live in isolation within the engineering walls. Vendors are beginning to address this issue today, but it will take some time before users as well as vendors determine exactly what is needed and how it can work within the business processes of a company.

AEC Forecast Assumptions

The following factors will contribute to the long-term expansion of the AEC CAD industry.

CAD Is Becoming a Business Requirement

Large design firms are growing at the expense of smaller firms, and 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.

AEC Market Penetration

A significant pool of untapped users still exists, and the relatively low market penetration of AEC CAD systems should allow steady worldwide growth during the next five years, despite constant volatility in demand for the buildings and infrastructure to be designed.

New Features in AEC CAD Products Are Achievable

Better, lower-cost visualization tools will be in increasing demand as sales and communication tools. Data and database functions are growing in importance in AEC design, creating opportunities to sell users significant new functionality. Some vendors will create products that foster communications in the entire design, construction, and maintenance process—products that will increase the payoff in CAD investments.

The following trends will inhibit growth in AEC.

Design Is Only Part of the Problem

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 not well-addressed by AEC systems today. Design tools can only thrive in the AEC structure when they support more of the entire business problem. Commitment to and cooperation on the problem from multiple vendors will allow Dataquest to increase the forecast growth rate further.

GIS/Mapping Forecast Assumptions

The following sections identify those factors that will promote growth in the worldwide GIS market.

Impact of Windows NT

Intergraph's move to Windows NT at the expense of UNIX will quickly make PC-based operating systems the dominant revenue stream in North America. In the long term, the GIS UNIX market is highly subject to erosion by Windows NT because of the appealing prospects of better integration of GIS and Windows-based productivity tools.

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 or have only entry-level systems in terms of value delivered.

New Technologies

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, and laser range finders are making it possible to create GISs that are significantly less expensive, 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. Finally, database companies themselves are gaining a better understanding of spatial analysis, a key factor in spreading use of GIS systems more broadly.

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

Long-term expansion of the GIS market will be constrained by the following factors.

High Cost of Entry Remains a Barrier

There will remain an uncertain, but certainly high, cost of creating a working GIS 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."

Price Pressures Inhibit Growth

Price pressure will hold down total revenue in the GIS market. Innovation is the only way to maintain prices in any software industry, and GIS vendors will struggle in their attempt to create compelling new applications and improved investment payoff for customers.

Electronic Design Automation Forecast Assumptions

It is fairly obvious that the EDA industry is not used to this level of prosperity. This market's 1996 estimates were almost 1 percent below the 1996 actual figures. This has been driven by an almost unprecedented seat count growth. Companies can no longer afford the level of tool sharing seen in the past. Mainstream companies have started re-engineering their engineering groups. Dataquest's lowest estimate of a week lost in the design cycle is $155,000, and that isn't counting lost market opportunity and so on. This makes the decision to by a new toolset fairly easy.

The bad news is that sales in CAE are still primarily in the older tools. Only in the two CAD applications, IC CAD and PCB Design, is there the impact of a new generation of tools. Dataquest continues to expect a slowdown after the second design cycle is completed in early 1999. The only way to grow through that dip would be to get the new register transfer level (RTL) methodology tools on the market by the end of next year—unfortunately, that doesn't look very likely at this point.

Electronic CAE

CAE was the one area that came in below the preliminary numbers. By operation system, it was apparent that NT is growing faster than expected. This is mirrored by UNIX sales being almost 3 percent lower than reported in the preliminary numbers. North America came in as expected, but Japan reported lower numbers, which was the cause of the miss. Europe came in higher, showing a lot more life than most people expected.

IC Layout

IC layout was where the industry showed its reluctance to believe its own reports. Although the preliminary numbers came in below Dataquest's expectations, the final numbers blew the Dataquest forecast out of the water. IC CAD grew more than 38 percent.

The general explanation from IC CAD suppliers was that they just didn't believe their preliminary numbers and therefore lowballed their response until they got the actual figures from their regions. Europe was the big surprise, coming in at almost 28 percent more than the preliminary numbers.

PCB Design

The PCB design market came in about 1 percent higher than the preliminary numbers, and here the UNIX-to-NT migration is really evident. Not unexpectedly, UNIX is all but finished as the platform of choice for PCB design. What wasn't taken into account was the decrease in the "swap-out" rate. Basically, the PCB world is upgrading hardware almost two years faster than in the past. This was another surprisingly strong market in Europe.

History and Forecast for All Applications and Operating Systems

Table 3 shows the history and forecast of all applications.

Forecast Methodology

Fundamental to the way Dataquest conducts its research is the underlying philosophy that the best data and analyses come from a well-balanced program. This program includes the following: balance between primary and secondary collection techniques; balance between supply-side and demand-side analysis; balance between focused, industry-specific research and coordinated, "big-picture" analysis aided by integration of data from the more than 25 separate high-technology industries Dataquest covers; and balance between the perspectives of experienced industry professionals and rigorous, disciplined techniques of seasoned market researchers.

Table 3
Top Level Worldwide CAD/CAM/CAE/GIS Software History and Forecast, All Applications and Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Software Revenue ($M)									
Worldwide, All Operating Systems	**5,283**	**6,307**	**7,159**	**8,078**	**9,265**	**10,223**	**11,599**	**13,266**	**13.1**
Worldwide									
UNIX	3,708	4,275	4,789	5,237	5,758	6,103	6,556	7,098	8.2
Windows NT	118	351	736	1,239	1,867	2,424	3,290	4,361	42.7
Personal Computer	1,265	1,499	1,478	1,492	1,564	1,648	1,722	1,786	3.9
Host/Proprietary	192	181	155	109	76	49	31	21	-33.1
All Operating Systems									
North America	1,825	2,138	2,531	2,969	3,474	3,848	4,453	5,162	15.3
Europe	1,691	2,046	2,249	2,368	2,620	2,857	3,136	3,464	9.0
Japan	1,406	1,637	1,772	1,984	2,223	2,395	2,632	2,905	10.4
Asia/Pacific	277	376	483	612	770	918	1,125	1,401	23.7
Rest of World	84	109	124	145	178	206	254	334	21.9
Year-to-Year Software Revenue Growth Rate (%)									
Worldwide, All Operating Systems	-	**19.4**	**13.5**	**12.8**	**14.7**	**10.3**	**13.5**	**14.4**	-
Worldwide									
UNIX	-	15.3	12.0	9.3	9.9	6.0	7.4	8.3	-
Windows NT	-	196.9	109.6	68.4	50.6	29.9	35.7	32.6	-
Personal Computer	-	18.5	-1.4	0.9	4.8	5.4	4.5	3.7	-
Host/Proprietary	-	-5.9	-14.1	-29.6	-30.4	-36.3	-35.5	-33.5	-
All Operating Systems									
North America	-	17.2	18.4	17.3	17.0	10.8	15.7	15.9	-
Europe	-	21.0	9.9	5.3	10.6	9.0	9.8	10.4	-
Japan	-	16.4	8.2	11.9	12.0	7.7	9.9	10.4	-
Asia/Pacific	-	35.7	28.3	26.7	25.8	19.2	22.5	24.5	-
Rest of World	-	30.5	13.4	17.0	22.7	15.6	23.2	31.7	-

NA = Not applicable
Source: Dataquest (August 1997)

Dataquest also analyzes trends in the macroenvironment, which can have major influences on both supply-side and demand-side forecasting. In addition to demographics, analysts look at gross national product (GNP) growth, interest rate fluctuation, business expectations, and capital spending plans. In the geopolitical arena, the group looks at trade issues, political stability or lack thereof, tariffs, nontariff barriers, and such factors as the effect on Europe of the events of 1996.

Figure 1 shows the CAD/CAM/CAE, AEC and GIS, and EDA forecasting model. The overall forecasting process uses a combination of techniques, such as time series and technological modeling. Market estimates and forecasts are derived using the following research techniques:

- Segment forecasting—Individual forecasts are derived for each application segment tracked by the CAD/CAM/CAE, AEC and GIS, and EDA groups. Specifically, each application, segmented by region and platform, is forecast and rolled up. In this way, each application segment incorporates its own set of unique assumptions.
- Demand-based analysis—Market growth is tracked and forecast in terms of the present and anticipated demand of current and future users. This requires the development of a total available market model and a satisfied available market figure to assess the levels of penetration accurately. Dataquest analysts also factor in the acceptance or ability for users to consume new technology.
- Capacity-based analysis—This method involves identifying future shipment volume constraints. These constraints, or "ceilings," can be the result of component availability, manufacturing capacity, or distribution capacity. In any case, capacity limitations are capable of keeping shipments below the demand level.

Changes to the Forecast Database

Within this forecasting model, Dataquest has made numerous assumption changes that better reflect the reality in the changing mechanical CAD/CAM/CAE, AEC and GIS, and EDA worlds. These changes include updating the hardware retirement model and altering the average selling prices (ASPs) for software, service, and hardware.

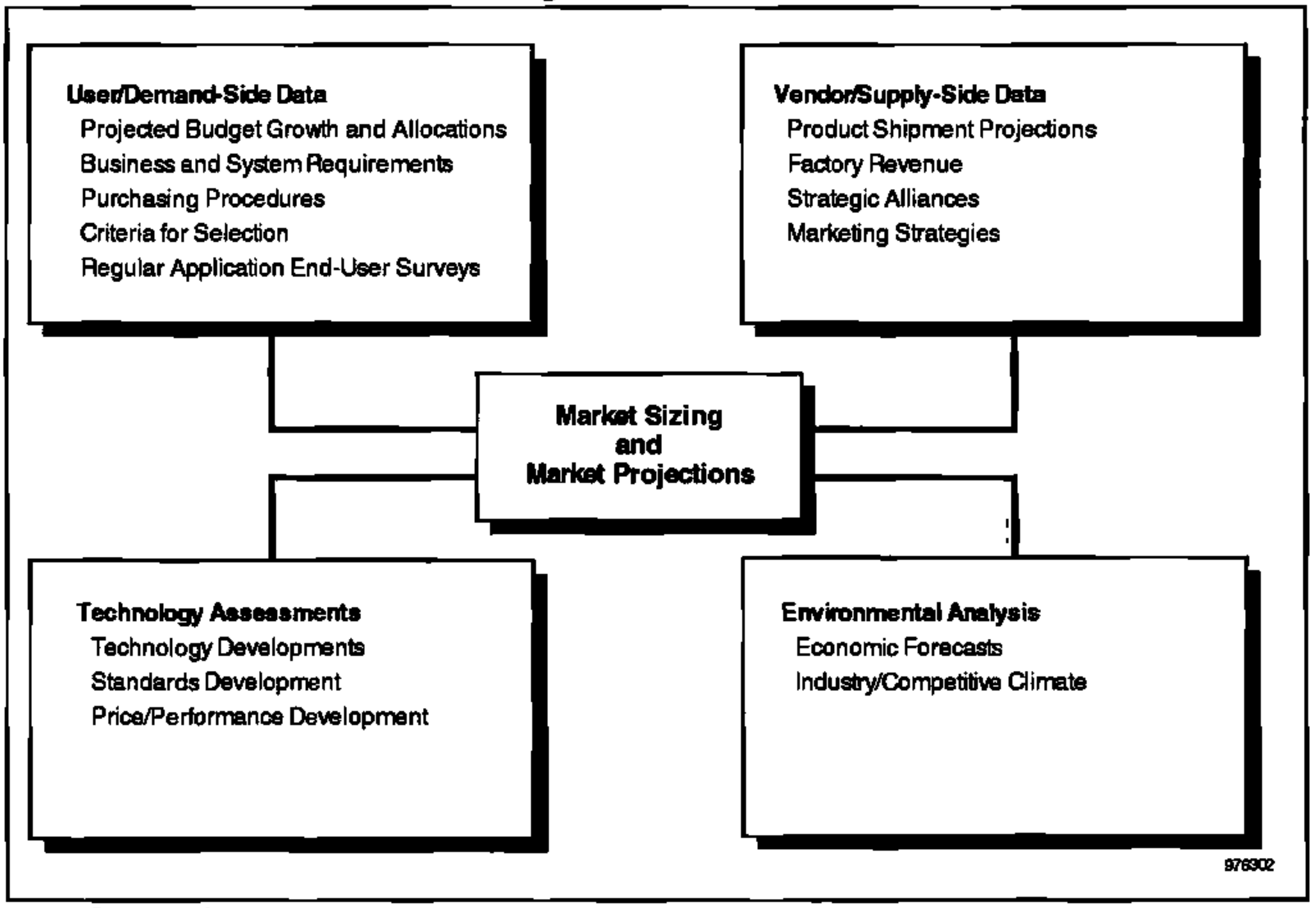
Segmentation Definitions

Operating Systems

The following defines the operating systems:

- UNIX—Includes all UNIX variants and older workstation operating systems.
- Host—Includes minicomputer and mainframe operating systems in which external workstations' functions are dependent on a host computer.
- Windows NT—The Microsoft operating system.
- PC—Includes DOS, Windows, Windows 95, OS/2, and Apple operating systems.

Figure 1
CAD/CAM/CAE and GIS Forecasting Model



Source: Dataquest (September 1997)

Line Items

Line item definitions are as follows:

- Average selling price (ASP) is defined as the average price of a product, inclusive of any discounts.
- CPU revenue is the portion of revenue derived from a system sale that is related to the value of the CPU.
- CPU shipment is defined as the number of CPUs delivered.
- CPU installed base is defined as the total number of CPUs in active, day-to-day use.
- Unit shipment is defined as the number of products delivered (that is, seats).
- Seats are defined as the number of possible simultaneous users.
- Installed seats are defined as the total number of seats in active, day-to-day use.
- Hardware revenue is defined as the sum of the revenue from the hardware system components: CPU revenue, terminal revenue, and peripherals revenue.

- Peripherals revenue is defined as the value of all the peripherals from turnkey sale. (Peripherals in this category typically are input and output devices.)
- Terminal revenue is defined as revenue derived from the sale of terminals used to graphically create, analyze, or manipulate designs. The term is applicable only to the host systems.
- Software revenue is revenue derived from the sale of application software.
- Service revenue is defined as revenue derived from the service and support of CAD/CAM/CAE, AEC and GIS, or EDA systems. Service is followed as software service and hardware service.
- Total factory revenue is defined as the amount of money received for goods measured in U.S. dollars and is the sum of hardware, software, and service revenue.

Regions

The following defines the different regions Dataquest tracks:

- North America
  - United States—The 48 contiguous states, Washington D.C., Alaska, Hawaii, and Puerto Rico
  - Canada—Single-country region
  - Mexico—Single-country region
- Europe
  - Western Europe—Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, and the United Kingdom
  - Rest of Western Europe—Andorra, Cyprus, Faroe Islands, Gibraltar, Greenland, Guernsey, Iceland, Jersey, Liechtenstein, Malta, Republic of Monaco, San Marino, and Vatican City
  - Central and Eastern Europe—Albania, Armenia, Azerbaijan, Belarus, Bosnia, Bulgaria, Croatia, Czech Republic, Estonia, Federal Republic of Yugoslavia (including Serbia and Montenegro), Georgia, Hungary, Kazakhstan, Krygyzstan, Latvia, Lithuania, Macedonia, Moldova, Poland, Romania, Russia (as far as the Urals), Slovakia, Slovenia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan
- Japan—Single-country region
- Asia/Pacific—Australia, Bangladesh, Brunei, Cambodia, China, Hong Kong, India, Indonesia, Korea, Laos, Malaysia, Maldives, Myanmar, Nepal, New Zealand, Pakistan, the Philippines, Singapore, Sri Lanka, Taiwan, Thailand, and Vietnam
- Rest of World—Africa, the Caribbean, the Middle East, Oceania, and South America

Chapter 2
Market Statistics Tables

Table A-1
CAD/CAM/CAE/GIS Software History and Forecast, Top Level Mechanical Forecast, Worldwide, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Software Revenue ($M)									
Worldwide, All Operating Systems	**2,436**	**2,963**	**3,345**	**3,689**	**4,108**	**4,502**	**4,893**	**5,332**	**9.8**
Worldwide									
UNIX	1,804	2,190	2,412	2,566	2,745	2,903	3,037	3,168	5.6
Windows NT	42	115	295	507	744	980	1,229	1,526	38.9
Personal Computer	460	540	538	546	567	585	604	621	2.9
Host/Proprietary	131	117	100	69	52	34	23	16	-30.4
All Operating Systems									
North America	730	859	1,009	1,139	1,265	1,400	1,540	1,689	10.9
Europe	825	1,024	1,149	1,197	1,317	1,419	1,534	1,683	7.9
Japan	753	902	970	1,081	1,194	1,283	1,359	1,440	8.2
Asia/Pacific	99	141	181	233	291	356	413	470	21.1
Rest of World	28	36	36	38	41	44	47	49	6.5
Year-to-Year Software Revenue Growth Rate (%)									
Worldwide, All Operating Systems	**-**	**21.6**	**12.9**	**10.3**	**11.4**	**9.6**	**8.7**	**9.0**	-
Worldwide									
UNIX	-	21.4	10.1	6.4	7.0	5.8	4.6	4.3	-
Windows NT	-	176.2	155.3	72.1	46.6	31.8	25.4	24.1	-
Personal Computer	-	17.4	-0.4	1.5	3.9	3.1	3.2	2.9	-
Host/Proprietary	-	-10.4	-14.6	-31.0	-24.6	-34.6	-31.8	-29.7	-
All Operating Systems									
North America	-	17.7	17.4	12.9	11.1	10.6	10.0	9.7	-
Europe	-	24.1	12.2	4.2	10.0	7.8	8.1	9.7	-
Japan	-	19.7	7.6	11.4	10.4	7.5	5.9	6.0	-
Asia/Pacific	-	42.2	28.0	28.9	25.0	22.3	16.0	13.8	-
Rest of World	-	29.3	-0.5	6.8	6.8	7.2	6.6	5.2	-

NA = Not applicable
Source: Dataquest (August 1997)

Table B-1
CAD/CAM/CAE/GIS Software History and Forecast, Detail Mechanical Forecast, Worldwide, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	287,782	335,469	352,016	369,100	395,100	418,800	444,400	470,400	6
Seats	298,796	344,522	361,193	375,700	400,100	422,500	447,000	472,300	6
Year-to-Year Increase (%)	5	15	5	4	6	6	6	6	-
Installed Base			retirements						
CPUs	816,452	923,709	1,019,026	1,098,400	1,181,600	1,275,400	1,375,500	1,478,800	8
Seats	880,923	978,271	1,066,176	1,138,500	1,214,600	1,301,900	1,396,100	1,494,600	7
Year-to-Year Increase (%)	10	11	9	7	7	7	7	7	-
Revenue Data ($M)									
CPU Revenue	3,458	3,936	4,160	4,488	4,697	4,900	5,148	5,395	5
Terminal Revenue	203	154	136	167	116	74	47	30	-26
Peripheral Revenue	286	342	349	355	348	335	323	312	-2
Hardware Revenue	**3,947**	**4,432**	**4,644**	**5,010**	**5,161**	**5,308**	**5,517**	**5,736**	**4**
Year-to-Year Increase (%)	11	12	5	8	3	3	4	4	-
Software Revenue	**2,436**	**2,963**	**3,345**	**3,689**	**4,108**	**4,502**	**4,893**	**5,332**	**10**
Year-to-Year Increase (%)	8	22	13	10	11	10	9	9	-
Software Service	907	918	1,103	1,448	1,602	1,750	1,890	2,043	13
Hardware Service	703	834	925	1,104	1,168	1,225	1,300	1,379	8
Service Revenue	**1,610**	**1,752**	**2,028**	**2,552**	**2,770**	**2,975**	**3,189**	**3,422**	**11**
Year-to-Year Increase (%)	12	9	16	26	9	7	7	7	-
Total Factory Revenue	**7,992**	**9,148**	**10,017**	**11,250**	**12,039**	**12,785**	**13,599**	**14,490**	**8**
Year-to-Year Increase (%)	10	14	10	12	7	6	6	7	-

NA = Not applicable
Source: Dataquest (August 1997)

Table B-2
CAD/CAM/CAE/GIS Software History and Forecast, Detail Mechanical Forecast, Worldwide, UNIX

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	108,741	125,287	136,547	134,000	138,400	142,700	147,400	152,000	2
Seats	108,741	125,287	136,547	134,000	138,400	142,700	147,400	152,000	2
Year-to-Year Increase (%)	15	15	9	-2	3	3	3	3	-
Installed Base									
CPUs	320,002	375,343	427,913	463,800	497,000	537,100	580,800	624,500	8
Seats	320,002	375,343	427,913	463,800	497,000	537,100	580,800	624,500	8
Year-to-Year Increase (%)	19	17	14	8	7	8	8	8	-
Revenue Data ($M)									
CPU Revenue	2,439	2,898	2,973	3,093	3,219	3,329	3,441	3,528	3
Terminal Revenue	-	-	-	-	-	-	-	-	NA
Peripheral Revenue	217	259	257	249	241	230	217	204	-4
Hardware Revenue	**2,655**	**3,157**	**3,230**	**3,342**	**3,460**	**3,560**	**3,658**	**3,732**	**3**
Year-to-Year Increase (%)	16	19	2	3	4	3	3	2	-
Software Revenue	**1,804**	**2,190**	**2,412**	**2,566**	**2,745**	**2,903**	**3,037**	**3,168**	**6**
Year-to-Year Increase (%)	15	21	10	6	7	6	5	4	-
Software Service	739	728	871	1,124	1,203	1,278	1,336	1,393	10
Hardware Service	555	699	775	897	966	1,032	1,101	1,164	8
Service Revenue	**1,294**	**1,427**	**1,646**	**2,021**	**2,169**	**2,310**	**2,437**	**2,558**	**9**
Year-to-Year Increase (%)	12	10	15	23	7	7	5	5	-
Total Factory Revenue	**5,754**	**6,775**	**7,288**	**7,929**	**8,374**	**8,773**	**9,132**	**9,458**	**5**
Year-to-Year Increase (%)	15	18	8	9	6	5	4	4	-

NA = Not applicable
Source: Dataquest (August 1997)

Table B-3
CAD/CAM/CAE/GIS Software History and Forecast, Detail Mechanical Forecast, Worldwide, NT/Hybrid

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	2,270	5,957	14,371	27,600	37,900	47,000	56,600	67,500	36
Seats	2,270	5,957	14,371	27,600	37,900	47,000	56,600	67,500	36
Year-to-Year Increase (%)	3,064	162	141	92	37	24	20	19	-
Installed Base									
CPUs	2,335	8,043	20,871	44,600	73,200	102,500	131,300	160,700	50
Seats	2,335	8,043	20,871	44,600	73,200	102,500	131,300	160,700	50
Year-to-Year Increase (%)	3,154	244	160	114	64	40	28	22	-
Revenue Data ($M)									
CPU Revenue	28	69	168	336	473	602	756	918	41
Terminal Revenue	-	-	-	-	-	-	-	-	NA
Peripheral Revenue	4	6	10	18	24	28	33	38	30
Hardware Revenue	**33**	**74**	**178**	**353**	**497**	**630**	**789**	**956**	**40**
Year-to-Year Increase (%)	3,893	128	139	99	41	27	25	21	-
Software Revenue	**42**	**115**	**295**	**507**	**744**	**980**	**1,229**	**1,526**	**39**
Year-to-Year Increase (%)	2,739	176	155	72	47	32	25	24	-
Software Service	15	31	66	162	239	322	410	512	51
Hardware Service	11	9	23	38	58	79	105	133	43
Service Revenue	**27**	**40**	**89**	**200**	**297**	**401**	**515**	**645**	**49**
Year-to-Year Increase (%)	15,766	49	124	125	49	35	28	25	-
Total Factory Revenue	**101**	**230**	**561**	**1,060**	**1,537**	**2,011**	**2,532**	**3,127**	**41**
Year-to-Year Increase (%)	4,009	127	145	89	45	31	26	23	-

NA = Not applicable
Source: Dataquest (August 1997)

Table B-4
CAD/CAM/CAE/GIS Software History and Forecast, Detail Mechanical Forecast, Worldwide, Personal Computer

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	173,134	201,491	198,238	205,300	216,900	228,000	239,500	250,200	5
Seats	173,136	201,675	198,513	205,300	216,900	228,000	239,500	250,200	5
Year-to-Year Increase (%)	-1	16	-2	3	6	5	5	4	-
Installed Base									
CPUs	474,378	523,399	555,396	577,200	600,300	626,900	656,400	688,100	4
Seats	474,378	523,399	555,396	577,200	600,300	626,900	656,400	688,100	4
Year-to-Year Increase (%)	8	10	6	4	4	4	5	5	-
Revenue Data ($M)									
CPU Revenue	598	693	693	743	786	830	864	894	5
Terminal Revenue	-	-	-	-	-	-	-	-	NA
Peripheral Revenue	46	48	44	48	51	54	57	59	6
Hardware Revenue	**644**	**740**	**738**	**791**	**837**	**884**	**921**	**952**	**5**
Year-to-Year Increase (%)	16	15	0	7	6	6	4	3	-
Software Revenue	**460**	**540**	**538**	**546**	**567**	**585**	**604**	**621**	**3**
Year-to-Year Increase (%)	3	17	0	2	4	3	3	3	-
Software Service	68	77	82	87	92	96	98	101	4
Hardware Service	30	31	30	39	41	43	45	47	9
Service Revenue	**98**	**107**	**112**	**126**	**133**	**139**	**144**	**148**	**6**
Year-to-Year Increase (%)	1	9	4	12	5	5	3	3	-
Total Factory Revenue	**1,202**	**1,388**	**1,387**	**1,463**	**1,537**	**1,608**	**1,668**	**1,721**	**4**
Year-to-Year Increase (%)	9	15	0	5	5	5	4	3	-

NA = Not applicable
Source: Dataquest (August 1997)

Table B-5
CAD/CAM/CAE/GIS Software History and Forecast, Detail Mechanical Forecast, Worldwide, Host/Proprietary

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	3,637	2,734	2,860	2,200	2,000	1,200	900	700	-25
Seats	14,649	11,603	11,762	8,800	6,900	4,900	3,400	2,600	-26
Year-to-Year Increase (%)	-12	-21	1	-25	-21	-30	-29	-24	-
Installed Base									
CPUs	19,737	16,925	14,846	12,800	11,000	9,000	7,000	5,400	-18
Seats	84,208	71,487	61,997	52,900	44,100	35,500	27,600	21,200	-19
Year-to-Year Increase (%)	-12	-15	-13	-15	-17	-20	-22	-23	-
Revenue Data ($M)									
CPU Revenue	393	277	326	315	218	138	87	55	-30
Terminal Revenue	203	154	136	167	116	74	47	30	-26
Peripheral Revenue	18	30	37	41	33	23	16	11	-21
Hardware Revenue	**615**	**460**	**498**	**523**	**367**	**235**	**150**	**96**	**-28**
Year-to-Year Increase (%)	-13	-25	8	5	-30	-36	-36	-36	-
Software Revenue	**131**	**117**	**100**	**69**	**52**	**34**	**23**	**16**	**-30**
Year-to-Year Increase (%)	-45	-10	-15	-31	-25	-35	-32	-30	-
Software Service	84	82	83	75	68	54	46	37	-15
Hardware Service	106	96	98	130	104	71	49	35	-18
Service Revenue	**191**	**179**	**181**	**205**	**171**	**125**	**94**	**72**	**-17**
Year-to-Year Increase (%)	0	-6	2	13	-17	-27	-25	-23	-
Total Factory Revenue	**936**	**756**	**780**	**798**	**590**	**394**	**267**	**184**	**-25**
Year-to-Year Increase (%)	-18	-19	3	2	-26	-33	-32	-31	-

NA = Not applicable
Source: Dataquest (August 1997)

Table B-6
CAD/CAM/CAE/GIS Software History and Forecast, Detail Mechanical Forecast, North America, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	105,999	118,917	119,740	127,800	136,200	144,600	153,700	162,800	6
Seats	108,988	120,622	121,416	128,700	136,700	144,900	154,000	163,000	6
Year-to-Year Increase (%)	1	11	1	6	6	6	6	6	-
Installed Base									
CPUs	304,001	334,956	357,968	380,700	407,600	440,700	477,200	515,000	8
Seats	325,918	351,771	370,946	390,300	414,500	445,400	480,300	517,100	7
Year-to-Year Increase (%)	8	8	5	5	6	7	8	8	-
Revenue Data ($M)									
CPU Revenue	943	1,056	1,156	1,261	1,324	1,408	1,517	1,619	7
Terminal Revenue	49	33	27	23	12	8	5	4	-33
Peripheral Revenue	28	32	38	37	35	33	33	32	-3
Hardware Revenue	**1,019**	**1,121**	**1,221**	**1,321**	**1,371**	**1,449**	**1,555**	**1,655**	**6**
Year-to-Year Increase (%)	7	10	9	8	4	6	7	6	-
Software Revenue	**730**	**859**	**1,009**	**1,139**	**1,265**	**1,400**	**1,540**	**1,689**	**11**
Year-to-Year Increase (%)	5	18	17	13	11	11	10	10	-
Software Service	247	236	305	419	469	524	582	642	16
Hardware Service	194	223	265	313	332	359	394	430	10
Service Revenue	**441**	**460**	**569**	**732**	**800**	**883**	**976**	**1,072**	**13**
Year-to-Year Increase (%)	11	4	24	29	9	10	11	10	-
Total Factory Revenue	**2,191**	**2,441**	**2,799**	**3,192**	**3,437**	**3,731**	**4,071**	**4,417**	**10**
Year-to-Year Increase (%)	7	11	15	14	8	9	9	8	-

NA = Not applicable
Source: Dataquest (August 1997)

Table B-7
CAD/CAM/CAE/GIS Software History and Forecast, Detail Mechanical Forecast, Europe, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	93,421	108,211	108,499	106,400	111,700	115,600	121,000	127,600	3
Seats	97,482	111,876	112,092	109,100	113,800	117,200	122,100	128,400	3
Year-to-Year Increase (%)	3	15	0	-3	4	3	4	5	-
Installed Base									
CPUs	286,677	312,132	332,527	342,500	354,600	371,000	391,100	414,800	5
Seats	310,428	332,599	350,580	358,200	367,900	381,900	399,800	421,500	4
Year-to-Year Increase (%)	5	7	5	2	3	4	5	5	-
Revenue Data ($M)									
CPU Revenue	1,163	1,313	1,377	1,411	1,451	1,474	1,539	1,619	3
Terminal Revenue	84	58	49	62	48	29	18	11	-26
Peripheral Revenue	61	91	105	102	98	92	88	85	-4
Hardware Revenue	**1,308**	**1,462**	**1,530**	**1,575**	**1,597**	**1,595**	**1,644**	**1,715**	**2**
Year-to-Year Increase (%)	6	12	5	3	1	0	3	4	-
Software Revenue	**825**	**1,024**	**1,149**	**1,197**	**1,317**	**1,419**	**1,534**	**1,683**	**8**
Year-to-Year Increase (%)	6	24	12	4	10	8	8	10	-
Software Service	333	315	389	481	525	562	603	653	11
Hardware Service	244	281	312	356	371	378	397	420	6
Service Revenue	**578**	**596**	**701**	**837**	**896**	**939**	**1,000**	**1,073**	**9**
Year-to-Year Increase (%)	12	3	18	19	7	5	6	7	-
Total Factory Revenue	**2,711**	**3,083**	**3,380**	**3,609**	**3,810**	**3,954**	**4,178**	**4,471**	**6**
Year-to-Year Increase (%)	7	14	10	7	6	4	6	7	-

NA = Not applicable
Source: Dataquest (August 1997)

Table B-8
CAD/CAM/CAE/GIS Software History and Forecast, Detail Mechanical Forecast, Japan, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	64,144	77,551	92,189	99,700	107,800	114,800	121,800	128,300	7
Seats	67,227	80,343	94,912	101,500	109,100	115,600	122,300	128,700	6
Year-to-Year Increase (%)	7	20	18	7	8	6	6	5	-
Installed Base									
CPUs	172,116	205,260	243,944	278,900	310,700	341,100	369,800	396,800	10
Seats	187,279	218,986	256,241	289,500	319,600	348,000	375,000	400,600	9
Year-to-Year Increase (%)	17	17	17	13	10	9	8	7	-
Revenue Data ($M)									
CPU Revenue	1,172	1,318	1,350	1,469	1,538	1,587	1,620	1,647	4
Terminal Revenue	57	48	41	49	31	18	10	6	-31
Peripheral Revenue	184	200	191	198	196	190	183	176	-2
Hardware Revenue	**1,413**	**1,565**	**1,581**	**1,716**	**1,765**	**1,796**	**1,813**	**1,829**	**3**
Year-to-Year Increase (%)	16	11	1	8	3	2	1	1	-
Software Revenue	**753**	**902**	**970**	**1,081**	**1,194**	**1,283**	**1,359**	**1,440**	**8**
Year-to-Year Increase (%)	13	20	8	11	10	7	6	6	-
Software Service	282	321	347	452	491	522	542	564	10
Hardware Service	231	280	286	346	364	376	384	393	7
Service Revenue	**513**	**601**	**633**	**798**	**856**	**898**	**925**	**957**	**9**
Year-to-Year Increase (%)	11	17	5	26	7	5	3	3	-
Total Factory Revenue	**2,679**	**3,069**	**3,184**	**3,595**	**3,814**	**3,977**	**4,098**	**4,226**	**6**
Year-to-Year Increase (%)	14	15	4	13	6	4	3	3	-

NA = Not applicable
Source: Dataquest (August 1997)

Table B-9
CAD/CAM/CAE/GIS Software History and Forecast, Detail Mechanical Forecast, Asia/Pacific, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	18,103	22,689	24,004	27,400	31,300	35,400	39,000	42,300	12
Seats	18,778	23,454	25,075	28,500	32,200	36,200	39,600	42,800	11
Year-to-Year Increase (%)	32	25	7	14	13	12	9	8	-
Installed Base									
CPUs	38,278	52,000	62,970	73,400	84,700	97,700	111,300	124,800	15
Seats	40,488	54,431	65,910	76,800	88,200	101,200	114,500	127,600	14
Year-to-Year Increase (%)	45	34	21	17	15	15	13	11	-
Revenue Data ($M)									
CPU Revenue	142	203	235	300	339	383	423	458	14
Terminal Revenue	12	14	18	31	23	18	12	8	-15
Peripheral Revenue	11	15	12	15	16	16	16	16	5
Hardware Revenue	**164**	**232**	**266**	**347**	**377**	**416**	**451**	**482**	**13**
Year-to-Year Increase (%)	46	41	15	30	9	10	8	7	-
Software Revenue	**99**	**141**	**181**	**233**	**291**	**356**	**413**	**470**	**21**
Year-to-Year Increase (%)	37	42	28	29	25	22	16	14	-
Software Service	35	39	54	85	106	129	150	170	26
Hardware Service	26	42	54	78	89	100	111	121	18
Service Revenue	**62**	**81**	**108**	**163**	**195**	**230**	**261**	**291**	**22**
Year-to-Year Increase (%)	36	31	34	51	19	18	14	12	-
Total Factory Revenue	**325**	**454**	**554**	**743**	**863**	**1,002**	**1,125**	**1,244**	**18**
Year-to-Year Increase (%)	41	40	22	34	16	16	12	11	-

NA = Not applicable
Source: Dataquest (August 1997)

Table B-10
CAD/CAM/CAE/GIS Software History and Forecast, Detail Mechanical Forecast, Rest of World, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	6,114	8,101	7,584	7,800	8,100	8,500	8,900	9,400	4
Seats	6,322	8,227	7,698	7,900	8,200	8,600	9,000	9,400	4
Year-to-Year Increase (%)	4	30	-6	3	3	5	5	5	-
Installed Base									
CPUs	15,380	19,360	21,617	23,000	23,900	24,900	26,100	27,500	5
Seats	16,810	20,486	22,499	23,700	24,500	25,400	26,500	27,800	4
Year-to-Year Increase (%)	20	22	10	5	3	4	4	5	-
Revenue Data ($M)									
CPU Revenue	38	47	42	46	46	48	50	51	4
Terminal Revenue	2	1	1	2	1	1	1	1	-11
Peripheral Revenue	3	3	3	3	3	3	3	3	0
Hardware Revenue	**43**	**51**	**47**	**51**	**51**	**52**	**54**	**55**	**3**
Year-to-Year Increase (%)	7	20	-9	9	1	2	3	1	-
Software Revenue	**28**	**36**	**36**	**38**	**41**	**44**	**47**	**49**	**7**
Year-to-Year Increase (%)	2	29	-1	7	7	7	7	5	-
Software Service	10	7	9	11	12	12	13	14	10
Hardware Service	7	8	8	11	12	13	14	15	12
Service Revenue	**17**	**15**	**17**	**22**	**23**	**25**	**27**	**29**	**11**
Year-to-Year Increase (%)	6	-10	16	25	8	8	8	5	-
Total Factory Revenue	**87**	**102**	**100**	**111**	**115**	**121**	**128**	**133**	**6**
Year-to-Year Increase (%)	5	17	-2	11	4	5	5	4	-

NA = Not applicable
Source: Dataquest (August 1997)

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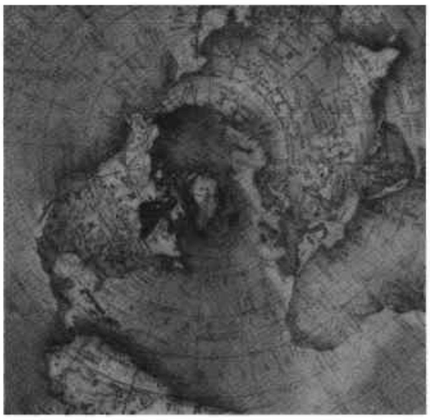

Dataquest

Mechanical CAD/CAM/CAE 1996 Market Share Update

Market Statistics

Program: Mechanical CAD/CAM/CAE Worldwide
Product Code: CMEC-WW-MS-9703
Publication Date: August 11, 1997
Filing: Market Statistics

Mechanical CAD/CAM/CAE 1996 Market Share Update

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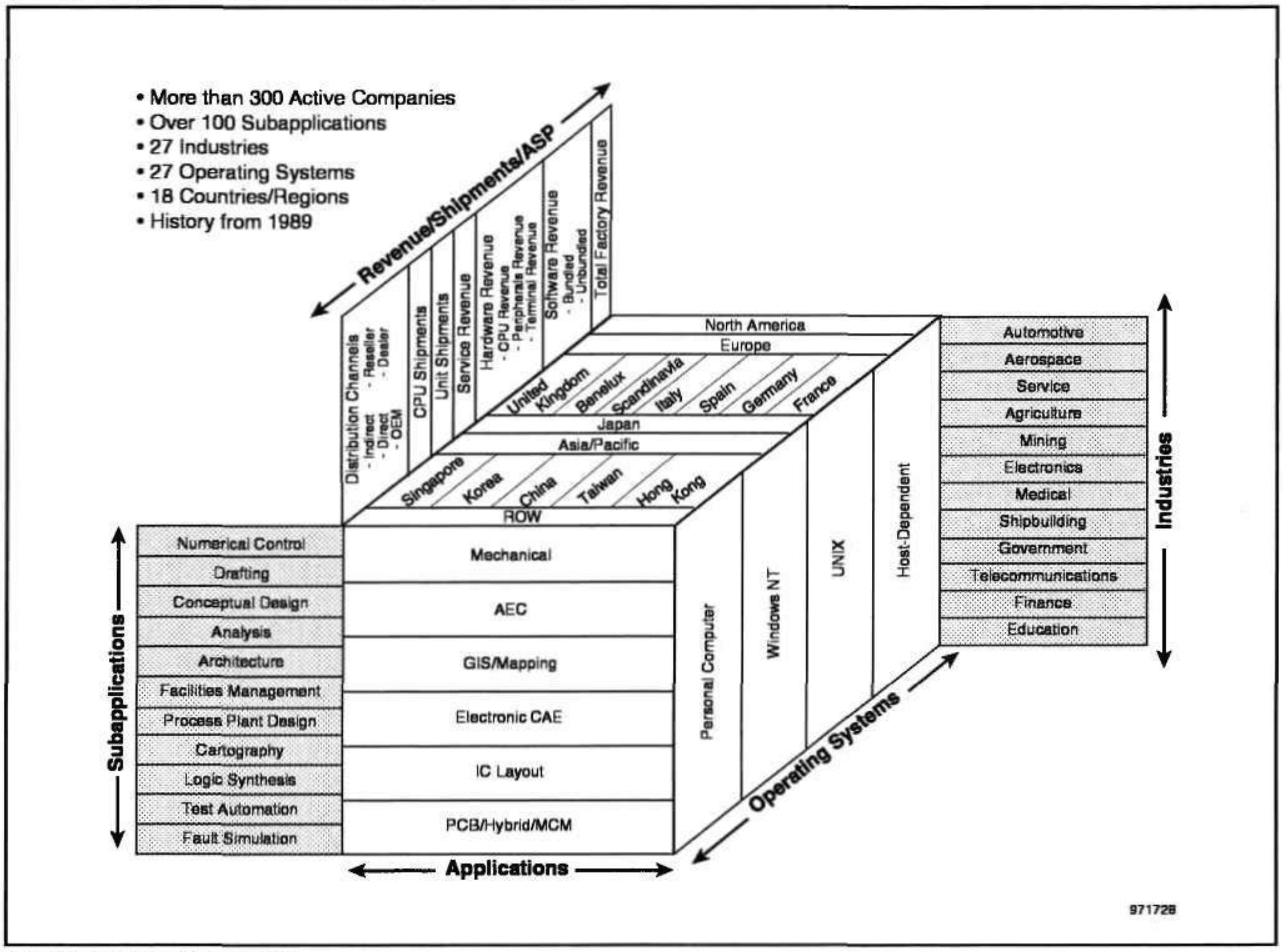
Chapter 1
Introduction

CAD/CAM/CAE, AEC/GIS, and EDA systems have dramatically changed the methods by which designers and production managers originate and implement products. CAD and CAE systems allow designers to create, draft, analyze, test, and manipulate products on a screen in two and three dimensions. As all these systems continue to decrease in cost, they become more available and cost-justifiable to new users.

In order to provide a comprehensive view of the CAD/CAM/CAE/GIS industry, Dataquest's CAD/CAM/CAE, AEC/GIS, and EDA programs maintain a large database of industry information. The type of information contained in the database is depicted in Figure 1-1.

Table 1-1 summarizes the performance in various segments of the CAD/CAM/CAE, AEC/GIS, and EDA markets in 1996 versus 1995.

Figure 1-1
CAD/CAM/CAE/GIS Market Database



Source: Dataquest (July 1997)

Table 1-1
Market Summary for All CAD Applications, 1995 to 1996 (Revenue in Millions of Dollars)

	Software Revenue 1995	Software Revenue 1996	1995-1996 Growth (%)	Hardware Revenue 1995	Hardware Revenue 1996	1995-1996 Growth (%)	Total Factory Revenue 1995	Total Factory Revenue 1996	1995-1996 Growth (%)	Seat Shipments 1995	Seat Shipments 1996	1995-1996 Growth (%)
Applications—For the Selected Operating System												
Mechanical	2,964.39	3,344.57	12.82	4,606.81	5,041.36	9.43	9,306.93	10,575.95	13.64	337,268.2	364,509.7	8.08
AEC	973.58	952.64	-2.15	1,440.20	1,290.30	-10.41	2,779.14	2,680.82	-3.54	257,438.0	226,581.9	-11.99
GIS/Mapping	785.01	904.12	15.17	1,166.53	1,180.66	1.21	2,445.04	2,765.05	13.09	121,901.0	130,461.0	7.02
Electronic CAE	1,001.30	1,226.55	22.50	1,143.53	1,193.16	4.34	2,954.74	3,347.09	13.28	104,743.1	107,728.6	2.85
IC Layout	316.49	437.94	38.37	349.07	352.25	0.91	957.31	1,149.59	20.08	16,002.0	16,752.7	4.69
PCB/MCM/Hybrid	268.87	292.86	8.92	342.25	363.66	6.26	832.80	875.62	5.14	26,566.4	29,599.3	11.42
Electronic Design Automation	1,586.66	1,957.35	23.36	1,834.85	1,909.07	4.04	4,744.86	5,372.29	13.22	147,311.5	154,080.5	4.60
All Applications	**6,309.64**	**7,158.68**	**13.46**	**9,048.38**	**9,421.38**	**4.12**	**19,275.97**	**21,394.11**	**10.99**	**863,918.8**	**875,633.1**	**1.36**
Region—For All Applications												
North America	2,138.08	2,531.07	18.38	2,971.31	3,049.14	2.62	6,502.18	7,376.27	13.44	355,372.0	339,700.4	-4.41
Europe	2,045.51	2,248.17	9.91	2,973.63	3,059.79	2.90	6,210.15	6,770.57	9.02	294,112.1	287,862.5	-2.12
Japan	1,637.45	1,772.40	8.24	2,579.30	2,710.15	5.07	5,304.24	5,677.81	7.04	136,249.6	164,611.4	20.82
Asia/Pacific	379.22	484.43	27.74	391.47	463.01	18.27	967.65	1,234.17	27.54	55,688.6	61,083.8	9.69
Rest of World	109.39	124.01	13.36	132.87	141.68	6.63	291.77	338.93	16.17	22,528.7	22,440.9	-0.39
Worldwide	**6,309.64**	**7,158.68**	**13.46**	**9,048.38**	**9,421.38**	**4.12**	**19,275.97**	**21,394.11**	**10.99**	**863,918.8**	**875,633.1**	**1.36**
Operating System—For All Applications												
UNIX	4,275.90	4,787.67	11.97	6,177.18	6,420.73	3.94	13,658.01	15,031.57	10.06	248,519.1	273,499.8	10.05
Host/Proprietary	181.03	155.49	-14.11	645.60	672.15	4.11	1,118.94	1,095.60	-2.09	5,424.4	5,530.5	1.96
NT/Hybrid	351.18	736.08	109.60	360.37	534.14	48.22	857.63	1,669.44	94.66	25,880.5	41,026.8	58.52
Personal Computer	1,501.53	1,479.44	-1.47	1,865.24	1,794.36	-3.80	3,641.39	3,597.50	-1.21	584,094.8	555,576.0	-4.88
All Operating Systems	**6,309.64**	**7,158.68**	**13.46**	**9,048.38**	**9,421.38**	**4.12**	**19,275.97**	**21,394.11**	**10.99**	**863,918.8**	**875,633.1**	**1.36**

Source: Dataquest (July 1997)

About This Document

This document contains Dataquest's detailed market share information on the CAD/CAM/CAE/GIS industry. Numbers presented in this book represent Dataquest's best estimate of the CAD/CAM/CAE/GIS markets at this time. Each vendor surveyed is given the opportunity to self-report revenue information for his/her company (see "Market Share Methodology" section for detailed explanation of how market numbers are compiled and scrubbed). The following list contains descriptions of the companies included in the Market Share books. See Tables 1-2, 1-3, 1-4, and 1-5 for changes in the companies tracked from our 1995 report.

- Mechanical Applications—All companies in database with mechanical revenue
- AEC and GIS Applications—All companies in database with AEC or GIS revenue. Dataquest also has added GIS data companies.
- EDA Applications—All companies in database with EDA (electronic CAE, IC layout, PCB/hybrid/MCM) revenue
- Europe—All companies with European revenue
- Asia—All companies with Asian revenue

Table 1-2
Companies Renamed since 1995

Original Company Name	New Company Name
AT&T	Lucent Technologies
CADWORKS	Drawbase Software
Contec	Applied Simulation Technology
Data I/O	Synario Design Automation
GRAFTEK	First Cadcam Inc.

Source: Dataquest (July 1997)

Table 1-3
Companies (or CAD Portions of Companies) Sold/Merged in 1995

Original Company Name	Acquired by/Merged with
Automotive Analytics	MacNeal-Schwendler
Camax	SDRC
Eostat	Space Imaging
High Level Design Systems	Cadence Design Systems
HoSoft	Applicon
Meta-Software	Avant!
Royal Digital Centers	Mentor Graphics
Strategic Mapping	ESRI
TYDAC Technology	PCI Group
UniCAD	Cooper & Chyan Technology

Source: Dataquest (July 1997)

Companies deleted from our database since 1995 are as follows:

- Altium
- Aspen Technologies
- Bionic Knight
- Carrier Corporation
- Cimplex
- Evolution Computing
- Motorola
- Pacsoft
- Sinus Software

Companies added to our database since 1995 are as follows:

- 3D/Eye Inc.
- Baystate Technologies
- BCT GmbH
- Compact Software
- ConsenSys Software Corporation
- Control Data
- DATACAD LLD
- ESI Group
- Incases
- Interactive Image Technology
- Knights Technology
- Logic Vision
- Rubicad
- Sente
- Sescoi
- SolidWorks
- Synplicity
- Virtual Chips

Dataquest no longer publishes top-level market statistics for the entire CAD/CAM/CAE/GIS industry. This data is available by calling Daya Nadamuni at (408) 468-8290. More detailed data on these markets may be requested through our client inquiry service.

This document presents Dataquest's final market share of 1996 shipments and revenue.

Dataquest's policy is to continually update its market information for current and past years with any new data received in order to arrive at the most accurate market representation possible.

Segmentation Definitions

This section lists the definitions specific to this document.

Applications

Mechanical

The mechanical segment refers to computer-aided tools used by engineers, designers, analysts, technicians, and draftspeople working predominantly in the discrete manufacturing industries, but includes government and education sectors as well. Common design applications include conceptual design, industrial design, structural or thermal analysis, detail design, and electromechanical design. Common manufacturing applications include tool and fixture design and numerical control part programming. Product data management and application development environments are also included in this segment.

Architecture, Engineering, and Construction (AEC)

The AEC segment covers the use of computer-aided tools by architects, contractors, plant engineers, civil engineers, and other people associated with these disciplines to aid in designing and managing buildings, industrial plants, ships, and other types of nondiscrete entities.

Geographic Information Systems (GIS)/Mapping

GIS is computer-based technology, and the segment comprises hardware, software, and data used to capture, edit, display, and analyze spatial (tagged by location) information.

Electronic Design Automation (EDA)

The EDA segment covers computer-based tools used to automate the design of an electronic product, including printed circuit boards, ICs, and systems. EDA includes ECAE, IC layout, and PCB/hybrid/MCM, as follows:

- Electronic computer-aided engineering (ECAE)—These are computer-aided tools used in the engineering or design phase of electronic products (as opposed to the physical layout phase of the product). Examples of electronic CAE applications are schematic capture and simulation.
- IC layout—This is a software application tool used to create and validate the physical implementation of an IC. The IC layout category comprises polygon editors, symbolic editors, placement and routing (gate array, cell, and block), and design verification tools (DRC/ERC/logic-to-layout).
- PCB/hybrid/MCM—This segment covers products used to create the placement and routing of the traces and components laid out on a printed circuit board. Also included in this category are thermal analysis tools.

Regions

- North America—Includes Canada, Mexico, and the United States (including the 48 contiguous states, Washington, D.C., Alaska, Hawaii, and Puerto Rico)
- Europe
  - Western Europe—Includes Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, and the United Kingdom
  - Rest of Western Europe—Includes Andorra, Cyprus, Faeroe Islands, Gibraltar, Greenland, Guernsey, Iceland, Jersey, Liechtenstein, Malta, Monaco, San Marino, and Vatican City
  - Central and Eastern Europe—Includes Albania, Armenia, Azerbaijan, Belarus, Bosnia, Bulgaria, Croatia, Czech Republic, Estonia, Federal Republic of Yugoslavia (including Serbia and Montenegro), Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Macedonia, Moldova, Poland, Romania, Russia (as far as the Urals), Slovakia, Slovenia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan
- Japan
- Asia/Pacific—Includes Australia, Bangladesh, Brunei, Cambodia, China, Hong Kong, India, Indonesia, Korea, Laos, Malaysia, Maldives, Myanmar, Nepal, New Zealand, Pakistan, the Philippines, Singapore, Sri Lanka, Taiwan, Thailand, and Vietnam
- Rest of World—Includes Africa, the Caribbean, the Middle East, Oceania, and South America

Operating Systems

Dataquest defines the operating systems as follows:

- UNIX—Includes all UNIX variants and older workstation operating systems
- Host—Includes minicomputer and mainframe operating systems in which the functions of external workstations are dependent on a host computer
- Windows NT—The Microsoft operating system
- PC—Includes DOS, Windows, Windows 95, and Apple operating systems

Metrics

The following paragraphs define measurements:

- Total Distribution Revenue—The total amount of money received by a company for all goods and services sold into the CAD/CAM/CAE/GIS market. It is the sum of factory revenue, OEM revenue, and reseller revenue
- Total Factory Revenue—The amount of money received by a manufacturer for its goods and services measured in U.S. dollars. Total factory revenue does not include revenue that a company may receive from products that are sold to another company for resale (OEM revenue). Total factory revenue is the sum of hardware revenue, software revenue, and service revenue
- Hardware Revenue—Revenue derived from the sales of CPUs (including operating systems), terminals (for host-dependent systems), and peripherals
- Software Revenue—Revenue derived from the sales of bundled (part of a turnkey system) and unbundled applications software that exists on a company's standard price list. It does not include operating systems revenue, which is part of the hardware revenue.
- Service Revenue—Revenue derived from the service and support of CAD/CAM/CAE, AEC/GIS, and EDA systems. Service revenue can be calculated in the market share tables by subtracting hardware and software revenue from total factory revenue. Service revenue includes the following:
  - Applications development—Adding new functionality through design and development of new customized CAD/CAM/CAE, AEC/GIS, and EDA software applications, or the modification, enhancement, or customization of existing software applications
  - Consulting—Including an assessment of a company's CAD/CAM/CAE, AEC/GIS, or EDA business IT needs and formulation of a plan based on needs identification
  - Integration services—Planning, implementing, migrating, and integrating software products
  - Maintenance—Fees for hardware and software
  - Management and operations services—Includes help desk, education and training, disaster recovery, vaulting, facilities management, configuration management, and relocation services
  - Service bureau—Includes construction of database, data conversion, product design, analysis, or manufacturing
- Unit Shipment—The number of seats delivered (number of possible simultaneous users of product delivered) excluding OEM shipments. CPU shipments are defined as the number of CPUs delivered, which is the same as unit shipments for all platforms but host-dependent platforms.

- Distribution Channels are defined as follows:
  - Direct—Sales direct to the end user
  - Indirect—Sales to resellers, from which dealer revenue is calculated
  - Dealer revenue—Dealer revenue is based on a multiplier of indirect revenue. Dealer revenue always exists for every vendor with indirect sales, and it is always equal to, or greater than, indirect revenue. Calculation of these dealer multipliers vary by vendor, by region, and by platform.
  - OEM—A channel through which vendors sell their finished product to other companies for resale through an agreement. Once sold, the product is usually modified slightly, relabeled, and rebranded by the new original equipment manufacturer, and then resold directly to the end user or through an indirect channel. Revenue as sold by that final vendor (who, from the perspective of the original component supplier, is also popularly known as the OEM) is then credited as revenue to the final supplier.
  - Reseller—The revenue a named company in the CAD/CAM/CAE, AEC/GIS, and EDA database receives for selling another company's product, such as Intergraph's revenue from Bentley Microstation products, IBM's revenue for reselling MicroCADAM, or Fujitsu's revenue for reselling software from several U.S. vendors.

Notes on Dataquest Metrics

The application of these distribution channel definitions to software revenue allows Dataquest to calculate vendor market share based on a combination of any of the above bulleted items. Typical reporting metrics for market share will be:

- Company software revenue is the sum of revenue from the direct, indirect, OEM, and reseller channels for any given company
- Product software revenue is the sum of revenue from the direct and indirect channels for any given company
- End-user spending is the sum of revenue from the direct, dealer, OEM, and reseller channels for any given company

To avoid double-counting the market, market size for company software revenue is the sum of revenue from the direct and indirect channels, and market size for end-user spending is the sum of revenue from the direct and dealer channels. Tables 1-4 and 1-5 provide views of the market, including market share by product software revenue and company software revenue for the entire CAD market. Dataquest will report end-user spending in an upcoming market share update.

Table 1-4
Top 25 Product Software Revenue, Software Companies, Worldwide, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	IBM	411.5	530.6	618.7	16.6	8.6
2	Parametric Technology	209.8	321.2	495.0	54.1	6.9
3	Autodesk	438.9	516.0	477.0	-7.6	6.7
4	Cadence	202.4	258.0	379.0	46.9	5.3
5	Intergraph	318.4	342.3	318.3	-7.0	4.4
6	Synopsys	142.7	193.5	245.1	26.7	3.4
7	Dassault	157.1	194.5	233.2	19.9	3.3
8	Fujitsu	182.1	210.8	225.0	6.7	3.1
9	Mentor Graphics	175.9	185.0	212.8	15.0	3.0
10	Computervision	163.1	163.7	191.7	17.1	2.7
11	EDS Unigraphics	140.5	155.5	191.3	23.0	2.7
12	ESRI	109.4	124.1	168.4	35.7	2.4
13	Structural Dynamics Research Corporation	115.4	144.8	153.0	5.7	2.1
14	MicroCADAM	91.7	129.2	152.0	17.7	2.1
15	MacNeal-Schwendler	93.6	117.6	124.3	5.7	1.7
16	Info. Services International Dentsu	66.0	85.2	117.2	37.6	1.6
17	Bentley Systems	26.0	81.2	107.0	31.7	1.5
18	Hitachi	88.9	94.5	105.1	11.2	1.5
19	Landmark Graphics	72.5	89.9	98.3	9.3	1.4
20	NEC	103.4	110.0	94.9	-13.7	1.3
21	Matra Datavision	75.6	87.4	91.8	4.9	1.3
22	CoCreate	74.5	79.0	90.2	14.2	1.3
23	Toshiba	78.1	97.3	85.7	-11.9	1.2
24	Quickturn Design Systems	59.0	70.7	83.3	17.7	1.2
25	AVANT!	32.2	53.3	82.5	54.9	1.2
	All North American Companies	3,828.2	4,643.9	5,443.9	17.2	76.0
	All European Companies	667.0	786.3	822.1	4.6	11.5
	All Asian Companies	789.8	879.5	892.7	1.5	12.5
	All Companies	**5,284.9**	**6,309.6**	**7,158.7**	**13.5**	**100.0**

Source: Dataquest (July 1997)

Table 1-5
Top 25 Company Software Revenue, Software Companies, Worldwide, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	IBM	358.4	464.0	518.6	11.7	7.2
2	Parametric Technology	206.5	321.2	495.0	54.1	6.9
3	Autodesk	438.6	510.9	472.2	-7.6	6.6
4	Cadence	199.3	254.3	375.3	47.6	5.2
5	Intergraph	318.4	292.5	285.1	-2.5	4.0
6	Synopsys	142.7	193.5	245.1	26.7	3.4
7	Mentor Graphics	175.9	183.3	210.6	14.9	2.9
8	Computervision	163.1	163.7	191.7	17.1	2.7
9	EDS Unigraphics	140.5	155.5	191.3	23.0	2.7
10	ESRI	109.4	124.1	168.4	35.7	2.4
11	Fujitsu	135.1	151.4	160.5	6.0	2.2
12	Structural Dynamics Research Corporation	115.4	144.9	153.1	5.7	2.1
13	MicroCADAM	91.7	129.2	152.0	17.6	2.1
14	MacNeal-Schwendler	93.6	117.6	124.3	5.7	1.7
15	Bentley Systems	4.2	81.3	107.0	31.6	1.5
16	Hitachi	88.9	94.5	105.1	11.2	1.5
17	Landmark Graphics	72.5	89.9	98.3	9.3	1.4
18	NEC	103.4	110.0	94.9	-13.7	1.3
19	Matra Datavision	75.6	87.4	91.8	4.9	1.3
20	CoCreate	74.5	79.0	90.2	14.2	1.3
21	Quickturn Design Systems	59.0	70.7	83.3	17.7	1.2
22	AVANT!	30.6	51.0	80.3	57.4	1.1
23	Nihon Unisys	69.9	77.1	79.3	3.0	1.1
24	Toshiba	78.1	88.5	78.0	-11.9	1.1
25	Zuken-Redac	67.7	72.4	77.0	6.4	1.1
	All North American Companies	3,828.2	4,643.9	5,443.9	17.2	76.0
	All European Companies	667.0	786.3	822.1	4.6	11.5
	All Asian Companies	789.8	879.5	892.7	1.5	12.5
	All Companies	**5,284.9**	**6,309.6**	**7,158.7**	**13.5**	**100.0**

Source: Dataquest (July 1997)

This reporting scheme means that the sum of vendor revenue (and market shares) will total to more than the sum of the market. Dataquest has used similar reporting for European and Asian clients for years in response to the realities of market requirements. We believe this is the best way to accurately report market opportunities and positioning worldwide. Advantages to this approach include:

- Dataquest does not double-count any total market opportunity, and we will continue to avoid overstating the actual revenue available, which will help our clients make the most reasonable investments.
- The high level of activity of vendors that are active in multiple channels will show up in market share tables, again without double-counting revenue. For example, it will be possible to understand the status of Bentley Systems as it relates to its involvement with Intergraph. We can report Bentley's company software revenue, end-user spending for Bentley products (some of which will be sold by Intergraph), Intergraph's sales from Intergraph products, Intergraph reseller sales from Bentley products, and sales made by Intergraph's own dealers. In general, this model will allow us to better detail market contributions by companies with complex business models, such as Fujitsu, IBM, and NEC.

Market Share Methodology

Dataquest uses both primary and secondary sources to produce our market share data. In the fourth quarter of each year and second quarter of the subsequent year, we survey all participants in each industry. Each vendor is offered the opportunity to self-report the information required. Although there is a primary contact for each company, large companies are surveyed across product lines and across geographic regions. Thus, there is a corresponding increase in the number of contacts at large companies. (Dataquest maintains a large contact database on all sources of information.) Examples of the job titles of people contacted for information are as follows:

- President and CEO
- Vice president and general manager
- Vice president of marketing
- Vice president, strategic product planning
- Director of strategic planning
- Director of marketing
- Director of market development
- Manager, CAD/CAM/CAE/GIS marketing programs
- Market research analyst

The Audit Process

Data supplied by vendors is evaluated against information drawn from many sources, including the following:

- Revenue published by major industry participants
- Estimates made by knowledgeable and reliable industry spokespersons
- Government data or trade association data
- Published product literature and price lists
- Interviews with knowledgeable manufacturers, distributors, and users
- Relevant economic data
- Information and data from online data banks
- Articles in both the general and trade press
- Annual reports, SEC documents, credit reports
- Company publications and press releases
- Reports from financial analysts
- User studies
- Reseller and supplier reports and reports from a vendor's competitors

Dataquest also sums vendor revenue across other industries covered by Dataquest to make sure that revenue is not credited twice, and checks with multiple sources at one company to cross-check data on that company.

Dataquest analysts have many years of experience in how to apply the tools described to get the most accurate information possible on a particular company (such as what to use when and what industry averages are). We believe that the estimates presented here are the most accurate and meaningful generally available today. It is the CAD/CAM/CAE, AEC/GIS, and EDA groups' policy to continually update our market information for any year, based on any new data received, in order to arrive at the most accurate market representation possible.

Dataquest's CAD/CAM/CAE, AEC/GIS, and EDA market numbers are often higher than those reported by other sources. We survey worldwide, which involves more vendors, higher total market revenue, lower market share per vendor, and a more accurate market picture—which is particularly useful when comparing regions or applications.

Reporting Changes

Beginning with Dataquest's March 4, 1996, publication, we published market share data that reports OEM revenue for all regions. Also, for the first time in the United States our market share tables included companies that resell products from other vendors as well as their own products (these are primarily Japanese companies), and companies that sell products primarily to other vendors (such as Dassault). In the past, this reporting was standard only in our products for Japan, Europe, and Asia/Pacific. We believe that this reporting accurately reflects the activity of all the vendors in the CAD/CAM/CAE, AEC/GIS, and EDA markets. To prevent double-counting of the market, we will continue to count the total market size by excluding OEM and reseller revenue. As a result, the sum of the individual software vendors will be greater than the total market size in all market share tables. On an inquiry basis, we can produce market share tables that exclude OEM revenue, or report only OEM revenue.

These reporting changes primarily reflect our efforts to both accurately depict markets while accounting for revenue by distribution channel. Dataquest's CAD/CAM/CAE, AEC/GIS, and EDA database was first developed in the turnkey era of CAD/CAM, when channel reporting was relatively unimportant. Today, of course, worldwide distribution and PC-based products require us to better report revenue by channel. While our existing database does account for much of this information, we believe improvements are necessary.

A Final Note

The tables Dataquest chooses to publish in statistics books are those we believe useful for the greatest number of clients. However, given the rich dynamics in distribution channels, it is not possible to understand the full opportunity from a single viewpoint. On request, we are happy to deliver alternative views of the market, as detailed tables—preferably delivered as Excel workbooks via e-mail. Any client needing an electronic version of our market statistics should contact Daya Nadamuni via e-mail at daya.nadamuni@dataquest.com. Our ongoing commitment is to maintain an accurate and complete model of the worldwide CAD/CAM/CAE, AEC/GIS, and EDA markets, and we welcome client input.

Publishing Schedule

Dataquest publishes market share and forecasting twice each year for each, allowing for both timely distribution of data and thorough analysis and forecasting. The annual delivery schedule is as follows:

- Market share was published and distributed to clients on March 14.
- A five-year forecast for CAD/CAM/CAE/GIS was shipped to clients on May 26.
- Final updated market share tables, based on additional data collection and analysis, were available in electronic format to clients on June 30. At this point, the market share database is frozen and will not be changed until the end of the year. For the next six months, supplementary market data will be based on this final market data.
- Complete final forecast tables will be published by September 30. These tables take into consideration changes in the market share during the previous six months.

Chapter 2
Market Statistics Tables

Table A-1
1996 Top 30 Mechanical Software Companies, Worldwide, All Operating Systems
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	IBM	368.3	494.5	579.7	17.2	17.3
2	Parametric Technology	209.8	321.2	495.0	54.1	14.8
3	Dassault	154.2	190.6	228.6	19.9	6.8
4	EDS Unigraphics	140.5	155.5	191.3	23.0	5.7
5	Autodesk	166.8	189.6	176.5	-6.9	5.3
6	Computervision	148.2	149.0	174.4	17.1	5.2
7	Structural Dynamics Research Corporation	115.4	144.8	153.0	5.7	4.6
8	MicroCADAM	91.7	129.2	152.0	17.7	4.5
9	MacNeal-Schwendler	90.8	114.0	124.3	9.0	3.7
10	Info. Services International Dentsu*	66.0	85.2	117.2	37.6	3.5
11	Fujitsu	83.7	97.0	107.3	10.7	3.2
12	Matra Datavision	75.6	87.4	91.8	4.9	2.7
13	CoCreate	74.5	79.0	90.2	14.2	2.7
14	Hitachi	66.7	70.9	79.9	12.7	2.4
15	NEC	61.7	72.9	62.9	-13.7	1.9
16	Toshiba*	54.5	66.7	62.5	-6.3	1.9
17	Nihon Unisys	48.1	52.8	54.4	3.0	1.6
18	Hitachi Zosen Info Systems	34.5	38.7	39.3	1.4	1.2
19	Ansys	32.5	32.6	37.0	13.6	1.1
20	Hakuto*	23.6	29.8	34.0	14.0	1.0
21	C. Itoh Techno-Science*	34.6	30.8	30.8	0	0.9
22	Intergraph	61.1	54.0	27.1	-49.8	0.8
23	Tecnomatix Technology	13.0	20.1	26.3	31.1	0.8
24	Sherpa Corp.	18.8	20.6	26.2	27.2	0.8
25	Marubeni Hytech*	18.3	19.9	23.0	15.3	0.7
26	ISD Software	10.5	14.5	22.7	56.5	0.7
27	Delcam International	11.6	16.7	21.9	31.1	0.7
28	Applicon	19.3	21.5	21.8	1.3	0.7
29	Sumisho Electronics*	18.4	18.8	21.6	14.5	0.6
30	ADRA Systems	18.0	19.0	21.1	11.2	0.6
	All North American Companies	1,720.6	2,140.9	2,500.8	16.8	74.8
	All European Companies	288.2	342.0	352.2	3.0	10.5
	All Asian Companies	428.4	481.5	491.5	2.1	14.7
	All Companies	**2,437.2**	**2,964.4**	**3,344.6**	**12.8**	**100.0**

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-2
1996 Top 30 Mechanical Software Companies, Worldwide, UNIX
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	IBM	278.3	405.2	509.1	25.6	21.1
2	Parametric Technology	188.9	269.8	386.1	43.1	16.0
3	Dassault	115.5	146.4	201.1	37.4	8.3
4	EDS Unigraphics	140.5	155.5	172.1	10.7	7.1
5	Computervision	141.3	142.4	166.7	17.1	6.9
6	Structural Dynamics Research Corporation	109.4	136.6	145.7	6.7	6.0
7	Info. Services International Dentsu*	62.7	80.9	111.3	37.6	4.6
8	MacNeal-Schwendler	59.9	86.6	91.8	6.0	3.8
9	Matra Datavision	74.0	75.5	79.2	4.9	3.3
10	Fujitsu	56.1	65.0	72.7	11.9	3.0
11	Hitachi	53.9	57.3	66.1	15.3	2.7
12	CoCreate	69.7	59.3	65.6	10.7	2.7
13	Nihon Unisys	43.8	51.8	53.6	3.5	2.2
14	MicroCADAM	36.7	51.7	45.6	-11.8	1.9
15	Toshiba*	39.6	50.0	42.5	-15.0	1.8
16	Hitachi Zosen Info Systems	34.5	38.7	39.3	1.4	1.6
17	NEC	42.0	43.7	37.7	-13.7	1.6
18	C. Itoh Techno-Science*	30.9	28.4	28.4	0	1.2
19	Ansys	22.1	24.5	27.8	13.5	1.2
20	Tecnomatix Technology	13.0	20.1	26.3	31.1	1.1
21	Sherpa Corp.	18.8	20.4	26.0	27.3	1.1
22	Marubeni Hytech*	18.3	19.9	23.0	15.3	1.0
23	Delcam International	11.0	16.0	20.8	29.7	0.9
24	Hakuto*	14.1	17.9	20.6	15.3	0.9
25	Intergraph	37.9	52.2	20.2	-61.4	0.8
26	Tokyo Electron*	16.0	17.4	20.0	15.3	0.8
27	Concentra	12.1	12.7	19.6	54.2	0.8
28	Seiko*	18.0	19.7	19.0	-3.5	0.8
29	MARC	15.5	18.2	17.7	-2.2	0.7
30	Alias Research	13.1	17.3	17.3	-	0.7
	All North American Companies	1,256.9	1,581.9	1,826.0	15.4	75.7
	All European Companies	205.2	234.1	215.5	-8.0	8.9
	All Asian Companies	341.7	374.5	370.5	-1.1	15.4
	All Companies	**1,803.8**	**2,190.5**	**2,412.0**	**10.1**	**100.0**

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-3
1996 Top 30 Mechanical Software Companies, Worldwide, NT/Hybrid
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	Parametric Technology	20.6	51.4	108.9	111.9	37.0
2	Autodesk	-	-	29.1	NA	9.9
3	EDS Unigraphics	-	-	19.1	NA	6.5
4	MicroCADAM	4.6	6.4	18.2	182.8	6.2
5	ISD Software	-	-	12.3	NA	4.2
6	Matra Datavision	-	9.6	10.1	4.4	3.4
7	Wacom	-	4.9	7.1	44.5	2.4
8	Intergraph	13.6	1.8	6.9	295.4	2.4
9	Bentley Systems	1.5	4.6	6.8	47.2	2.3
10	SolidWorks Corporation	-	-	6.3	NA	2.1
11	Structural Dynamics Research Corporation	-	4.8	6.1	28.1	2.1
12	Omron	-	5.8	5.8	-0.6	2.0
13	CoCreate	-	3.2	5.6	72.4	1.9
14	CAD Lab	-	0.7	5.2	662.4	1.8
15	Radan Computational	0.1	-	5.1	NA	1.7
16	Ansys	-	3.9	4.8	23.0	1.6
17	CAD Distribution	0.1	3.5	4.8	37.6	1.6
18	Mutoh Industries*	2.5	2.3	4.7	100.0	1.6
19	NEC	-	5.2	4.5	-13.7	1.5
20	MCS	-	1.4	3.7	174.9	1.3
21	Graphtec Engineering	-	-	2.6	NA	0.9
22	Toshiba Engineering*	-	-	2.5	NA	0.9
23	BCT GMBH	-	0.4	2.5	500.6	0.9
24	Vero International Software	-	-	2.3	NA	0.8
25	DP Technology	-	1.0	1.9	96.1	0.6
26	3D/Eye Inc.	-	-	1.8	NA	0.6
27	MARC	-	-	1.6	NA	0.5
28	Spatial Technology	0.9	1.4	1.3	-6.1	0.4
29	Mechanical Dynamics	-	-	1.2	NA	0.4
30	MacNeal-Schwendler	-	1.1	1.2	8.5	0.4
	All North American Companies	40.3	83.9	228.2	172.1	77.4
	All European Companies	1.5	15.7	44.3	182.7	15.0
	All Asian Companies	-	15.9	22.2	39.6	7.5
	All Companies	**41.8**	**115.4**	**294.7**	**155.3**	**100.0**

NA = Not available
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-4
1996 Top 30 Mechanical Software Companies, Worldwide, Personal Computer (Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	Autodesk	157.0	179.8	142.3	-20.9	26.4
2	MicroCADAM	50.4	71.1	88.2	24.1	16.4
3	Fujitsu	20.9	24.2	26.9	11.0	5.0
4	NEC	19.7	24.0	20.8	-13.7	3.9
5	Toshiba*	14.9	16.7	20.0	20.0	3.7
6	CoCreate	4.9	16.5	19.0	15.3	3.5
7	Andor*	17.6	15.9	17.8	12.0	3.3
8	Hakuto*	9.4	11.9	13.4	12.0	2.5
9	Design Automation	7.0	11.6	13.3	14.4	2.5
10	Cimatron	5.1	9.3	12.9	38.3	2.4
11	Hitachi	9.6	10.2	11.4	12.0	2.1
12	Investronica SA	10.6	11.1	10.6	-3.8	2.0
13	Wiechers Datentechnik	8.2	7.6	9.2	20.9	1.7
14	Tebis	5.1	8.0	8.9	11.1	1.7
15	MCS	9.0	7.5	8.7	16.5	1.6
16	CNC Software	7.6	8.4	8.7	3.7	1.6
17	Computervision	6.9	6.6	7.7	17.1	1.4
18	Bentley Systems	2.1	6.6	6.4	-2.7	1.2
19	Formtek	5.2	5.7	6.2	8.9	1.1
20	Algor Interactive Systems	4.1	6.0	6.1	1.4	1.1
21	Ashlar	5.8	5.7	5.9	4.2	1.1
22	Info. Services International Dentsu*	3.3	4.3	5.9	37.6	1.1
23	Serbi	5.0	5.9	5.6	-4.1	1.0
24	Viagrafix	5.5	5.6	5.4	-2.5	1.0
25	Surfware	2.7	5.0	5.4	8.1	1.0
26	ADRA Systems	5.1	5.1	5.4	4.8	1.0
27	PAFEC	1.3	2.4	5.3	118.7	1.0
28	Sumisho Electronics*	5.2	4.6	5.1	12.0	1.0
29	BCT GMBH	3.0	3.8	4.7	23.9	0.9
30	Ziegler Informatics	5.0	3.3	4.6	40.3	0.9
	All North American Companies	310.9	372.9	359.5	-3.6	66.8
	All European Companies	77.7	89.2	90.2	1.2	16.8
	All Asian Companies	72.1	79.2	88.2	11.3	16.4
	All Companies	**460.7**	**541.3**	**537.9**	**-0.6**	**100.0**

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-5
1996 Top Mechanical Software Companies, Worldwide, Host/Proprietary
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	IBM	90.0	89.3	69.6	-22.1	69.5
2	Dassault	38.7	44.2	27.4	-38.0	27.4
3	MacNeal-Schwendler	30.9	25.1	27.3	8.9	27.3
4	Fujitsu	6.7	7.8	7.7	-0.8	7.7
5	C. Itoh Techno-Science*	3.6	2.4	2.4	-	2.4
6	Hitachi	3.1	3.3	2.3	-30.0	2.3
7	Mechanical Dynamics	2.1	1.9	1.7	-9.0	1.7
8	Exapt	6.1	4.5	1.3	-71.8	1.3
9	Ansys	3.3	1.3	1.1	-14.8	1.1
10	Mitsubishi Electric*	1.5	1.2	0.9	-30.0	0.9
11	Nihon Unisys	4.3	1.1	0.8	-22.3	0.8
12	Toyo Information Systems*	0.9	0.8	0.6	-30.0	0.6
13	Kubota Computer	0.9	0.8	0.5	-33.1	0.5
14	Whessoe Computing Systems	0.6	0.5	0.4	-17.3	0.4
15	Computational Mechanics	0.5	0.5	0.4	-32.5	0.4
16	Sherpa Corp.	-	0.2	0.2	18.8	0.2
17	debis Systemhaus	0.2	0.2	0.2	0.2	0.2
18	Altair Computing	-	-	0.2	NA	0.2
19	Century Research Center	0.4	0.3	0.2	-30.0	0.2
20	Access Corp.	0.5	0.4	0.2	-49.8	0.2
21	Framasoft	0.4	0.4	0.2	-61.9	0.2
22	CIMTEK	0.2	0.1	0.1	-8.4	0.1
23	Technodia*	0	0	0	-30.0	0
24	First Cadcam Inc.	0.4	0.3	-	-100.0	-
25	Cimtel	0	0	-	-100.0	-
	All North American Companies	112.4	102.3	87.2	-14.8	87.2
	All European Companies	3.9	3.1	2.2	-27.1	2.2
	All Asian Companies	14.5	11.9	10.6	-10.4	10.6
	All Companies	**130.8**	**117.2**	**100.1**	**-14.6**	**100.0**

NA = Not available
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-6
1996 Top 30 Mechanical Software Companies, North America, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	Parametric Technology	114.7	160.6	217.8	35.6	21.6
2	IBM	86.4	95.1	123.9	30.3	12.3
3	EDS Unigraphics	92.7	93.3	112.8	20.9	11.2
4	Structural Dynamics Research Corporation	52.0	68.3	73.3	7.3	7.3
5	Autodesk	75.5	83.4	73.2	-12.2	7.3
6	Computervision	30.8	48.1	64.0	33.0	6.3
7	Dassault	43.2	47.6	61.7	29.5	6.1
8	MacNeal-Schwendler	48.3	50.0	54.7	9.3	5.4
9	Ansys	17.2	15.4	18.7	21.4	1.9
10	CoCreate	11.2	11.9	16.2	37.0	1.6
11	Sherpa Corp.	10.3	13.4	15.7	17.2	1.6
12	Intergraph	33.1	24.8	14.1	-43.1	1.4
13	Concentra	8.1	8.0	12.0	50.3	1.2
14	MicroCADAM	5.0	9.0	10.6	17.6	1.1
15	Formtek	9.2	10.0	10.5	4.7	1.0
16	Algor Interactive Systems	6.5	9.7	10.4	7.3	1.0
17	Altair Computing	4.3	6.0	10.0	66.0	1.0
18	Gerber Systems	7.1	8.3	9.4	13.0	0.9
19	ADRA Systems	9.4	8.1	8.9	10.4	0.9
20	MCS	8.3	8.6	8.8	2.4	0.9
21	Applicon	8.8	8.3	8.8	5.5	0.9
22	Tecnomatix Technology	6.8	7.4	8.6	16.5	0.9
23	Alias Research	7.9	8.6	8.6	-	0.9
24	Deneb Robotics	5.6	6.5	7.3	13.0	0.7
25	Bentley Systems	1.8	5.5	6.2	12.8	0.6
*26	Mechanical Dynamics	6.3	4.7	6.1	29.2	0.6
27	CGTech	3.0	5.5	5.8	5.9	0.6
28	CNC Software	5.1	5.6	5.8	3.5	0.6
29	Matra Datavision	5.3	4.4	5.5	25.9	0.5
30	ICEM Technologies	3.8	4.5	5.3	17.5	0.5
	All North American Companies	714.3	837.7	982.2	17.3	97.4
	All European Companies	14.8	20.2	24.8	23.1	2.5
	All Asian Companies	1.2	1.6	1.8	8.8	0.2
	All Companies	**730.3**	**859.4**	**1,008.8**	**17.4**	**100.0**

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-7
1996 Top 30 Mechanical Software Companies, North America, UNIX (Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	Parametric Technology	103.3	134.9	169.9	25.9	23.0
2	IBM	56.0	77.2	109.4	41.7	14.8
3	EDS Unigraphics	92.7	93.3	101.6	8.8	13.7
4	Structural Dynamics Research Corporation	48.1	63.2	69.7	10.4	9.4
5	Computervision	29.2	46.0	61.2	33.0	8.3
6	Dassault	32.3	36.6	54.3	48.4	7.3
7	MacNeal-Schwendler	31.9	38.0	40.4	6.3	5.5
8	Sherpa Corp.	10.3	13.3	15.6	17.3	2.1
9	Ansys	11.7	11.6	14.0	21.4	1.9
10	Concentra	8.1	8.0	12.0	50.3	1.6
11	CoCreate	10.4	8.9	11.8	32.8	1.6
12	Intergraph	20.6	24.0	10.5	-56.3	1.4
13	Altair Computing	4.2	5.9	9.5	60.9	1.3
14	Gerber Systems	7.1	8.3	9.4	13.0	1.3
15	Tecnomatix Technology	6.8	7.4	8.6	16.5	1.2
16	Alias Research	7.9	8.6	8.6	-	1.2
17	Formtek	6.4	7.0	7.4	4.7	1.0
18	Deneb Robotics	5.6	6.5	7.3	13.0	1.0
19	Applicon	8.5	6.6	6.9	4.9	0.9
20	ADRA Systems	6.8	5.9	6.7	13.0	0.9
21	ICEM Technologies	3.8	4.5	5.0	12.8	0.7
22	Matra Datavision	5.2	3.8	4.8	25.8	0.6
23	Mechanical Dynamics	5.1	3.8	4.7	22.8	0.6
24	Algor Interactive Systems	2.6	3.9	4.4	13.0	0.6
25	CGTech	2.1	3.9	4.0	4.4	0.5
26	CIMLINC	2.6	3.4	3.4	-	0.5
27	Cadis Software	0.4	1.1	3.3	205.6	0.4
28	MicroCADAM	2.0	3.6	3.2	-11.8	0.4
29	Adina R&D	2.4	2.7	3.1	13.0	0.4
30	First Cadcam Inc.	2.2	2.6	3.0	16.5	0.4
	All North American Companies	511.5	619.1	720.0	16.3	97.3
	All European Companies	11.8	16.0	18.3	14.7	2.5
	All Asian Companies	1.0	1.4	1.6	13.8	0.2
	All Companies	**524.4**	**636.5**	**739.9**	**16.2**	**100.0**

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-8
1996 Top 30 Mechanical Software Companies, North America, NT/Hybrid
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	Parametric Technology	11.2	25.7	47.9	86.5	47.3
2	Autodesk	-	-	12.1	NA	11.9
3	EDS Unigraphics	-	-	11.3	NA	11.1
4	SolidWorks Corporation	-	-	4.7	NA	4.6
5	Intergraph	7.3	0.8	3.6	346.2	3.6
6	Bentley Systems	0.7	2.1	3.0	45.4	3.0
7	Structural Dynamics Research Corporation	-	3.0	2.9	-1.4	2.9
8	Ansys	-	1.9	2.4	31.6	2.4
9	MCS	-	0.9	2.2	159.2	2.2
10	3D/Eye Inc.	-	-	1.8	NA	1.7
11	DP Technology	-	0.8	1.5	100.0	1.5
12	MicroCADAM	0.3	0.5	1.3	182.4	1.3
13	CoCreate	-	0.5	1.0	106.9	1.0
14	Spatial Technology	0.4	0.6	0.7	6.7	0.7
15	CGTech	0.3	0.6	0.6	16.5	0.6
16	Matra Datavision	-	0.5	0.6	25.3	0.6
17	MacNeal-Schwendler	-	0.5	0.5	9.2	0.5
18	Mechanical Dynamics	-	-	0.5	NA	0.5
19	NOVASOFT Systems	-	0.2	0.5	100.0	0.5
20	B.A. Intelligence Networks	-	0.2	0.4	100.0	0.4
21	SRAC	-	0.4	0.4	-6.8	0.4
22	Gibbs and Assoc.	-	-	0.4	NA	0.4
23	MARC	-	-	0.2	NA	0.2
24	IBM	-	-	0.2	NA	0.2
25	ICEM Technologies	-	-	0.2	NA	0.2
26	CONSENS	-	0.1	0.2	60.0	0.2
27	Radan Computational	-	-	0.2	NA	0.2
28	Auto-Trol	-	-	0.1	NA	0.1
29	Delcam International	-	-	0.1	NA	0.1
30	Altair Computing	-	-	0.1	NA	0.1
	All North American Companies	19.5	38.6	100.1	158.9	98.8
	All European Companies	0.1	0.5	1.2	150.4	1.2
	All Asian Companies	-	-	-	NA	-
	All Companies	**19.6**	**39.1**	**101.3**	**158.8**	**100.0**

NA = Not available
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-9
1996 Top 30 Mechanical Software Companies, North America, Personal Computer (Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	Autodesk	71.0	78.4	58.9	-24.9	41.5
2	MicroCADAM	2.8	5.0	6.2	24.1	4.3
3	Algor Interactive Systems	3.9	5.8	6.0	3.5	4.2
4	CNC Software	5.1	5.6	5.8	3.5	4.1
5	MCS	5.8	4.7	5.2	10.9	3.7
6	Viagrafix	4.9	5.0	5.1	3.5	3.6
7	Surfware	1.9	3.6	3.8	6.5	2.7
8	Baystate Technologies	-	1.1	3.5	215.4	2.5
9	CoCreate	0.7	2.5	3.4	38.3	2.4
10	Formtek	2.8	3.0	3.2	4.7	2.2
11	Ashlar	3.5	3.0	3.1	4.2	2.2
12	Bentley Systems	1.0	3.0	2.8	-3.9	2.0
13	Computervision	1.5	2.1	2.8	33.1	2.0
14	ADRA Systems	2.7	2.2	2.3	3.5	1.6
15	Workgroup Tech.	-	1.8	2.2	23.9	1.6
16	SRAC	1.5	1.5	2.2	42.9	1.5
17	DP Technology	1.6	1.9	2.0	3.5	1.4
18	Pathtrace Engineering Systems	1.4	1.5	2.0	30.8	1.4
19	Cimatron	0.5	0.9	1.9	107.5	1.4
20	Applicon	0.3	1.7	1.8	8.3	1.3
21	MacNeal-Schwendler	-	0.6	1.8	216.8	1.2
22	3D/Eye Inc.	-	-	1.8	NA	1.2
23	Ansys	3.8	1.4	1.7	21.4	1.2
24	Gibbs and Assoc.	1.9	2.2	1.6	-29.1	1.1
25	Variation Systems Analysis	1.1	1.3	1.3	3.5	0.9
26	CGTech	0.6	1.1	1.2	5.9	0.8
27	Engineering Mechanics	3.0	1.0	1.1	3.5	0.8
28	GRAPHSOFT	0.7	1.0	1.1	4.2	0.7
29	Boothroyd Dewhurst	0.9	1.0	1.0	-1.4	0.7
30	NOVASOFT Systems	0.1	1.0	1.0	3.5	0.7
	All North American Companies	137.9	152.2	136.8	-10.1	96.3
	All European Companies	2.7	3.5	5.2	47.9	3.7
	All Asian Companies	0.1	0.1	0.1	3.5	0
	All Companies	**140.7**	**155.7**	**142.1**	**-8.8**	**100.0**

NA = Not available
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-10
1996 Top Mechanical Software Companies, North America, Host/Proprietary
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	IBM	30.4	17.9	14.3	-20.1	56.1
2	MacNeal-Schwendler	16.4	11.0	12.0	9.2	47.1
3	Dassault	10.8	11.1	7.4	-33.0	29.0
4	Mechanical Dynamics	0.9	0.7	0.7	-5.2	2.6
5	Ansys	1.7	0.6	0.6	-8.9	2.2
6	Altair Computing	-	-	0.2	NA	0.8
7	Access Corp.	0.4	0.4	0.2	-50.0	0.7
8	Sherpa Corp.	-	0.1	0.1	9.5	0.6
9	Computational Mechanics	0.2	0.2	0.1	-50.0	0.4
10	Kubota Computer	0.1	0.1	0.1	-50.0	0.2
11	debis Systemhaus	-	-	0	NA	0.1
12	Framasoft	-	-	0	NA	0
13	Exapt	2.0	1.5	-	-100.0	-
14	First Cadcam Inc.	0.3	0.3	-	-100.0	-
	All North American Companies	45.4	27.7	25.3	-8.6	99.3
	All European Companies	0.2	0.2	0.1	-45.4	0.4
	All Asian Companies	0.1	0.1	0.1	-50.0	0.2
	All Companies	**45.7**	**28.0**	**25.5**	**-9.1**	**100.0**

NA = Not available
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total
Source: Dataquest (July 1997)

Table A-11
1996 Top 30 Mechanical Software Companies, Europe, All Operating Systems
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	IBM	165.9	249.5	298.5	19.6	26.0
2	Parametric Technology	68.3	109.2	173.3	58.6	15.1
3	Dassault	86.3	110.5	132.3	19.7	11.5
4	Computervision	90.9	73.6	81.1	10.2	7.1
5	Matra Datavision	63.5	70.0	68.8	-1.6	6.0
6	EDS Unigraphics	33.7	43.6	55.5	27.4	4.8
7	Autodesk	53.4	60.7	55.2	-9.1	4.8
8	Structural Dynamics Research Corporation	29.8	38.7	43.1	11.3	3.7
9	CoCreate	37.3	43.5	42.4	-2.4	3.7
10	MacNeal-Schwendler	18.4	32.0	36.1	12.7	3.1
11	ISD Software	10.5	14.5	22.4	55.0	2.0
12	ASCAD	12.1	14.9	16.5	10.9	1.4
13	Tecnomatix Technology	5.7	11.6	16.3	40.1	1.4
14	Tebis	5.2	12.5	14.0	12.3	1.2
15	Delcam International	5.6	7.7	12.9	68.1	1.1
16	CAD Lab	11.4	13.6	12.8	-5.6	1.1
17	MicroCADAM	7.3	10.3	12.2	17.6	1.1
18	Applicon	9.7	12.4	12.1	-1.9	1.1
19	ICEM Technologies	6.2	9.8	11.2	14.7	1.0
20	Ansys	8.5	10.1	11.1	9.9	1.0
21	Sherpa Corp.	8.4	7.2	10.5	45.7	0.9
22	Straessle Informationssysteme	15.6	12.0	10.3	-14.2	0.9
23	Wiechers Datentechnik	8.9	8.3	8.9	7.1	0.8
24	Investronica SA	5.7	6.0	8.6	43.8	0.7
25	Radan Computational	8.2	7.6	8.2	7.4	0.7
26	Sescoi	-*	6.0	7.5	25.0	0.7
27	ADRA Systems	4.4	6.8	7.5	9.4	0.7
28	BCT GMBH	3.0	4.2	7.2	71.6	0.6
29	Eigner + Partner	5.4	6.3	6.8	8.4	0.6
30	Intergraph	21.2	19.7	6.5	-67.0	0.6
	All North American Companies	579.3	746.8	867.0	16.1	75.5
	All European Companies	246.0	277.6	282.1	1.6	24.5
	All Asian Companies	-	-	-	NA	-
	All Companies	**825.3**	**1,024.4**	**1,149.0**	**12.2**	**100.0**

NA = Not available
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-12
1996 Top 30 Mechanical Software Companies, Europe, UNIX
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	IBM	132.5	206.0	263.5	27.9	31.1
2	Parametric Technology	61.5	91.7	135.1	47.3	15.9
3	Dassault	64.7	84.9	116.5	37.2	13.7
4	Computervision	86.4	70.4	77.5	10.2	9.1
5	Matra Datavision	62.1	60.4	59.4	-1.7	7.0
6	EDS Unigraphics	33.7	43.6	49.9	14.6	5.9
7	Structural Dynamics Research Corporation	29.2	37.0	41.0	10.7	4.8
8	CoCreate	34.8	32.6	30.8	-5.4	3.6
9	MacNeal-Schwendler	12.2	24.3	26.6	9.6	3.1
10	Tecnomatix Technology	5.7	11.6	16.3	40.1	1.9
11	ASCAD	11.5	12.8	14.1	10.7	1.7
12	Delcam International	5.3	7.4	12.3	66.4	1.4
13	ICEM Technologies	6.2	9.8	10.8	10.1	1.3
14	Sherpa Corp.	8.4	7.1	10.4	45.8	1.2
15	Straessle Informationssysteme	15.6	12.0	10.3	-14.2	1.2
16	Applicon	9.5	10.0	9.6	-4.3	1.1
17	Ansys	5.8	7.6	8.3	9.9	1.0
18	ISD Software	7.5	10.4	7.6	-27.6	0.9
19	Eigner + Partner	5.4	6.3	6.8	8.4	0.8
20	Han Dataport	7.1	7.8	6.5	-17.4	0.8
21	CAD Lab	8.0	7.5	6.4	-14.2	0.8
22	Sescoi	-	4.8	6.0	25.0	0.7
23	PROCAD GmbH	3.1	5.2	5.7	9.9	0.7
24	ADRA Systems	3.2	5.0	5.6	12.4	0.7
25	MARC	3.8	4.5	5.3	19.0	0.6
26	Tebis	0.5	4.6	5.3	14.4	0.6
27	Intergraph	13.0	19.1	4.8	-74.6	0.6
28	Concentra	3.3	3.4	4.7	37.1	0.6
29	Alias Research	3.3	4.3	4.3	-	0.5
30	Mechanical Dynamics	3.1	3.0	4.1	35.3	0.5
	All North American Companies	454.2	581.7	678.7	16.7	80.1
	All European Companies	177.1	190.3	169.1	-11.2	19.9
	All Asian Companies	-	-	-	NA	-
	All Companies	**631.3**	**772.0**	**847.8**	**9.8**	**100.0**

NA = Not available
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-13
1996 Top 30 Mechanical Software Companies, Europe, NT/Hybrid
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	Parametric Technology	6.8	17.5	38.1	118.1	35.3
2	ISD Software	-	-	12.2	NA	11.3
3	Autodesk	-	-	9.1	NA	8.4
4	Matra Datavision	-	7.7	7.5	-2.1	7.0
5	EDS Unigraphics	-	-	5.5	NA	5.1
6	CAD Lab	-	0.7	5.1	654.8	4.8
7	CAD Distribution	0.1	3.5	4.8	37.6	4.4
8	Radan Computational	-	-	4.5	NA	4.2
9	Bentley Systems	0.7	2.1	3.1	43.9	2.8
10	CoCreate	-	1.8	2.6	47.3	2.4
11	BCT GMBH	-	0.4	2.5	500.6	2.3
12	Structural Dynamics Research Corporation	-	1.0	1.7	79.8	1.6
13	Intergraph	4.8	0.6	1.7	160.8	1.5
14	MicroCADAM	0.4	0.5	1.5	182.4	1.4
15	Ansys	-	1.2	1.4	19.1	1.3
16	Vero International Software	-	-	1.3	NA	1.2
17	ASCAD	-	0.9	1.0	14.4	0.9
18	SolidWorks Corporation	-	-	0.9	NA	0.8
19	PROCAD GmbH	0.3	0.6	0.8	39.0	0.7
20	MCS	-	0.3	0.7	172.2	0.7
21	Delcam International	-	-	0.6	NA	0.6
22	IBM	-	-	0.5	NA	0.5
23	MARC	-	-	0.5	NA	0.4
24	Catalpa groupe Missler	-	-	0.5	NA	0.4
25	ICEM Technologies	-	-	0.4	NA	0.4
26	B.A. Intelligence Networks	-	0.3	0.4	36.0	0.4
27	Mechanical Dynamics	-	-	0.4	NA	0.4
28	MacNeal-Schwendler	-	0.3	0.4	12.6	0.3
29	Spatial Technology	0.2	0.3	0.3	-2.4	0.3
30	CGTech	0.2	0.2	0.2	20.1	0.2
	All North American Companies	12.3	26.4	68.6	159.6	63.6
	All European Companies	0.8	13.7	39.3	186.1	36.4
	All Asian Companies	-	-	-	NA	-
	All Companies	**13.1**	**40.2**	**108.0**	**168.6**	**100.0**

NA = Not available
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-14
1996 Top 30 Mechanical Software Companies, Europe, Personal Computer (Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	Autodesk	50.2	58.4	44.4	-23.9	28.8
2	CoCreate	2.4	9.1	8.9	-1.5	5.8
3	Wiechers Datentechnik	8.1	7.5	8.9	18.4	5.8
4	Tebis	4.7	7.9	8.8	11.1	5.7
5	Investronica SA	5.7	6.0	8.6	43.8	5.6
6	MicroCADAM	4.0	5.7	7.1	24.1	4.6
7	Serbi	5.0	5.9	5.6	-4.1	3.6
8	BCT GMBH	3.0	3.8	4.7	23.9	3.0
9	Ziegler Informatics	4.9	3.3	4.6	40.3	3.0
10	Cimatron	1.6	3.4	4.4	30.6	2.8
11	Whessoe Computing Systems	3.5	3.8	3.9	1.8	2.5
12	PAFEC	1.3	-	3.7	NA	2.4
13	Computervision	4.5	3.2	3.6	10.3	2.3
14	Bentley Systems	1.0	3.0	2.9	-5.0	1.9
15	Anilam Electronics	2.8	2.6	2.7	3.0	1.8
16	ISD Software	3.0	4.0	2.6	-34.4	1.7
17	Applicon	0.3	2.4	2.6	8.3	1.7
18	Pathtrace Engineering Systems	1.5	1.6	2.1	31.0	1.4
19	Just In Time Systems	1.9	2.5	2.1	-17.8	1.3
20	ADRA Systems	1.2	1.8	1.9	1.3	1.2
21	Matra Datavision	1.4	1.8	1.9	2.1	1.2
22	MCS	1.8	1.5	1.7	16.5	1.1
23	Kloeckner-Moeller	1.9	1.7	1.7	0.5	1.1
24	RoboCAD Solutions	2.2	1.9	1.6	-14.5	1.0
25	Formtek	1.2	1.4	1.5	13.7	1.0
26	Sescoi	-	1.2	1.5	25.0	1.0
27	CADdy Spain	1.3	1.4	1.4	0	0.9
28	ASCAD	0.6	1.2	1.3	10.3	0.9
29	CAD Lab	3.4	5.4	1.3	-76.4	0.8
30	Vero International Software	1.4	1.7	1.2	-29.4	0.8
	All North American Companies	77.2	94.9	82.7	-12.9	53.6
	All European Companies	64.7	71.0	71.7	1.0	46.4
	All Asian Companies	-	*	-	NA	-
	All Companies	**141.9**	**165.8**	**154.4**	**-6.9**	**100.0**

NA = Not available
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-15
1996 Top Mechanical Software Companies, Europe, Host/Proprietary
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	IBM	33.5	43.6	34.5	-20.8	88.6
2	Dassault	21.7	25.6	15.9	-38.1	40.8
3	MacNeal-Schwendler	6.3	7.0	7.9	12.6	20.3
4	Exapt	4.0	3.0	1.3	-57.4	3.3
5	Mechanical Dynamics	0.6	0.6	0.6	4.4	1.5
6	Ansys	0.8	0.4	0.3	-17.6	0.9
7	Whessoe Computing Systems	0.4	0.3	0.3	-15.4	0.7
8	debis Systemhaus	0.2	0.2	0.2	-5.8	0.6
9	Computational Mechanics	0.2	0.2	0.2	-12.5	0.5
10	Framasoft	0.4	0.4	0.2	-63.0	0.4
11	Sherpa Corp.	-	0.1	0.1	36.1	0.3
12	CIMTEK	0.2	0.1	0.1	-8.4	0.2
13	Access Corp.	0	0	0	-44.3	0
14	Cimtel	0	0	-	-100.0	-
15	First Cadcam Inc.	0	0	-	-100.0	-
	All North American Companies	35.6	43.8	37.0	-15.7	94.9
	All European Companies	3.4	2.6	2.0	-24.6	5.1
	All Asian Companies	-	-	-	NA	-
	All Companies	**39.0**	**46.4**	**38.9**	**-16.2**	**100.0**

NA = Not available
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Dataquest (July 1997)

Table A-16
1996 Top 30 Mechanical Software Companies, Japan, All Operating Systems
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	MicroCADAM	75.2	104.7	123.1	17.6	12.7
2	Info. Services International Dentsu*	66.0	85.2	117.2	37.6	12.1
3	IBM	76.4	106.0	109.8	3.5	11.3
4	Fujitsu	83.7	97.0	107.3	10.7	11.1
5	Hitachi	66.7	70.9	79.9	12.7	8.2
6	Parametric Technology	26.3	41.8	71.1	70.2	7.3
7	NEC	61.7	72.9	62.9	-13.7	6.5
8	Toshiba*	54.5	66.7	62.5	-6.3	6.4
9	Nihon Unisys	48.1	52.8	54.4	3.0	5.6
10	Hitachi Zosen Info Systems	34.2	38.3	38.9	1.4	4.0
11	Hakuto*	23.6	29.8	34.0	14.0	3.5
12	CoCreate	22.4	22.9	31.6	37.8	3.3
13	C. Itoh Techno-Science*	34.6	30.8	30.8	0	3.2
14	Structural Dynamics Research Corporation	25.6	31.3	25.9	-17.3	2.7
15	MacNeal-Schwendler	22.3	29.6	24.9	-16.1	2.6
16	Marubeni Hytech*	18.3	19.9	23.0	15.3	2.4
17	Sumisho Electronics*	18.4	18.8	21.6	14.5	2.2
18	Tokyo Electron*	16.0	17.4	20.0	15.3	2.1
19	Dassault	13.9	19.1	19.9	4.3	2.0
20	Autodesk	16.3	19.0	19.8	4.7	2.0
21	Seiko*	18.0	19.7	19.0	-3.5	2.0
22	Andor*	17.6	15.9	17.8	12.0	1.8
23	Mutoh Industries*	14.2	13.1	17.0	29.5	1.8
24	Mitsui Engineering	12.9	14.0	16.1	15.2	1.7
25	Computervision	22.3	14.0	15.7	12.1	1.6
26	Matra Datavision	4.2	5.2	11.9	127.3	1.2
27	Design Automation	6.1	10.0	11.5	14.4	1.2
28	MARC	9.6	11.1	9.8	-12.2	1.0
29	Toyo Information Systems*	7.6	8.1	9.0	10.7	0.9
30	Graphtec Engineering	7.9	8.6	8.6	0.5	0.9
	All North American Companies	319.3	408.2	461.0	12.9	47.5
	All European Companies	9.7	17.9	23.1	28.7	2.4
	All Asian Companies	424.3	475.8	486.0	2.1	50.1
	All Companies	**753.3**	**901.9**	**970.1**	**7.6**	**100.0**

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-17
1996 Top 30 Mechanical Software Companies, Japan, UNIX
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	Info. Services International Dentsu*	62.7	80.9	111.3	37.6	16.4
2	IBM	56.8	86.1	95.5	11.0	14.0
3	Fujitsu	56.1	65.0	72.7	11.9	10.7
4	Hitachi	53.9	57.3	66.1	15.3	9.7
5	Parametric Technology	23.7	35.1	55.4	58.1	8.1
6	Nihon Unisys	43.8	51.8	53.6	3.5	7.9
7	Toshiba*	39.6	50.0	42.5	-15.0	6.2
8	Hitachi Zosen Info Systems	34.2	38.3	38.9	1.4	5.7
9	NEC	42.0	43.7	37.7	-13.7	5.5
10	MicroCADAM	30.1	41.9	36.9	-11.8	5.4
11	C. Itoh Techno-Science*	30.9	28.4	28.4	0	4.2
12	Structural Dynamics Research Corporation	25.1	30.6	24.6	-19.6	3.6
13	Marubeni Hytech*	18.3	19.9	23.0	15.3	3.4
14	CoCreate	20.9	17.2	23.0	33.6	3.4
15	Hakuto*	14.1	17.9	20.6	15.3	3.0
16	Tokyo Electron*	16.0	17.4	20.0	15.3	2.9
17	Seiko*	18.0	19.7	19.0	-3.5	2.8
18	MacNeal-Schwendler	14.7	22.5	18.4	-18.4	2.7
19	Dassault	10.4	14.6	17.5	19.6	2.6
20	Sumisho Electronics*	13.1	14.2	16.4	15.3	2.4
21	Mitsui Engineering	12.4	13.5	15.5	15.3	2.3
22	Computervision	21.6	13.4	15.0	12.1	2.2
23	Matra Datavision	4.1	4.5	10.3	127.2	1.5
24	MARC	9.6	11.1	8.9	-20.1	1.3
25	Mutoh Industries*	7.8	7.3	8.4	15.3	1.2
26	Toyo Information Systems*	6.7	7.3	8.4	15.3	1.2
27	Adam Net	6.7	7.2	7.7	6.8	1.1
28	Kubota Computer	6.0	6.6	7.6	15.3	1.1
29	Sharp*	6.1	8.3	7.5	-10.2	1.1
30	CADIX	4.2	4.2	7.0	65.7	1.0
	All North American Companies	220.9	281.0	298.8	6.4	43.9
	All European Companies	8.0	12.7	15.5	21.7	2.3
	All Asian Companies	338.7	370.2	366.6	-1.0	53.8
	All Companies	**567.6**	**663.9**	**681.0**	**2.6**	**100.0**

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-18
1996 Top 30 Mechanical Software Companies, Japan, NT/Hybrid
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	Parametric Technology	2.6	6.7	15.6	134.1	24.0
2	MicroCADAM	3.8	5.2	14.8	182.4	22.6
3	Wacom	-	4.9	7.1	44.5	10.8
4	Omron	-	5.8	5.8	-0.6	8.8
5	Mutoh Industries*	2.5	2.3	4.7	100.0	7.2
6	NEC	-	5.2	4.5	-13.7	6.9
7	Autodesk	-	-	3.3	NA	5.0
8	Graphtec Engineering	-	-	2.6	NA	4.0
9	Toshiba Engineering*	-	-	2.5	NA	3.9
10	CoCreate	-	0.9	2.0	108.1	3.0
11	Matra Datavision	-	0.6	1.3	126.3	2.0
12	Structural Dynamics Research Corporation	-	0.4	1.0	175.5	1.6
13	MARC	-	-	0.8	NA	1.2
14	Ansys	-	0.5	0.6	16.7	1.0
15	Vero International Software	-	-	0.6	NA	0.9
16	EDS Unigraphics	-	-	0.6	NA	0.9
17	SolidWorks Corporation	-	-	0.4	NA	0.6
18	Radan Computational	-	-	0.4	NA	0.6
19	Intergraph	0.6	0.1	0.3	300.0	0.5
20	Mechanical Dynamics	-	-	0.3	NA	0.4
21	MacNeal-Schwendler	-	0.3	0.2	-16.2	0.4
22	CGTech	0.1	0.2	0.2	20.1	0.4
23	Spatial Technology	0.2	0.3	0.2	-20.4	0.3
24	IBM	-	-	0.2	NA	0.3
25	Bentley Systems	0	0	0.2	290.2	0.3
26	MCS	-	0	0.1	172.2	0.2
27	SRAC	-	0.1	0.1	-42.6	0.1
28	Delcam International	-	-	0.1	NA	0.1
29	Gibbs and Assoc.	-	-	0.1	NA	0.1
30	ICEM Technologies	-	-	0	NA	0.1
	All North American Companies	7.3	14.8	40.7	174.5	62.3
	All European Companies	0.1	0.6	2.4	314.6	3.7
	All Asian Companies	-	15.9	22.2	39.6	34.0
	All Companies	**7.3**	**31.3**	**65.3**	**108.6**	**100.0**

NA = Not available
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-19
1996 Top 30 Mechanical Software Companies, Japan, Personal Computer
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	MicroCADAM	41.3	57.6	71.4	24.1	36.5
2	Fujitsu	20.9	24.2	26.9	11.0	13.7
3	NEC	19.7	24.0	20.8	-13.7	10.6
4	Toshiba*	14.9	16.7	20.0	20.0	10.2
5	Andor*	17.6	15.9	17.8	12.0	9.1
6	Autodesk	15.5	18.0	16.2	-10.2	8.3
7	Hakuto*	9.4	11.9	13.4	12.0	6.8
8	Design Automation	6.1	10.0	11.5	14.4	5.9
9	Hitachi	9.6	10.2	11.4	12.0	5.8
10	CoCreate	1.5	4.8	6.7	39.1	3.4
11	Info. Services International Dentsu*	3.3	4.3	5.9	37.6	3.0
12	Sumisho Electronics*	5.2	4.6	5.1	12.0	2.6
13	Kozo Keikaku Engineering*	3.7	3.3	4.2	27.8	2.1
14	Mutoh Industries*	3.8	3.5	4.0	12.0	2.0
15	Graphtec Engineering	-	-	2.6	NA	1.3
16	Argo Graphics*	1.9	2.0	2.3	12.0	1.2
17	Mitsubishi Electric*	1.8	1.7	1.9	12.0	1.0
18	Cimatron	0.3	0.7	1.8	142.1	0.9
19	Ashlar	1.2	1.6	1.7	4.2	0.8
20	Wacom	4.7	1.1	1.3	18.7	0.7
21	Anilam Electronics	1.1	1.2	1.3	12.0	0.7
22	Uchida Yoko	-	0.8	1.3	60.6	0.7
23	Workgroup Tech.	-	0.7	0.9	23.9	0.5
24	ADRA Systems	0.9	0.8	0.9	12.0	0.4
25	Surfware	0.1	0.3	0.8	224.0	0.4
26	MacNeal-Schwendler	-	0.3	0.8	143.2	0.4
27	Adam Net	0.2	0.2	0.8	230.5	0.4
28	Investronica SA	-	-	0.7	NA	0.4
29	Computervision	0.7	0.6	0.7	12.1	0.4
30	Formtek	0.8	0.9	0.6	-27.2	0.3
	All North American Companies	66.3	88.9	104.2	17.2	53.2
	All European Companies	1.5	4.5	5.1	13.9	2.6
	All Asian Companies	71.2	77.9	86.6	11.1	44.2
	All Companies	**139.0**	**171.3**	**195.9**	**14.3**	**100.0**

NA = Not available
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-20
1996 Top Mechanical Software Companies, Japan, Host/Proprietary
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	IBM	19.6	20.0	14.1	-29.6	50.2
2	Fujitsu	6.7	7.8	7.7	-0.8	27.5
3	MacNeal-Schwendler	7.6	6.5	5.5	-16.2	19.5
4	C. Itoh Techno-Science*	3.6	2.4	2.4	-	8.6
5	Dassault	3.5	4.4	2.4	-46.0	8.5
6	Hitachi	3.1	3.3	2.3	-30.0	8.3
7	Mitsubishi Electric*	1.5	1.2	0.9	-30.0	3.1
8	Nihon Unisys	4.3	1.1	0.8	-22.3	3.0
9	Toyo Information Systems*	0.9	0.8	0.6	-30.0	2.1
10	Kubota Computer	0.7	0.6	0.4	-30.0	1.6
11	Mechanical Dynamics	0.4	0.5	0.3	-23.5	1.2
12	Century Research Center	0.4	0.3	0.2	-30.0	0.8
13	Ansys	0.5	0.2	0.1	-19.2	0.5
14	Whessoe Computing Systems	0.1	0.1	0.1	-30.0	0.2
15	Altair Computing	-	-	0	NA	0.1
16	Technodia*	0	0	0	-30.0	0.1
17	Computational Mechanics	0.1	0	0	-30.0	0.1
18	Framasoft	0	0	0	-53.8	0
19	First Cadcam Inc.	0.1	0.1	-	-100.0	-
	All North American Companies	24.8	23.6	17.4	-26.3	62.0
	All European Companies	0.2	0.1	0.1	-38.0	0.3
	All Asian Companies	14.4	11.7	10.6	-10.0	37.7
	All Companies	**39.4**	**35.4**	**28.0**	**-20.9**	**100.0**

NA = Not available
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-21
1996 Top 30 Mechanical Software Companies, Asia/Pacific, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	IBM	29.0	38.8	42.3	9.1	23.4
2	Parametric Technology	0.1	9.6	32.9	241.1	18.2
3	Autodesk	16.7	20.9	22.9	10.0	12.7
4	EDS Unigraphics	12.6	15.6	17.2	10.7	9.5
5	Dassault	10.8	13.3	14.6	9.6	8.1
6	Structural Dynamics Research Corporation	7.6	6.5	10.9	67.9	6.0
7	Computervision	2.8	10.3	10.1	-1.6	5.6
8	MacNeal-Schwendler	1.8	2.4	7.5	212.1	4.1
9	Matra Datavision	2.6	7.0	4.6	-34.4	2.5
10	MicroCADAM	3.0	3.9	4.6	17.9	2.5
11	Delcam International	2.3	2.8	3.1	7.8	1.7
12	Intergraph	2.4	2.1	2.8	33.3	1.5
13	Formtek	0.7	0.8	2.1	172.8	1.1
14	Sharp*	1.5	2.1	1.9	-10.2	1.0
15	Cimatron	1.1	1.7	1.8	9.3	1.0
16	Ansys	1.3	1.9	1.8	-5.4	1.0
17	Design Automation	0.9	1.6	1.8	14.4	1.0
18	MCS	1.3	1.8	1.8	-0.7	1.0
19	Alias Research	-	1.7	1.7	-	1.0
20	Gerber Systems	1.1	1.2	1.5	21.0	0.8
21	Straessle Informationssysteme	1.1	1.6	1.4	-14.2	0.8
22	ADRA Systems	0.7	1.1	1.4	19.3	0.8
23	Concentra	0.1	0.3	1.2	372.3	0.7
24	Bentley Systems	0.3	0.8	1.0	14.6	0.5
25	Mechanical Dynamics	1.0	1.0	1.0	-3.1	0.5
26	PAFEC	-	-	1.0	NA	0.5
27	Investronica SA	3.8	3.9	0.8	-79.5	0.4
28	MARC	-	-	0.8	NA	0.4
29	Vero International Software	0.2	0.3	0.7	115.4	0.4
30	CNC Software	0.5	0.6	0.7	16.8	0.4
	All North American Companies	85.0	120.6	162.8	35.0	90.1
	All European Companies	12.3	17.8	14.1	-20.6	7.8
	All Asian Companies	2.9	4.1	3.8	-7.4	2.1
	All Companies	**100.2**	**142.4**	**180.7**	**26.8**	**100.0**

NA = Not available
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-22
1996 Top 30 Mechanical Software Companies, Asia/Pacific, UNIX
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	IBM	24.3	31.9	36.4	14.0	29.3
2	Parametric Technology	0.1	8.1	25.6	216.7	20.6
3	EDS Unigraphics	12.6	15.6	15.5	-0.4	12.5
4	Dassault	8.1	10.2	12.9	25.6	10.4
5	Structural Dynamics Research Corporation	6.9	5.7	10.3	80.4	8.3
6	Computervision	2.7	9.8	9.7	-1.6	7.8
7	MacNeal-Schwendler	1.2	1.8	5.5	202.9	4.4
8	Matra Datavision	2.6	6.0	4.0	-34.5	3.2
9	Delcam International	2.2	2.7	2.9	6.8	2.3
10	Intergraph	1.5	2.0	2.1	2.5	1.7
11	Sharp*	1.5	2.1	1.9	-10.2	1.5
12	Alias Research	-	1.7	1.7	-	1.4
13	Gerber Systems	1.1	1.2	1.5	21.0	1.2
14	Formtek	0.5	0.5	1.4	172.8	1.2
15	Ansys	0.9	1.5	1.4	-5.4	1.1
16	MicroCADAM	1.2	1.6	1.4	-11.8	1.1
17	Straessle Informationssysteme	1.1	1.6	1.4	-14.2	1.1
18	Concentra	0.1	0.3	1.2	372.3	1.0
19	ADRA Systems	0.5	0.8	1.0	20.0	0.8
20	Mechanical Dynamics	0.8	0.8	0.8	-7.7	0.6
21	MARC	-	-	0.7	NA	0.6
22	Autodesk	1.0	1.3	0.7	-45.0	0.6
23	Altair Computing	0.3	0.4	0.6	45.4	0.5
24	Hitachi Zosen Info Systems	0.3	0.4	0.4	1.4	0.3
25	PAFEC	-	-	0.3	NA	0.3
26	MCS	0.4	0.6	0.3	-56.9	0.2
27	CIMLINC	-	0.3	0.3	-	0.2
28	CSAR Corp.	-	0.2	0.2	53.2	0.2
29	Auto-Trol	-	0.1	0.2	145.1	0.2
30	CAD Centre	0.1	0.1	0.2	95.1	0.2
	All North American Companies	57.2	83.8	113.1	35.1	91.0
	All European Companies	6.3	10.8	8.9	-17.5	7.2
	All Asian Companies	2.0	2.8	2.3	-20.4	1.8
	All Companies	**65.5**	**97.4**	**124.3**	**27.6**	**100.0**

NA = Not available
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-23
1996 Top 30 Mechanical Software Companies, Asia/Pacific, NT/Hybrid
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	Parametric Technology	0	1.5	7.2	369.0	40.7
2	Autodesk	-	-	3.8	NA	21.3
3	EDS Unigraphics	-	-	1.7	NA	9.7
4	Intergraph	0.5	0.1	0.7	953.7	4.0
5	MicroCADAM	0.1	0.2	0.5	197.2	3.1
6	Matra Datavision	-	0.8	0.5	-34.7	2.8
7	Bentley Systems	0.1	0.3	0.5	47.1	2.7
8	MCS	-	0.2	0.4	151.2	2.5
9	Structural Dynamics Research Corporation	-	0.4	0.4	0.8	2.4
10	Vero International Software	-	-	0.4	NA	2.1
11	SolidWorks Corporation	-	-	0.3	NA	1.8
12	B.A. Intelligence Networks	-	0.1	0.3	160.0	1.5
13	Ansys	-	0.2	0.2	2.5	1.4
14	DP Technology	-	0.1	0.2	158.5	1.0
15	Delcam International	-	-	0.1	NA	0.8
16	Mechanical Dynamics	-	-	0.1	NA	0.4
17	MacNeal-Schwendler	-	0	0.1	298.9	0.4
18	IBM	-	-	0.1	NA	0.4
19	Spatial Technology	0.1	0.1	0.1	-45.4	0.4
20	MARC	-	-	0.1	NA	0.4
21	CAD Lab	-	-	0.1	NA	0.3
22	ISD Software	-	-	0	NA	0.2
23	SRAC	-	-	0	NA	0.2
24	Gibbs and Assoc.	-	-	0	NA	0.1
25	Research Engineers—Civilsoft	-	0	0	1298.0	0.1
26	Auto-Trol	-	-	0	NA	0.1
27	Altair Computing	-	-	0	NA	0
28	CIMLINC	-	-	0	NA	0
29	CGTech	0	0	0	-88.3	0
30	CoCreate	-	0	-	-100.0	-
	All North American Companies	0.8	3.4	16.6	392.3	93.6
	All European Companies	0.2	0.8	1.1	47.0	6.4
	All Asian Companies	-	-	-	NA	-
	All Companies	**1.0**	**4.1**	**17.7**	**328.1**	**100.0**

NA = Not available
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-24
1996 Top 30 Mechanical Software Companies, Asia/Pacific, Personal Computer (Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	Autodesk	15.7	19.6	18.5	-5.8	57.6
2	MicroCADAM	1.6	2.1	2.6	24.1	8.3
3	Design Automation	0.9	1.6	1.8	14.4	5.5
4	Cimatron	0.8	1.4	1.7	19.9	5.2
5	MCS	0.9	1.0	1.0	7.5	3.3
6	Investronica SA	3.8	3.9	0.8	-79.5	2.5
7	CNC Software	0.5	0.6	0.7	16.8	2.1
8	PAFEC	-	-	0.6	NA	2.0
9	Formtek	0.2	0.2	0.6	172.8	1.9
10	Bentley Systems	0.1	0.5	0.4	-2.8	1.4
11	Computervision	0.1	0.5	0.4	-1.5	1.4
12	Just In Time Systems	-	-	0.4	NA	1.1
13	ADRA Systems	0.2	0.3	0.4	17.5	1.1
14	Vero International Software	0.2	0.3	0.3	3.4	1.1
15	B.A. Intelligence Networks	0.2	0.2	0.3	14.5	0.9
16	MacNeal-Schwendler	-	0	0.2	802.7	0.7
17	Surfware	0.3	0.5	0.2	-56.8	0.7
18	SRAC	0.1	-	0.2	NA	0.6
19	DP Technology	0.1	0.2	0.2	13.8	0.6
20	Ansys	0.3	0.2	0.2	-5.4	0.5
21	Matra Datavision	0.1	0.2	0.1	-31.9	0.4
22	Research Engineers—Civilsoft	0.1	0.1	0.1	39.8	0.3
23	Gibbs and Assoc.	-	-	0.1	NA	0.3
24	Ashlar	-	0.1	0.1	4.2	0.3
25	Structural Dynamics Research Corporation	0.7	0.3	0.1	-72.1	0.3
26	CADWORKS	0.1	0.1	0.1	-43.9	0.2
27	Applicon	0	0	0	8.3	0.2
28	Algor Interactive Systems	0	0	0	33.1	0.1
29	RoboCAD Solutions	0	0	0	33.1	0.1
30	Pathtrace Engineering Systems	0	0	0	198.3	0.1
	All North American Companies	22.1	27.1	26.5	-2.1	82.6
	All European Companies	5.8	6.1	4.0	-34.0	12.6
	All Asian Companies	0.9	1.2	1.5	22.5	4.8
	All Companies	**28.8**	**34.4**	**32.1**	**-6.9**	**100.0**

NA = Not available
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-25
1996 Top Mechanical Software Companies, Asia/Pacific, Host/Proprietary (Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	IBM	4.8	6.9	5.9	-14.9	89.2
2	Dassault	2.7	3.1	1.8	-43.3	26.7
3	MacNeal-Schwendler	0.6	0.5	1.6	211.1	24.9
4	Mechanical Dynamics	0.2	0.2	0.1	-28.8	1.6
5	Ansys	0.1	0.1	0.1	-29.8	0.8
6	Altair Computing	-	-	0	NA	0.2
7	Framasoft	-	0	0	19.3	0
8	Computational Mechanics	0	0	-	-100.0	-
	All North American Companies	4.8	6.4	6.6	2.7	100.0
	All European Companies	0.1	0	0	-95.0	0
	All Asian Companies	-	-	-	NA	-
	All Companies	**4.9**	**6.4**	**6.6**	**2.2**	**100.0**

NA = Not available
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-26
1996 Top 30 Mechanical Software Companies, Rest of World, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	Autodesk	5.0	5.7	5.3	-7.0	14.7
2	Engineering Mechanics	-	4.5	5.2	15.4	14.6
3	IBM	10.6	5.0	5.2	3.5	14.5
4	Computervision	1.4	3.0	3.5	17.1	9.7
5	Cimatron	2.8	3.5	3.4	-2.3	9.5
6	Intergraph	1.5	4.9	2.4	-49.8	6.8
7	Delcam International	1.1	2.2	2.2	1.1	6.1
8	MicroCADAM	1.1	1.3	1.5	17.2	4.2
9	MacNeal-Schwendler	-	-	1.2	NA	3.4
10	NOVASOFT Systems	0.4	1.0	1.1	15.6	3.1
11	Matra Datavision	-	0.9	0.9	4.9	2.6
12	Formtek	0.7	0.8	0.8	9.1	2.3
13	MCS	-	0.1	0.7	498.0	2.0
14	Investronica SA	0.5	0.5	0.6	4.0	1.6
15	CNC Software	0.5	0.5	0.5	6.5	1.5
16	Ansys	1.0	0.6	0.5	-20.7	1.4
17	Whessoe Computing Systems	0.4	0.5	0.5	6.0	1.3
18	Straessle Informationssysteme	-	0.3	0.3	-14.2	0.8
19	Viagrafix	0.2	0.2	0.2	6.5	0.5
20	DP Technology	-	0.1	0.2	15.3	0.5
21	Baystate Technologies	-	0	0.2	215.4	0.4
22	B.A. Intelligence Networks	0.1	0.1	0.2	14.4	0.4
23	Computational Mechanics	0.1	0.1	0.1	10.3	0.4
24	Tebis	-	0.1	0.1	12.3	0.4
25	Bentley Systems	0	0.1	0.1	21.0	0.4
26	Surfware	0.1	0.1	0.1	13.7	0.3
27	SRAC	0.1	0.1	0.1	-24.9	0.3
28	ADRA Systems	0.2	0.1	0.1	17.5	0.3
29	CGTech	0.1	0.1	0.1	8.0	0.3
30	CAD Centre	0	0	0.1	265.8	0.3
	All North American Companies	22.6	27.6	27.8	0.6	77.4
	All European Companies	5.4	8.5	8.1	-4.4	22.6
	All Asian Companies	-	-	-	NA	-
	All Companies	**28.0**	**36.2**	**36.0**	**-0.5**	**100.0**

NA = Not available
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-27
1996 Top 30 Mechanical Software Companies, Rest of World, UNIX
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	IBM	8.9	4.1	4.4	6.6	22.9
2	Engineering Mechanics	-	3.0	3.6	20.0	18.9
3	Computervision	1.3	2.8	3.3	17.1	17.5
4	Delcam International	1.1	2.1	2.1	-0.2	10.9
5	Intergraph	0.9	4.7	1.8	-61.4	9.5
6	MacNeal-Schwendler	-	-	0.9	NA	4.8
7	Matra Datavision	-	0.8	0.8	4.9	4.2
8	Formtek	0.5	0.5	0.6	9.1	3.0
9	NOVASOFT Systems	0.3	0.5	0.6	20.0	3.0
10	MicroCADAM	0.5	0.5	0.5	-11.8	2.4
11	Ansys	0.7	0.5	0.4	-20.5	2.0
12	Cimatron	0.4	0.6	0.3	-48.3	1.6
13	Straessle Informationssysteme	-	0.3	0.3	-14.2	1.5
14	Autodesk	0.3	0.3	0.2	-53.5	0.8
15	MCS	-	0	0.1	133.3	0.6
16	CAD Centre	0	0	0.1	260.1	0.5
17	Computational Mechanics	0.1	0.1	0.1	20.0	0.5
18	ADRA Systems	0.2	0.1	0.1	20.0	0.4
19	CGTech	0	0.1	0.1	2.5	0.4
20	Whessoe Computing Systems	0	0	0.1	20.0	0.3
21	Tebis	-	0	0.1	14.4	0.3
22	DP Technology	-	0	0.1	20.0	0.3
23	First Cadcam Inc.	0	0	0	23.0	0.2
24	SRAC	0	0	0	-29.3	0.2
25	Algor Interactive Systems	0	0	0	20.0	0.2
26	B.A. Intelligence Networks	0.1	0	0	20.0	0.1
27	Bentley Systems	-	0	0	-24.3	0
28	Siemens Nixdorf Informations-systeme	0.4	0.4	-	-100.0	-
29	Mechanical Dynamics	0.1	0.1	-	-100.0	-
30	Structural Dynamics Research Corporation	0.1	0	-	-100.0	-
	All North American Companies	13.1	16.4	15.4	-6.0	80.7
	All European Companies	2.0	4.3	3.7	-14.3	19.3
	All Asian Companies	-	-	-	NA	-
	All Companies	**15.0**	**20.6**	**19.0**	**-7.7**	**100.0**

NA = Not available
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-28
1996 Top Mechanical Software Companies, Rest of World, NT/Hybrid
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	Autodesk	-	-	0.9	NA	36.2
2	Intergraph	0.3	0.2	0.6	296.7	25.9
3	MCS	-	-	0.2	NA	7.7
4	MicroCADAM	0.1	0.1	0.2	182.4	7.2
5	NOVASOFT Systems	-	0.1	0.1	30.0	5.2
6	Delcam International	-	-	0.1	NA	4.4
7	Matra Datavision	-	0.1	0.1	4.4	4.2
8	Bentley Systems	0	0	0.1	56.1	2.8
9	Ansys	-	0.1	0.1	-14.8	2.5
10	B.A. Intelligence Networks	-	0	0	30.0	1.8
11	DP Technology	-	0	0	30.0	1.5
12	Vero International Software	-	-	0	NA	0.7
13	CGTech	0	-	0	NA	0.2
14	SRAC	-	0	0	-75.4	0.2
15	Research Engineers—Civilsoft	-	-	0	NA	0.1
16	MacNeal-Schwendler	-	-	0	NA	0.1
17	Structural Dynamics Research Corporation	-	0	-	-100.0	-
	All North American Companies	0.4	0.6	2.2	281.1	90.3
	All European Companies	0.4	0.1	0.2	142.4	9.7
	All Asian Companies	-	-	-	NA	-
	All Companies	**0.8**	**0.7**	**2.4**	**261.1**	**100.0**

NA = Not available
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-29
1996 Top 30 Mechanical Software Companies, Rest of World, Personal Computer (Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	Autodesk	4.7	5.3	4.3	-20.3	31.6
2	Cimatron	1.9	2.9	3.1	7.1	23.0
3	Engineering Mechanics	-	1.5	1.6	6.5	12.2
4	MicroCADAM	0.6	0.7	0.9	24.1	6.5
5	Investronica SA	0.5	0.5	0.6	4.0	4.2
6	CNC Software	0.5	0.5	0.5	6.5	4.0
7	MCS	-	0.1	0.4	482.4	3.2
8	NOVASOFT Systems	0	0.4	0.4	6.5	3.0
9	Whessoe Computing Systems	0.3	0.3	0.4	6.5	2.8
10	Formtek	0.2	0.2	0.2	9.1	1.8
11	Viagrafix	0.2	0.2	0.2	6.5	1.3
12	Baystate Technologies	-	0	0.2	215.4	1.2
13	Computervision	0.1	0.1	0.2	17.1	1.1
14	Surfware	0.1	0.1	0.1	13.7	0.8
15	Tebis	-	0.1	0.1	11.1	0.7
16	B.A. Intelligence Networks	0.1	0.1	0.1	6.5	0.6
17	DP Technology	-	0.1	0.1	6.5	0.6
18	SRAC	0	0.1	0.1	-11.9	0.5
19	Bentley Systems	0	0.1	0.1	3.1	0.5
20	Ziegler Informatics	0	0	0	40.3	0.3
21	Superdraft	0	0	0	6.5	0.3
22	Ansys	0.2	0.1	0	-21.4	0.3
23	Algor Interactive Systems	0	0	0	6.5	0.3
24	MacNeal-Schwendler	-	-	0	NA	0.3
25	Engineered Software	-	-	0	NA	0.3
26	GRAPHSOFT	0	0	0	3.5	0.2
27	Matra Datavision	-	0	0	8.9	0.2
28	Research Engineers—Civilsoft	0	0	0	39.8	0.2
29	Computational Mechanics	0	0	0	6.5	0.2
30	CGTech	0	0	0	4.0	0.2
	All North American Companies	7.4	9.9	9.3	-6.1	69.0
	All European Companies	3.0	4.1	4.2	2.7	31.0
	All Asian Companies	-	-	-	NA	-
	All Companies	**10.3**	**14.0**	**13.5**	**-3.5**	**100.0**

NA = Not available
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-30
1996 Top Mechanical Software Companies, Rest of World, Host/Proprietary (Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	IBM	1.7	0.9	0.8	-10.0	81.3
2	MacNeal-Schwendler	-	-	0.3	NA	26.7
3	Whessoe Computing Systems	0.1	0.1	0	-10.0	4.7
4	Computational Mechanics	0	0	0	-10.0	2.8
5	Ansys	0.1	0	0	-41.0	1.4
6	Mechanical Dynamics	0	0	-	-100.0	-
7	First Cadcam Inc.	-	0	-	-100.0	-
	All North American Companies	1.7	0.8	1.0	19.7	94.5
	All European Companies	0.1	0.1	0.1	-10.0	5.5
	All Asian Companies	-	-	-	NA	-
	All Companies	**1.8**	**0.9**	**1.0**	**17.5**	**100.0**

NA = Not available
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table B-1
1996 All Mechanical Software Companies, Worldwide, All Operating Systems
(Revenue in Millions of Dollars)

Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
3D/Eye Inc.	-	-	3.5	NA	0.1
Access Corp.	0.8	0.6	0.5	-25.2	0
Adam Net	6.9	7.5	8.5	13.8	0.3
Adina R&D	8.0	9.0	10.3	15.0	0.3
ADRA Systems	18.0	19.0	21.1	11.2	0.6
Algor Interactive Systems	6.8	10.0	10.5	5.2	0.3
Alias Research	13.1	17.3	17.3	-	0.5
Altair Computing	5.7	8.0	12.0	50.2	0.4
Andor*	17.6	15.9	17.8	12.0	0.5
Anilam Electronics	4.1	3.8	4.1	5.8	0.1
Ansys	32.5	32.6	37.0	13.6	1.1
Applicon	19.3	21.5	21.8	1.3	0.7
Argo Graphics*	3.6	3.8	4.3	13.5	0.1
ASCAD	12.1	14.9	16.5	10.9	0.5
Ashlar	5.8	5.7	5.9	4.2	0.2
Auto-Trol	4.4	4.1	4.2	3.3	0.1
Autodesk	166.8	189.6	176.5	-6.9	5.3
B.A. Intelligence Networks	2.6	2.7	3.3	21.9	0.1
Baystate Technologies	-	1.3	4.1	217.1	0.1
BCT GMBH	3.0	4.2	7.2	71.6	0.2
Bentley Systems	3.9	12.2	13.9	14.2	0.4
Boothroyd Dewhurst	1.4	1.6	1.6	-0.6	0
C. Itoh Techno-Science*	34.6	30.8	30.8	0	0.9
CAD Centre	0.7	0.9	1.6	78.8	0
CAD Distribution	3.8	5.8	5.1	-13.1	0.2
CAD Lab	11.4	13.6	13.0	-4.7	0.4
CADdy Spain	1.3	1.4	1.4	0	0
Cadis Software	0.4	1.2	3.3	175.0	0.1
CADIX	4.2	4.7	7.3	55.4	0.2
Cadkey	6.8	7.4	-	-100.0	-
CADSI	2.1	3.1	3.2	4.8	0.1
CADWORKS	0.2	0.2	0.1	-44.4	0
Catalpa groupe Missler	1.1	1.5	1.3	-12.5	0
Century Research Center	1.1	1.1	1.1	2.5	0
CGTech	6.0	10.0	10.4	4.0	0.3
Cimatron	7.3	11.3	14.2	26.2	0.4
CIMLINC	4.8	5.8	5.9	0.6	0.2
CIMTEK	4.1	1.2	1.6	31.0	0
Cimtel	0.8	1.0	1.0	-0.6	0

Table B-1 (Continued)
1996 All Mechanical Software Companies, Worldwide, All Operating Systems
(Revenue in Millions of Dollars)

Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
CMstat	0.7	0.7	1.9	160.0	0.1
CNC Software	7.6	8.4	8.7	3.7	0.3
CoCreate	74.5	79.0	90.2	14.2	2.7
Computational Mechanics	2.1	2.1	2.1	-3.2	0.1
Computervision	148.2	149.0	174.4	17.1	5.2
Concentra	12.1	12.7	19.6	54.2	0.6
CONSENS	-	0.6	1.0	60.0	0
Control Data	-	2.3	2.8	21.7	0.1
CSAR Corp.	1.2	3.4	5.2	53.2	0.2
Dassault	154.2	190.6	228.6	19.9	6.8
Database Applications	0.5	0.5	0.7	50.9	0
debis Systemhaus	3.2	3.5	4.0	13.5	0.1
Delcam International	11.6	16.7	21.9	31.1	0.7
Deneb Robotics	8.0	9.3	8.4	-9.4	0.3
Design Automation	7.0	11.6	13.3	14.4	0.4
DP Technology	3.7	4.8	6.0	25.2	0.2
EDS Unigraphics	140.5	155.5	191.3	23.0	5.7
Eigner + Partner	5.4	6.3	7.0	11.2	0.2
Engineered Software	0.6	0.6	0.6	2.3	0
Engineering Computer Services*	6.9	7.9	-	-100.0	-
Engineering Mechanics	8.1	7.6	8.6	13.1	0.3
ESI Group	-	4.5	5.0	11.1	0.1
Exapt	7.2	5.7	2.6	-54.0	0.1
FHECOR*	0.5	0.6	0.6	0	0
First Cadcam Inc.	3.3	3.7	3.8	3.0	0.1
Formtek	17.4	18.9	20.6	8.9	0.6
Framasoft	4.7	4.7	3.9	-17.1	0.1
Fujitsu	83.7	97.0	107.3	10.7	3.2
Gerber Systems	12.1	13.1	14.9	14.0	0.4
Gibbs and Assoc.	1.9	2.2	2.6	18.2	0.1
GRAPHSOFT	1.0	1.5	1.5	3.5	0
Graphtec Engineering	7.9	8.6	8.6	0.5	0.3
Hakuto*	23.6	29.8	34.0	14.0	1.0
Han Dataport	7.1	7.8	6.5	-17.4	0.2
Hitachi	66.7	70.9	79.9	12.7	2.4
Hitachi Zosen Info Systems	34.5	38.7	39.3	1.4	1.2
IBM	368.3	494.5	579.7	17.2	17.3
ICEM Technologies	10.9	15.3	17.5	14.7	0.5
IMSI	0.5	0.4	0.4	4.5	0

Table B-1 (Continued)
1996 All Mechanical Software Companies, Worldwide, All Operating Systems
(Revenue in Millions of Dollars)

Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
Info. Services International Dentsu*	66.0	85.2	117.2	37.6	3.5
Intergraph	61.1	54.0	27.1	-49.8	0.8
Investronica SA	10.6	11.1	10.6	-3.8	0.3
ISD Software	10.5	14.5	22.7	56.5	0.7
ISKA	0.9	1.1	1.2	11.7	0
Just In Time Systems	1.9	2.5	2.4	-3.3	0.1
Kloeckner-Moeller	1.9	1.7	1.7	0.5	0.1
Kozo Keikaku Engineering*	7.4	7.3	8.4	15.0	0.3
Kubota Computer	8.3	8.9	9.8	10.7	0.3
Livermore Software Tech.	1.1	1.6	1.5	-6.9	0
MacNeal-Schwendler	90.8	114.0	124.3	9.0	3.7
MARC	15.5	18.2	19.5	7.4	0.6
Marubeni Hytech*	18.3	19.9	23.0	15.3	0.7
Matra Datavision	75.6	87.4	91.8	4.9	2.7
MCS	13.0	13.6	14.7	7.7	0.4
Mechanical Dynamics	13.9	12.6	15.5	23.4	0.5
MicroCADAM	91.7	129.2	152.0	17.7	4.5
Mitsubishi Electric*	6.3	6.3	6.7	5.7	0.2
Mitsui Engineering	12.9	14.0	16.1	15.2	0.5
Mutoh Industries*	14.2	13.1	17.0	29.5	0.5
NEC	61.7	72.9	62.9	-13.7	1.9
Nihon Itek*	5.1	5.5	6.4	15.3	0.2
Nihon Unisys	48.1	52.8	54.4	3.0	1.6
NOVASOFT Systems	2.2	4.8	3.9	-17.9	0.1
Omron	5.2	7.8	7.7	-0.6	0.2
Pacific Numerix	-	-	0.3	NA	0
PAFEC	5.2	6.0	7.9	32.9	0.2
Parametric Technology	209.8	321.2	495.0	54.1	14.8
Pathtrace Engineering Systems	3.0	3.2	4.2	29.2	0.1
PROCAD GmbH	3.5	5.8	6.5	12.8	0.2
Radan Computational	9.0	8.2	9.2	12.9	0.3
Research Engineers—Civilsoft	0.4	0.6	0.9	44.7	0
Ricoh	2.2	4.8	4.1	-13.4	0.1
RoboCAD Solutions	2.3	1.9	1.6	-13.7	0
Seiko*	18.0	19.7	19.0	-3.5	0.6
Serbi	5.0	5.9	5.6	-4.1	0.2
Sescoi	-	8.0	10.0	25.0	0.3
Sharp*	7.6	10.4	9.4	-10.2	0.3

Table B-1 (Continued)
1996 All Mechanical Software Companies, Worldwide, All Operating Systems
(Revenue in Millions of Dollars)

Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
Sherpa Corp.	18.8	20.6	26.2	27.2	0.8
Siemens Nixdorf Informationssysteme	24.7	25.2	-	-100.0	-
Softdesk	1.2	0.9	-	-100.0	-
Softronics	1.9	2.0	1.0	-50.0	0
SolidWorks Corporation	-	-	7.0	NA	0.2
Spatial Technology	2.5	3.9	3.7	-6.1	0.1
SRAC	3.4	4.8	5.6	16.6	0.2
Straessle Informationssysteme	18.3	16.4	14.1	-14.2	0.4
Structural Dynamics Research Corporation	115.4	144.8	153.0	5.7	4.6
Sumisho Electronics*	18.4	18.8	21.6	14.5	0.6
Superdraft	1.4	1.4	1.3	-6.7	0
Surfware	2.7	5.0	5.4	8.1	0.2
Tebis	5.7	12.6	14.2	12.3	0.4
Technodia*	3.6	3.9	4.5	14.9	0.1
Tecnomatix Technology	13.0	20.1	26.3	31.1	0.8
Tokyo Electron*	16.0	17.4	20.0	15.3	0.6
Toshiba Engineering*	11.1	11.8	4.2	-64.0	0.1
Toshiba*	54.5	66.7	62.5	-6.3	1.9
Toyo Information Systems*	7.6	8.1	9.0	10.7	0.3
Uchida Yoko	0.3	1.4	2.2	60.6	0.1
Variation Systems Analysis	2.4	2.6	2.8	8.2	0.1
Vero International Software	1.6	2.1	4.5	115.9	0.1
Viagrafix	5.5	5.6	5.4	-2.5	0.2
Wacom	5.9	6.0	8.4	39.6	0.3
Whessoe Computing Systems	5.3	5.4	5.5	2.3	0.2
Wiechers Datentechnik	9.0	8.4	9.2	9.4	0.3
Workgroup Tech.	3.0	6.3	7.8	24.1	0.2
Yokogawa Digital Computer	0.2	0.2	0.2	-4.4	0
Ziegler Informatics	5.0	3.3	4.6	40.3	0.1
Zuken-Redac	0.7	0.5	-	-100.0	-
All North American Companies	1,720.6	2,140.9	2,500.8	16.8	74.8
All European Companies	288.2	342.0	352.2	3.0	10.5
All Asian Companies	428.4	481.5	491.5	2.1	14.7
All Companies	**2,437.2**	**2,964.4**	**3,344.6**	**12.8**	**100.0**

Table C-1
1996 Top 30 Mechanical Software Companies, Total Vendor Market Share, Worldwide, All Operating Systems (Revenue in Millions of Dollars, Actual Units)

Rank	Company Name	CPU Shipments	Software Revenue	CPU Revenue	Service Revenue	Total Distribution Revenue	1996 Market Share (%)
1	IBM	64,322	579.7	922.7	376.1	2,033.3	19.2
2	Sun Microsystems	45,968	-	933.9	255.8	1,189.7	11.2
3	Hewlett-Packard	44,882	-	836.6	205.0	1,041.6	9.8
4	Digital Equipment	68,715	-	712.9	105.5	818.4	7.7
5	Parametric Technology	-	495.0	-	165.0	660.0	6.2
6	Silicon Graphics	23,606	-	582.3	64.7	647.0	6.1
7	Fujitsu	14,197	107.3	208.2	101.1	416.6	3.9
8	EDS Unigraphics	7,432	191.3	78.6	35.1	305.0	2.9
9	Structural Dynamics Research Corporation	-	153.0	-	132.2	285.3	2.7
10	Computervision	-	174.4	-	101.1	275.5	2.6
11	Dassault	-	228.6	-	40.0	268.6	2.5
12	NEC	16,275	62.9	112.9	26.0	255.6	2.4
13	Nihon Unisys	1,562	54.4	70.0	64.9	206.8	2.0
14	Hitachi	4,915	79.9	83.0	18.2	181.1	1.7
15	Autodesk	-	176.5	-	1.0	177.5	1.7
16	MicroCADAM	-	152.0	-	8.0	160.0	1.5
17	Info. Services International Dentsu*	603	117.2	21.7	-	138.9	1.3
18	Matra Datavision	1,992	91.8	28.9	11.8	138.7	1.3
19	Argo Graphics*	1,709	4.3	66.2	-	136.2	1.3
20	Intergraph	1,975	27.1	43.2	53.9	133.9	1.3
21	MacNeal-Schwendler	-	124.3	-	9.0	133.3	1.3
22	Sumisho Electronics*	1,307	21.6	40.2	-	129.2	1.2
23	Toshiba*	4,848	62.5	65.1	15.1	127.6	1.2
24	CoCreate	-	90.2	-	34.0	124.3	1.2
25	Mitsubishi Electric*	1,106	6.7	41.7	-	109.8	1.0
26	Hitachi Zosen Info Systems	7,684	39.3	30.0	17.6	95.3	0.9
27	Hakuto*	1,657	34.0	38.4	2.9	75.3	0.7
28	Technodia*	335	4.5	23.9	10.7	72.3	0.7
29	Delcam International	821	21.9	17.7	14.8	57.0	0.5
30	Mutoh Industries*	1,428	17.0	20.1	10.5	56.6	0.5
	Other Companies	87,134	-	285.2	7.3	393.9	3.7
	All North American Companies	199,900	2,500.8	3,189.1	1,714.3	7,580.8	71.7
	All European Companies	12,980	352.2	143.3	148.7	685.8	6.5
	All Asian Companies	64,496	491.5	950.9	334.8	1,915.4	18.1
	All Companies	**364,510**	**3,344.6**	**4,568.5**	**2,205.1**	**10,575.9**	**100.0**

Note: Vendor data includes OEM revenue and shipments, so sum of vendors is greater than total.
Source: Dataquest (July 1997)

Table C-2
1996 Top 30 Mechanical Software Companies, Total Vendor Market Share, Worldwide, UNIX (Revenue in Millions of Dollars, Actual Units)

Rank	Company Name	CPU Shipments	Software Revenue	CPU Revenue	Service Revenue	Total Distribution Revenue	1996 Market Share (%)
1	IBM	26,286	509.1	631.7	281.6	1,508.8	19.3
2	Sun Microsystems	45,968	-	933.9	255.8	1,189.7	15.2
3	Hewlett-Packard	29,038	-	788.8	196.6	985.4	12.6
4	Silicon Graphics	23,606	-	582.3	64.7	647.0	8.3
5	Parametric Technology	-	386.1	-	128.7	514.8	6.6
6	Digital Equipment	18,364	-	278.0	45.3	323.3	4.1
7	Fujitsu	6,091	72.7	160.0	68.8	301.5	3.8
8	EDS Unigraphics	7,432	172.1	70.8	31.6	274.5	3.5
9	Structural Dynamics Research Corporation	-	145.7	-	125.9	271.6	3.5
10	Computervision	-	166.7	-	96.7	263.4	3.4
11	Dassault	-	201.1	-	35.2	236.4	3.0
12	Nihon Unisys	1,558	53.6	69.5	50.0	190.3	2.4
13	Hitachi	3,110	66.1	68.7	15.0	149.8	1.9
14	NEC	3,766	37.7	50.3	15.4	139.6	1.8
15	Info. Services International Dentsu*	430	111.3	20.7	-	132.0	1.7
16	Matra Datavision	1,732	79.2	25.1	10.4	120.1	1.5
17	Sumisho Electronics*	223	16.4	31.4	-	101.8	1.3
18	Intergraph	1,281	20.2	33.6	37.3	99.1	1.3
19	MacNeal-Schwendler	-	91.8	-	6.9	98.6	1.3
20	Mitsubishi Electric*	578	4.0	37.8	-	96.7	1.2
21	Hitachi Zosen Info Systems	7,684	39.3	30.0	17.6	95.3	1.2
22	CoCreate	-	65.6	-	28.8	94.4	1.2
23	Toshiba*	1,450	42.5	44.3	11.3	86.8	1.1
24	Technodia*	335	4.4	23.9	10.7	72.2	0.9
25	Argo Graphics*	340	2.1	33.5	-	69.1	0.9
26	Delcam International	821	20.8	16.8	14.1	54.2	0.7
27	Mitsui Engineering	158	15.5	7.7	20.8	51.9	0.7
28	C. Itoh Techno-Science*	764	28.4	13.7	4.1	48.9	0.6
29	MicroCADAM	-	45.6	-	2.4	48.0	0.6
30	ASCAD	920	14.1	22.6	5.2	47.1	0.6
	All North American Companies	112,324	1,826.0	2,570.9	1,434.3	5,937.3	75.8
	All European Companies	5,449	215.5	102.2	107.6	444.7	5.7
	All Asian Companies	31,177	370.5	708.7	260.1	1,451.0	18.5
	All Companies	**148,950**	**2,412.0**	**3,381.9**	**1,802.0**	**7,833.0**	**100.0**

Note: Vendor data includes OEM revenue and shipments, so sum of vendors is greater than total.
Source: Dataquest (July 1997)

Table C-3
1996 Top 30 Mechanical Software Companies, Total Vendor Market Share, Worldwide, NT/Hybrid (Revenue in Millions of Dollars, Actual Units)

Rank	Company Name	CPU Shipments	Software Revenue	CPU Revenue	Service Revenue	Total Distribution Revenue	1996 Market Share (%)
1	Parametric Technology	-	108.9	-	36.3	145.2	25.4
2	Digital Equipment	4,155	-	42.0	7.1	49.1	8.6
3	Intergraph	695	6.9	9.5	16.6	34.8	6.1
4	EDS Unigraphics	-	19.1	7.9	3.5	30.5	5.3
5	Autodesk	-	29.1	-	0.2	29.3	5.1
6	MicroCADAM	-	18.2	-	1.0	19.2	3.4
7	ISD Software	509	12.3	1.5	1.2	16.7	2.9
8	Mutoh Industries*	461	4.7	6.7	2.4	15.6	2.7
9	Matra Datavision	-	10.1	3.2	1.3	15.3	2.7
10	CAD Lab	-	5.2	4.0	2.9	13.5	2.4
11	NEC	852	4.5	4.5	1.3	12.2	2.1
12	Structural Dynamics Research Corporation	-	6.1	-	5.3	11.4	2.0
13	Radan Computational	186	5.1	2.8	1.6	9.9	1.7
14	Omron	154	5.8	2.8	0.7	9.3	1.6
15	SolidWorks Corporation	-	6.3	-	2.7	9.0	1.6
16	Bentley Systems	-	6.8	-	0.8	7.6	1.3
17	Wacom	-	7.1	-	0.5	7.5	1.3
18	CoCreate	-	5.6	-	1.9	7.5	1.3
19	Ansys	-	4.8	-	1.3	6.1	1.1
20	CAD Distribution	-	4.8	-	0.5	5.3	0.9
21	Graphtec Engineering	45	2.6	1.9	0.2	5.3	0.9
22	Hewlett-Packard	422	-	4.4	0.8	5.2	0.9
23	Toshiba Engineering*	151	2.5	1.7	0.8	5.1	0.9
24	MCS	-	3.7	0.1	0.8	4.6	0.8
25	BCT GMBH	28	2.5	0.8	0.4	3.8	0.7
26	Delcam International	-	1.1	0.9	0.7	2.9	0.5
27	Spatial Technology	-	1.3	-	1.4	2.7	0.5
28	DP Technology	-	1.9	0.1	0.7	2.7	0.5
29	Vero International Software	-	2.3	0.2	0.2	2.7	0.5
30	Mechanical Dynamics	1	1.2	0	0.9	2.1	0.4
	Other Companies	6,720	-	71.8	-	71.8	12.6
	All North American Companies	5,272	228.2	64.2	84.1	378.2	66.1
	All European Companies	732	44.3	14.0	9.2	71.8	12.6
	All Asian Companies	1,663	22.2	17.7	5.8	50.0	8.7
	All Companies	**14,387**	**294.7**	**167.7**	**99.1**	**571.8**	**100.0**

Note: Vendor data includes OEM revenue and shipments, so sum of vendors is greater than total.
Source: Dataquest (July 1997)

Table C-4
1996 Top 30 Mechanical Software Companies, Total Vendor Market Share, Worldwide, Personal Computer (Revenue in Millions of Dollars, Actual Units)

Rank	Company Name	CPU Shipments	Software Revenue	CPU Revenue	Service Revenue	Total Distribution Revenue	1996 Market Share (%)
1	IBM	37,472	-	155.9	-	155.9	11.2
2	Autodesk	-	142.3	-	0.8	143.0	10.3
3	NEC	11,657	20.8	58.1	9.3	103.8	7.5
4	Digital Equipment	42,856	-	98.7	3.6	102.3	7.4
5	Fujitsu	8,105	26.9	48.2	25.3	100.5	7.2
6	MicroCADAM	-	88.2	-	4.6	92.8	6.7
7	Argo Graphics*	1,368	2.3	32.7	-	67.1	4.8
8	Hewlett-Packard	15,422	-	43.4	7.7	51.0	3.7
9	Investronica SA	3,903	10.6	10.6	7.9	42.8	3.1
10	Toshiba*	3,397	20.0	20.8	3.7	40.8	2.9
11	Hakuto*	1,176	13.4	15.4	1.2	30.0	2.2
12	Andor*	495	17.8	5.2	-	27.7	2.0
13	Sumisho Electronics*	1,083	5.1	8.8	-	27.4	2.0
14	Hitachi	1,436	11.4	12.4	2.6	26.4	1.9
15	CoCreate	-	19.0	-	3.4	22.4	1.6
16	Tebis	194	8.9	2.6	5.4	18.5	1.3
17	Design Automation	557	13.3	3.4	0.3	17.0	1.2
18	Cimatron	-	12.9	-	3.5	16.5	1.2
19	Wiechers Datentechnik	265	9.2	2.7	2.4	14.3	1.0
20	Mutoh Industries*	532	4.0	5.9	1.3	13.5	1.0
21	Computervision	-	7.7	-	4.4	12.1	0.9
22	MCS	44	8.7	0.2	1.8	10.9	0.8
23	Formtek	115	6.2	0	3.7	9.9	0.7
24	Mitsubishi Electric*	517	1.9	2.8	-	8.7	0.6
25	CNC Software	-	8.7	-	-	8.7	0.6
26	ADRA Systems	-	5.4	-	2.5	7.8	0.6
27	Serbi	585	5.6	1.7	-	7.4	0.5
28	Bentley Systems	-	6.4	-	0.8	7.2	0.5
29	BCT GMBH	252	4.7	1.6	0.8	7.0	0.5
30	Info. Services International Dentsu*	173	5.9	1.1	-	6.9	0.5
	Other Companies	80,247	-	183.1	-	183.1	13.2
	All North American Companies	80,136	359.5	265.6	47.7	673.0	48.5
	All European Companies	6,747	90.2	25.4	25.7	158.4	11.4
	All Asian Companies	31,181	88.2	219.0	45.5	373.1	26.9
	All Companies	**198,312**	**537.9**	**693.1**	**119.0**	**1,387.6**	**100.0**

Note: Vendor data includes OEM revenue and shipments, so sum of vendors is greater than total.
Source: Dataquest (July 1997)

Table C-5
1996 Top Mechanical Software Companies, Total Vendor Market Share, Worldwide, Host/Proprietary (Revenue in Millions of Dollars, Actual Units)

Rank	Company Name	CPU Shipments	Software Revenue	CPU Revenue	Service Revenue	Total Distribution Revenue	1996 Market Share (%)
1	IBM	563	69.6	135.1	94.5	367.6	46.9
2	Digital Equipment	3,340	-	294.1	49.6	343.7	43.9
3	Dassault	-	27.4	-	4.8	32.2	4.1
4	MacNeal-Schwendler	-	27.3	-	2.0	29.3	3.7
5	Nihon Unisys	4	0.8	0.5	14.9	16.5	2.1
6	Fujitsu	-	7.7	-	7.0	14.7	1.9
7	Hitachi	369	2.3	2.0	0.6	4.9	0.6
8	Mitsubishi Electric*	12	0.9	1.1	-	4.5	0.6
9	C. Itoh Techno-Science*	77	2.4	1.1	0.3	4.2	0.5
10	Exapt	49	1.3	0.9	0.5	3.7	0.5
11	Mechanical Dynamics	0	1.7	0	1.2	2.9	0.4
12	Toyo Information Systems*	12	0.6	0.7	0.2	1.7	0.2
13	Ansys	-	1.1	-	0.3	1.4	0.2
14	debis Systemhaus	-	0.2	0.5	0.6	1.4	0.2
15	Kubota Computer	-	0.5	-	0.2	0.7	0.1
16	Century Research Center	1	0.2	0.1	0.1	0.6	0.1
17	Altair Computing	-	0.2	-	0.3	0.6	0.1
18	Access Corp.	-	0.2	-	0.2	0.4	0
19	Whessoe Computing Systems	-	0.4	-	-	0.4	0
20	Computational Mechanics	-	0.4	-	-	0.4	0
21	Sherpa Corp.	-	0.2	-	0.1	0.4	0
22	Framasoft	-	0.2	-	0.1	0.3	0
23	CIMTEK	3	0.1	0.1	0.1	0.3	0
24	Technodia*	-	0	-	-	0	0
	Other Companies	166	-	30.3	7.3	139.0	17.7
	All North American Companies	2,167	87.2	288.4	148.2	592.2	75.6
	All European Companies	52	2.2	1.5	6.2	11.0	1.4
	All Asian Companies	475	10.6	5.6	23.3	41.3	5.3
	All Companies	**2,860**	**100.1**	**325.8**	**185.0**	**783.5**	**100.0**

Note: Vendor data includes OEM revenue and shipments, so sum of vendors is greater than total.
Source: Dataquest (July 1997)

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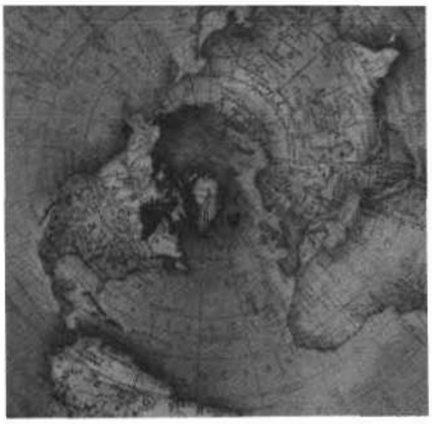

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1996 Mechanical CAD/CAM/CAE Asia/Pacific Market Share Update

Market Statistics

Program: Mechanical CAD/CAM/CAE Applications Asia/Pacific
Product Code: CMEC-AP-MS-9701
Publication Date: September 1, 1997
Filing: Market Statistics

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Chapter 1
Introduction

About This Document

This Market Statistics report contains Dataquest's detailed market share information on the mechanical CAD/DAM/CAE industry at the country level. This document is meant to supplement the worldwide mechanical CAD/CAM/CAE market share book by providing mechanical CAD/CAM/CAE market share detail for Asia/Pacific countries.

Definitions

This section lists the definitions specific to this document. For other definitions, please see the worldwide market statistics book.

Asia/Pacific

Includes Australia, Bangladesh, Brunei, Cambodia, China, Hong Kong, India, Indonesia, Korea, Laos, Malaysia, Maldives, Myanmar, Nepal, New Zealand, Pakistan, Philippines, Singapore, Sri Lanka, Taiwan, Thailand, and Vietnam

Publishing Schedule

Dataquest publishes market share and forecasting at the country level once each year. Our delivery schedule is as follows:

- Asia/Pacific country-level market share tables for 1996, based on data collection and analysis beginning in January 1997, are presented in this report. At this point, the market share database is frozen and will not be changed until the end of 1997.
- Forecast tables will be available electronically by September 5, and books will be shipped by September 26. These forecast tables will contain country-level information for the Asia/Pacific region.

A Final Note

Dataquest's policy is to continually update its market information for current and past years with any new data received in order to arrive at the most accurate market representation possible. Our ongoing commitment is to maintain an accurate and complete model of the entire CAD/CAM/CAE, AEC and GIS, and EDA worldwide markets, and we welcome your input. Please feel free to contact any member of the CAD/CAM/CAE, AEC and GIS, or EDA team if you have any questions or concerns.

Chapter 2
Market Statistics Tables

Table A-1
Top 30 Mechanical Software Companies, Worldwide, All Operating Systems
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	IBM	368.3	494.5	579.7	17.2	17.3
2	Parametric Technology	209.8	321.2	495.0	54.1	14.8
3	Dassault	154.2	190.6	228.6	19.9	6.8
4	EDS Unigraphics	140.5	155.5	191.3	23.0	5.7
5	Autodesk	166.8	189.6	176.5	-6.9	5.3
6	Computervision	148.2	149.0	174.4	17.1	5.2
7	Structural Dynamics Research Corporation	115.4	144.8	153.0	5.7	4.6
8	MICROCADAM	91.7	129.2	152.0	17.7	4.5
9	MacNeal-Schwendler	90.8	114.0	124.3	9.0	3.7
10	Info. Services Int'l. Dentsu*	66.0	85.2	117.2	37.6	3.5
11	Fujitsu	83.7	97.0	107.3	10.7	3.2
12	Matra Datavision	75.6	87.4	91.8	4.9	2.7
13	CoCreate	74.5	79.0	90.2	14.2	2.7
14	Hitachi	66.7	70.9	79.9	12.7	2.4
15	NEC	61.7	72.9	62.9	-13.7	1.9
16	Toshiba*	54.5	66.7	62.5	-6.3	1.9
17	Nihon Unisys	48.1	52.8	54.4	3.0	1.6
18	Hitachi Zosen Info Systems	34.5	38.7	39.3	1.4	1.2
19	ANSYS	32.5	32.6	37.0	13.6	1.1
20	Hakuto*	23.6	29.8	34.0	14.0	1.0
21	C. Itoh Techno-Science*	34.6	30.8	30.8	0	0.9
22	Intergraph	61.1	54.0	27.1	-49.8	0.8
23	Tecnomatix Technology	13.0	20.1	26.3	31.1	0.8
24	Sherpa Corporation	18.8	20.6	26.2	27.2	0.8
25	Marubeni Hytech*	18.3	19.9	23.0	15.3	0.7
26	ISD Software	10.5	14.5	22.7	56.5	0.7
27	Delcam International	11.6	16.7	21.9	31.1	0.7
28	Applicon	19.3	21.5	21.8	1.3	0.7
29	Sumisho Electronics*	18.4	18.8	21.6	14.5	0.6
30	Adra Systems	18.0	19.0	21.1	11.2	0.6
	All North American Companies	1,720.6	2,140.9	2,500.8	16.8	74.8
	All European Companies	288.2	342.0	352.2	3.0	10.5
	All Asian Companies	428.4	481.5	491.5	2.1	14.7
	All Companies	**2,437.2**	**2,964.4**	**3,344.6**	**12.8**	**100.0**

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-2
Top 30 Mechanical Software Companies, Asia/Pacific, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	IBM	29.0	38.8	42.3	9.1	23.4
2	Parametric Technology	0.1	9.6	32.9	241.1	18.2
3	Autodesk	16.7	20.9	22.9	10.0	12.7
4	EDS Unigraphics	12.6	15.6	17.2	10.7	9.5
5	Dassault	10.8	13.3	14.6	9.6	8.1
6	Structural Dynamics Research Corporation	7.6	6.5	10.9	67.9	6.0
7	Computervision	2.8	10.3	10.1	-1.6	5.6
8	MacNeal-Schwendler	1.8	2.4	7.5	212.1	4.1
9	Matra Datavision	2.6	7.0	4.6	-34.4	2.5
10	MICROCADAM	3.0	3.9	4.6	17.9	2.5
11	Delcam International	2.3	2.8	3.1	7.8	1.7
12	Intergraph	2.4	2.1	2.8	33.3	1.5
13	FORMTEK	0.7	0.8	2.1	172.8	1.1
14	Sharp*	1.5	2.1	1.9	-10.2	1.0
15	Cimatron	1.1	1.7	1.8	9.3	1.0
16	ANSYS	1.3	1.9	1.8	-5.4	1.0
17	Design Automation	0.9	1.6	1.8	14.4	1.0
18	MCS	1.3	1.8	1.8	-0.7	1.0
19	Alias Research	-	1.7	1.7	-	1.0
20	Gerber Systems	1.1	1.2	1.5	21.0	0.8
21	Straessle Informationssysteme	1.1	1.6	1.4	-14.2	0.8
22	Adra Systems	0.7	1.1	1.4	19.3	0.8
23	Concentra	0.1	0.3	1.2	372.3	0.7
24	Bentley Systems	0.3	0.8	1.0	14.6	0.5
25	Mechanical Dynamics	1.0	1.0	1.0	-3.1	0.5
26	Pafec	-	-	1.0	NA	0.5
27	Investronica SA	3.8	3.9	0.8	-79.5	0.4
28	MARC	-	-	0.8	NA	0.4
29	Vero International Software	0.2	0.3	0.7	115.4	0.4
30	CNC Software	0.5	0.6	0.7	16.8	0.4
	All North American Companies	85.0	120.6	162.8	35.0	90.1
	All European Companies	12.3	17.8	14.1	-20.6	7.8
	All Asian Companies	2.9	4.1	3.8	-7.4	2.1
	All Companies	**100.2**	**142.4**	**180.7**	**26.8**	**100.0**

NA = Not applicable
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (July 1997)

Table A-3
Top Mechanical Software Companies, China, All Operating Systems
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	EDS Unigraphics	2.3	4.9	6.5	33.5	26.7
2	IBM	3.5	5.0	5.6	11.6	23.0
3	Parametric Technology	-	0.8	4.2	421.9	17.0
4	Dassault	1.5	1.7	1.9	12.2	7.9
5	Structural Dynamics Research Corporation	1.1	0.8	1.6	87.1	6.5
6	Computervision	0.4	1.5	1.5	-1.6	5.9
7	MacNeal-Schwendler	0.6	0.8	1.2	48.6	5.1
8	MICROCADAM	0.5	0.7	0.8	17.9	3.4
9	Autodesk	0.5	0.6	0.7	15.1	2.7
10	ANSYS	0.4	0.5	0.6	16.9	2.5
11	Gerber Systems	0.4	0.4	0.5	38.3	2.2
12	Cimatron	0.2	0.3	0.3	9.3	1.3
13	Matra Datavision	0.4	0.5	0.3	-34.4	1.2
14	Intergraph	0.2	0.2	0.2	33.3	0.8
15	Delcam International	0.1	0.2	0.2	7.8	0.7
16	B.A. Intelligence Networks	0.1	0.1	0.1	78.8	0.6
17	Mechanical Dynamics	0.5	0.1	0.1	-3.1	0.6
18	Investronica SA	-	-	0.1	NA	0.5
19	Spatial Technology	0.1	0.2	0.1	-45.4	0.3
20	Applicon	0.1	0.1	0.1	5.5	0.3
21	CAD Centre	0.1	0.1	0	-66.7	0.1
22	Bentley Systems	-	-	0	NA	0.1
23	Pacific Numerix	-	-	0	NA	0
24	Engineered Software	-	-	0	NA	0
	Other Companies	1.1	1.1	0.6	-44.6	2.5
	All North American Companies	9.8	16.0	23.0	43.4	93.7
	All European Companies	0.8	1.0	1.0	-7.2	3.9
	All Asian Companies	-	-	-	NA	-
	All Companies	**11.7**	**18.1**	**24.5**	**35.2**	**100.0**

NA = Not applicable
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (July 1997)

Table A-4
Top Mechanical Software Companies, Hong Kong, All Operating Systems
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	Parametric Technology	-	1.4	4.2	203.4	25.7
2	IBM	2.3	3.1	3.0	-1.0	18.5
3	Computervision	0.5	1.7	1.7	-1.6	10.3
4	Structural Dynamics Research Corporation	1.2	1.0	1.7	73.2	10.1
5	EDS Unigraphics	0.3	0.8	1.2	52.5	7.4
6	Dassault	-	1.1	1.1	-0.5	6.4
7	Autodesk	0.7	0.8	0.9	15.6	5.7
8	MICROCADAM	0.5	0.7	0.8	17.9	5.0
9	Pafec	-	-	0.7	NA	4.4
10	Investronica SA	-	-	0.6	NA	3.9
11	Intergraph	0.4	0.3	0.5	33.3	2.7
12	Vero International Software	0.2	0.1	0.3	115.4	1.9
13	Matra Datavision	0.4	0.5	0.3	-34.4	1.9
14	Gerber Systems	0.2	0.2	0.3	11.1	1.7
15	Cimatron	0.1	0.1	0.1	9.3	0.7
16	Just In Time Systems	-	-	0.1	NA	0.6
17	CNC Software	0.1	0.1	0.1	8.7	0.6
18	CIMLINC	-	0.1	0.1	8.1	0.4
19	Bentley Systems	-	-	0	NA	0.3
20	Gibbs and Associates	-	-	0	NA	0.2
21	MacNeal-Schwendler	0.6	0.7	-	-100.0	-
22	MCS	0.3	0.3	-	-100.0	-
	Other Companies	0.9	0.7	0.4	-49.7	2.3
	All North American Companies	6.7	10.8	14.0	29.9	84.7
	All European Companies	0.8	0.7	2.2	202.4	13.0
	All Asian Companies	-	-	-	NA	-
	All Companies	**8.4**	**12.2**	**16.5**	**35.1**	**100.0**

NA = Not applicable
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (July 1997)

Table A-5
Top 30 Mechanical Software Companies, Korea, All Operating Systems
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	IBM	5.4	8.5	9.6	12.6	21.9
2	Parametric Technology	-	2.2	8.1	266.5	18.3
3	Autodesk	4.3	5.1	5.3	4.1	12.1
4	MacNeal-Schwendler	-	-	3.7	NA	8.5
5	Structural Dynamics Research Corporation	1.8	1.9	3.4	81.9	7.7
6	Dassault	7.7	2.9	3.3	13.1	7.6
7	FORMTEK	-	-	2.1	NA	4.7
8	Computervision	0.5	1.7	1.7	-1.6	3.9
9	Delcam International	0.7	1.5	1.6	7.8	3.7
10	Adra Systems	0.6	0.9	1.1	16.1	2.5
11	Straessle Informationssysteme	0.9	1.1	1.0	-14.2	2.2
12	MICROCADAM	0.5	0.7	0.8	17.9	1.9
13	MCS	-	0.4	0.7	65.5	1.7
14	ANSYS	0.4	0.5	0.6	12.7	1.4
15	Matra Datavision	0.4	0.9	0.6	-34.4	1.4
16	Altair Computing	-	-	0.6	NA	1.4
17	EDS Unigraphics	0.6	3.2	0.5	-85.6	1.0
18	Intergraph	0.4	0.3	0.5	33.3	1.0
19	Concentra	0.1	0.1	0.4	228.3	0.9
20	Mechanical Dynamics	0.5	0.3	0.4	45.3	0.9
21	Bentley Systems	-	-	0.2	NA	0.6
22	CIMLINC	-	0.2	0.2	8.1	0.5
23	Cimatron	0.1	0.2	0.2	9.3	0.5
24	Gerber Systems	0.1	0.2	0.2	16.7	0.5
25	Vero International Software	-	0.1	0.2	115.4	0.4
26	Applicon	0.1	0.1	0.1	5.5	0.3
27	Pafec	-	-	0.1	NA	0.3
28	CAD Lab	-	-	0.1	NA	0.3
29	CNC Software	0.1	0.1	0.1	14.3	0.2
30	Just In Time Systems	-	-	0.1	NA	0.2
	Other Companies	3.1	3.3	1.0	-69.3	2.3
	All North American Companies	14.5	25.5	38.8	52.0	88.4
	All European Companies	2.5	3.8	4.1	6.2	9.2
	All Asian Companies	0.1	0.1	-	-100.0	-
	All Companies	**20.2**	**32.8**	**43.9**	**33.7**	**100.0**

NA = Not applicable
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (July 1997)

Table A-6
Top Mechanical Software Companies, Singapore, All Operating Systems
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	Parametric Technology	-	1.3	3.1	135.0	22.1
2	IBM	1.9	2.6	2.5	-1.0	18.3
3	EDS Unigraphics	2.8	1.5	2.4	62.7	17.6
4	Structural Dynamics Research Corporation	1.6	1.3	2.0	49.6	14.3
5	Dassault	-	0.9	0.9	-0.5	6.3
6	MICROCADAM	0.5	0.7	0.8	17.9	6.0
7	Autodesk	0.5	0.6	0.7	13.5	5.3
8	Computervision	0.2	0.7	0.7	-1.6	5.3
9	Concentra	0.1	0.1	0.4	228.3	3.0
10	B.A. Intelligence Networks	0.2	0.2	0.2	43.6	1.7
11	Vero International Software	0	0.1	0.2	115.4	1.3
12	Delcam International	0.6	0.2	0.2	7.8	1.3
13	Intergraph	0.1	0.1	0.2	33.3	1.1
14	Cimatron	0.1	0.1	0.1	9.3	0.8
15	Just In Time Systems	-	-	0.1	NA	0.7
16	CNC Software	0.1	0.1	0.1	8.7	0.7
17	DP Technology	0	0.1	0.1	37.1	0.5
18	CAD Centre	-	0	0	265.8	0.2
19	Bentley Systems	-	-	0	NA	0.2
20	Gibbs and Associates	-	-	0	NA	0.2
21	Applicon	0	0	0	5.5	0.2
22	ISD Software	-	-	0	NA	0.1
23	Pacific Numerix	-	-	0	NA	0.1
24	ANSYS	0.1	0.1	-	-100.0	-
	Other Companies	1.2	0.6	0.3	-38.8	2.4
	All North American Companies	7.8	9.1	12.9	41.8	93.2
	All European Companies	1.1	0.4	0.6	65.3	4.4
	All Asian Companies	-	-	-	NA	-
	All Companies	**10.1**	**10.0**	**13.9**	**38.2**	**100.0**

NA = Not applicable
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (July 1997)

Table A-7
Top Mechanical Software Companies, Taiwan, All Operating Systems
(Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	Parametric Technology	-	2.0	5.2	160.7	17.4
2	Autodesk	3.6	4.5	4.8	5.9	15.9
3	IBM	3.1	4.5	4.5	1.5	15.1
4	Structural Dynamics Research Corporation	1.9	1.5	2.2	52.0	7.4
5	Dassault	1.5	1.5	1.6	2.0	5.2
6	EDS Unigraphics	0.6	1.0	1.5	52.0	5.1
7	MacNeal-Schwendler	-	-	1.2	NA	4.1
8	Computervision	0.3	1.2	1.2	-1.6	4.0
9	MCS	1.0	1.0	1.0	-0.7	3.4
10	Cimatron	0.6	0.9	1.0	9.3	3.2
11	MICROCADAM	0.5	0.7	0.8	17.9	2.7
12	Delcam International	0.4	0.5	0.5	7.8	1.8
13	Gerber Systems	0.3	0.4	0.5	12.2	1.6
14	Hitachi Zosen Info Systems	0.3	0.4	0.4	1.4	1.3
15	Intergraph	0.3	0.3	0.4	33.3	1.2
16	ANSYS	0.3	0.4	0.3	-28.3	1.0
17	DP Technology	0.1	0.2	0.3	38.5	0.8
18	B.A. Intelligence Networks	0.2	0.2	0.2	45.1	0.8
19	Bentley Systems	-	-	0.2	NA	0.7
20	Straessle Informationssysteme	0.2	0.2	0.2	-14.2	0.6
21	CNC Software	0.2	0.2	0.2	9.8	0.6
22	Spatial Technology	0.1	0.2	0.1	-45.4	0.3
23	Livermore Software Laboratories	0	0.1	0.1	-27.1	0.2
24	Vero International Software	-	0	0	115.4	0.1
25	Ricoh	-	-	0	NA	0.1
26	ISD Software	-	-	0	NA	0.1
27	CAD Centre	-	-	0	NA	0.1
28	Diehl Graphsoft Inc.	-	0	-	-100.0	-
	Other Companies	3.5	4.0	4.0	0.5	13.4
	All North American Companies	12.1	17.6	23.9	35.9	79.3
	All European Companies	1.5	1.8	1.8	1.7	6.0
	All Asian Companies	0.3	0.4	0.4	3.5	1.3
	All Companies	**17.5**	**23.7**	**30.1**	**26.8**	**100.0**

NA = Not applicable
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (July 1997)

Table A-8
Top 30 Mechanical Software Companies, Rest of Asia/Pacific, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	1995-1996 Growth (%)	1996 Market Share (%)
1	IBM	12.9	15.1	17.0	12.3	32.8
2	Autodesk	7.1	9.2	10.5	14.1	20.3
3	Parametric Technology	-	1.9	8.1	319.1	15.7
4	Dassault	-	5.2	5.9	12.9	11.3
5	EDS Unigraphics	6.1	4.2	5.0	20.9	9.7
6	Matra Datavision	0.5	5.1	3.4	-34.4	6.5
7	Computervision	0.9	3.4	3.3	-1.6	6.4
8	MacNeal-Schwendler	0.6	0.8	1.2	51.2	2.4
9	Intergraph	1.0	0.9	1.2	33.3	2.2
10	Delcam International	0.4	0.5	0.5	7.8	1.0
11	MICROCADAM	0.3	0.4	0.4	17.9	0.8
12	Mechanical Dynamics	-	0.6	0.4	-27.3	0.8
13	Bentley Systems	-	-	0.4	NA	0.8
14	Concentra	-	-	0.4	NA	0.7
15	ANSYS	0.2	0.3	0.3	-7.2	0.6
16	Adra Systems	0.1	0.2	0.3	35.2	0.5
17	CNC Software	0.2	0.2	0.2	33.1	0.4
18	Straessle Informationssysteme	-	0.2	0.2	-14.2	0.4
19	Research Engineers—Civilsoft	0.1	0.1	0.1	56.7	0.2
20	Cimatron	0.1	0.1	0.1	9.3	0.2
21	CAD Centre	-	-	0.1	NA	0.2
22	Just In Time Systems	-	-	0.1	NA	0.2
23	DP Technology	0	0.1	0.1	67.8	0.2
24	Algor Interactive Systems	0	0.1	0.1	34.3	0.2
25	Pafec	-	-	0.1	NA	0.1
26	Gibbs and Associates	-	-	0.1	NA	0.1
27	RoboCAD Solutions	0	0	0	33.1	0.1
28	Diehl Graphsoft Inc.	-	0	0	24.2	0.1
29	FORMTEK	0.7	0.8	-	-100.0	-
30	Pathtrace Systems Inc.	0	0	-	-100.0	-
	Other Companies	2.6	3.5	1.2	-65.7	2.4
	All North American Companies	28.7	36.0	46.1	28.1	89.0
	All European Companies	1.1	6.0	4.5	-24.8	8.7
	All Asian Companies	-	-	-	NA	-
	All Companies	**32.3**	**45.5**	**51.8**	**13.9**	**100.0**

NA = Not applicable
Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (July 1997)

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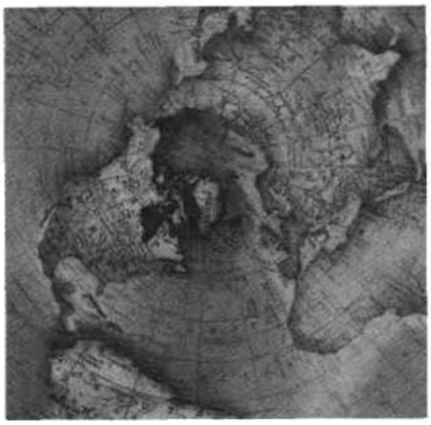

Dataquest

Mechanical CAD/CAM/CAE Preliminary Forecast

Market Statistics

Program: Mechanical CAD/CAM/CAE Worldwide
Product Code: CMEC-WW-MS-9702
Publication Date: May 26, 1997
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Mechanical CAD/CAM/CAE Preliminary Forecast

Introduction

Dataquest's CAD/CAM/CAE and GIS forecast is based upon market share software revenue gathered primarily during the first quarter of 1997. Dataquest's software forecast for all CAD/CAM/CAE and GIS applications includes:

- Three-year historical software and hardware revenue by region and operating system
- Five-year forecast of software, hardware, and service revenue by region and operating system
- Three-year history and five-year forecast of hardware shipments and installed base data

Although Dataquest does not forecast currency exchange rates, forecasts are made with the best 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 March 1997 exchange rate will remain stable in the future (see Tables 1 and 2).

Dataquest's 1996 Market Share document (published as CAEC-WW-MS-9701, CEDA-WW-MS-9701, and CMEC-WW-MS-9701) was published and sent to clients in March.

The market share data for 1996 is being verified and updated, and it will be available in July as a Market Share Update document. Country-level, industry, and subapplication data will be available at that time.

Dataquest will also perform an updated forecast that will be expanded to include country-level information, additional metrics, and in-depth analysis. This forecast update will be available in September.

Worldwide Forecast Assumptions

The following sections describe the main forces driving the CAD/CAM/CAE and GIS worldwide software forecast.

All Applications

As CAD/CAM/CAE/GIS becomes more of a replacement market, market leaders would appear to have the upper hand; the cost of switching is high. However, software that lets users get a better product to market faster and software that helps eliminate business risks will always be in demand—regardless of market share. Thus, there is always an opportunity for new vendors in technical markets.

The primary trend in design software function is toward operating at a higher level of abstraction. In all applications, Dataquest has seen an evolution of focus from "electronic paper" to component modeling, and now to systems modeling with the eventual goal being to fully simulate, evaluate, redesign, and test the design inside the computer prior to manufacture. At the same time, increased computing power is allowing

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

	1995	1996	Forecast 2001	Growth (%) 1995-1996	CAGR (%) 1996-2001
Europe (U.S.$ Million)					
Software Revenue	2,079.76	2,260.94	3,592.97	8.7	9.7
Hardware Revenue	2,865.71	2,889.03	3,656.60	0.8	4.8
Service Revenue	1,332.51	1,479.91	2,188.73	11.1	8.1
Total Factory Revenue	6,271.98	6,622.56	9,438.30	5.6	7.3
ECU/U.S.$ Exchange Rate*	0.77	0.80	0.87	3.9	1.7
Europe (ECU Million)					
Software Revenue	1,601.41	1,808.75	3,125.89	12.9	11.6
Hardware Revenue	2,206.60	2,311.22	3,181.24	4.7	6.6
Service Revenue	1,026.03	1,183.93	1,904.20	15.4	10.0
Total Factory Revenue	4,829.43	5,298.05	8,211.32	9.7	9.2
Japan (U.S. $ Million)					
Software Revenue	1,626.87	1,826.57	3,168.19	12.3	11.6
Hardware Revenue	2,768.44	2,887.25	3,799.36	4.3	5.6
Service Revenue	1,245.70	1,413.26	2,368.03	13.5	10.9
Total Factory Revenue	5,640.61	6,126.54	9,335.58	8.6	8.8
Japan/U.S.$ Exchange Rate*	93.90	108.81	122.70	15.9	2.4
Japan (Yen Million)					
Software Revenue	152,762.86	198,749.18	388,736.40	30.1	14.4
Hardware Revenue	259,956.74	314,161.14	466,182.05	20.9	8.2
Service Revenue	116,970.90	153,776.53	290,556.81	31.5	13.6
Total Factory Revenue	529,652.93	666,629.01	1,145,475.25	25.9	11.4
North America (U.S.$ Million)					
Software Revenue	2,140.11	2,498.04	4,854.01	16.7	14.2
Hardware Revenue	2,791.37	3,009.14	4,668.89	7.8	9.2
Service Revenue	1,452.15	1,765.08	3,274.58	21.5	13.2
Total Factory Revenue	6,382.03	7,270.15	12,797.48	13.9	12.0
Worldwide (U.S.$ Million)					
Software Revenue	6,312.67	7,134.39	12,968.10	13.0	12.7
Hardware Revenue	9,091.97	9,504.22	13,469.54	4.5	7.2
Service Revenue	4,333.32	5,028.29	8,688.42	16.0	11.6
Total Factory Revenue	19,729.96	21,657.07	35,126.06	9.8	10.2

*Assuming a stable currency, the 2001 exchange rate is March 1997 exchange rate.
Source: Dataquest (April 1997)

Table 2
Foreign Currency per U.S. Dollar

		Actual				Current			Year-to-Year Change (%)					
Country	Currency	1992	1993	1994	1995	1996	1997	1998	1992-1993	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998
Austria	Schilling	10.95	11.65	11.40	10.06	10.59	10.88	11.93	6.4	-2.1	-11.8	5.3	2.7	9.7
Belgium	Franc	32.02	34.67	33.66	29.42	30.96	31.83	34.96	8.3	-2.9	-12.6	5.2	2.8	9.8
Denmark	Krone	6.02	6.49	6.35	5.59	5.81	5.95	6.46	7.8	-2.2	-12.0	3.9	2.4	8.6
Finland	Markka	4.45	5.73	5.21	4.37	4.59	4.68	5.06	28.8	-9.1	-16.1	5.0	1.9	8.3
France	Franc	5.27	5.67	5.54	4.97	5.12	5.23	5.72	7.6	-2.3	-10.3	3.0	2.2	9.2
Germany	D-Mark	1.56	1.66	1.62	1.43	1.50	1.55	1.69	6.4	-2.4	-11.7	4.9	3.0	9.6
Italy	Lira	1,227.75	1,577.85	1,609.34	1,628.21	1,542.72	1,555.45	1,691.21	28.5	2.0	1.2	-5.3	0.8	8.7
Netherlands	Guilder	1.75	1.86	1.82	1.60	1.69	1.73	1.91	6.3	-2.2	-12.1	5.6	2.6	10.0
Norway	Krone	6.18	7.11	7.04	6.33	6.46	6.51	6.79	15.0	-1.0	-10.1	2.1	0.8	4.3
Spain	Peseta	101.90	127.87	133.48	124.40	126.68	130.24	143.72	25.5	4.4	-6.8	1.8	2.8	10.4
Sweden	Krona	5.81	7.82	7.70	7.14	6.71	6.82	7.65	34.6	-1.5	-7.3	-6.0	1.6	12.2
Switzerland	Franc	1.40	1.48	1.37	1.18	1.24	1.29	1.46	5.7	-7.4	-13.9	5.1	3.7	13.8
United Kingdom	Pound	0.57	0.67	0.65	0.63	0.64	0.63	0.62	17.5	-3.0	-3.1	1.6	-1.1	-1.9
Europe Average	ECU	0.77	0.86	0.84	0.77	0.80	0.81	0.87	11.4	-1.5	-8.7	3.9	1.3	7.7
China	Renminbi	5.51	5.76	8.54	8.32	8.34	8.34	8.33	4.5	48.3	-2.6	0.2	-0.1	-0.1
Hong Kong	Dollar	7.74	7.74	7.73	7.74	7.73	7.74	7.75	0.0	-0.1	0.1	-0.1	0.1	0.1
Japan	Yen	126.34	110.85	101.56	93.90	108.81	112.19	122.77	-12.3	-8.4	-7.5	15.9	3.1	9.4
Korea	Won	782.41	799.42	805.80	770.57	805.16	824.39	882.62	2.2	0.8	-4.4	4.5	2.4	7.1
Singapore	Dollar	1.63	1.62	1.53	1.43	1.41	1.41	1.44	-0.9	-5.3	-6.5	-1.4	0.2	1.8
Taiwan	Dollar	24.93	26.15	26.45	26.48	27.47	27.50	27.55	4.9	1.1	0.1	3.7	0.1	0.2

Source: Dataquest (April 1997)

the nature of design to evolve; it now includes constituencies among manufacturing and product support, as well as from users, themselves. Thus, the engineering process is being expanded to include input from a broader base.

At the same time, the nature of design data itself is expanding because of a focus on geometry to include multiple data types—making the challenge of system modeling even more complex. Also, the World Wide Web holds the potential to expand the nature of collaborative design by harnessing the joint power of anticipated increases in both computing power and communications bandwidth. Thus, there is little limit to the problems that design or GIS software can tackle. The primary challenge will continue to be developing robust, leading-edge software ahead of competitors. During the forecast period, Dataquest anticipates significant, but not revolutionary, advances in the ability of the existing programmer pool to produce new software.

Mechanical Forecast Assumptions

The following factors will promote expansion of the mechanical CAD/CAM/CAE market.

Renewed Investment in Mechanical CAD Technology

Over the past two years, Dataquest has seen renewed investment in mechanical CAD/CAM/CAE technology among the major aerospace and automotive companies, particularly in North America and Europe. Now that these companies have completed their investment cycles, Dataquest expects to see corresponding investment by their supplier bases as a key driver of the market going forward. Further, many of these major companies who reinvested in base CAD technology will be looking to further invest in design automation. The industry should see add-on, niche applications pushing the market toward higher growth over the forecast period.

New Software, New Platforms, and New Users

Despite the fact that it is still a UNIX-based world, there is a very strong interest in NT-based mechanical design solutions. Vendors spent 1995 and 1996 making solutions available on the NT platform, and finally, designers and engineers have a number of packages to choose from. The prospects of lower-cost software on lower-cost platforms have sparked renewed interest in CAD technology among designers who have not been purchasing CAD systems in recent years.

Untapped Users Eager for Technology

While CAD investment in Europe and North America will begin to slow down over the forecast period, the Asia/Pacific region is just beginning to take off, fueled by CAD investments from local and national governments (such as Indonesia's IPTN) and multinational companies. As manufacturing continues to move offshore into the Asia/Pacific region, Dataquest expects to see an increased level of CAD sophistication among users. Similarly, mechanical CAD/CAM/CAE growth in Japan is expected to undergo major reinvestment over the forecast period. The UNIX platform dominates the mechanical sector in Japan today, and the Japanese mechanical market still places a heavy emphasis on 2-D design rather than solid modeling. Dataquest expects to see a movement of many Japanese CAD users from 2-D and proprietary systems to 3-D commercial systems over the forecast period.

The following trends will slow growth in the mechanical CAD/CAM/CAE market.

CAD Investments Are Cyclical

The major aerospace and automotive companies, particularly in Europe, have been significant drivers of the double-digit mechanical CAD/CAM/CAE growth over the last two years. However, these companies have now completed their investment cycles in CAD technology for the next four to six years. Investment in CAD by these companies will slow significantly until the next investment cycle begins, bringing down the overall market growth.

Meeting User Needs beyond Design

For the mechanical CAD/CAM/CAE market to show the high growth that it has of recent years, designers need applications that do more than just design. Design needs to become more tightly integrated with manufacturing and analysis, and beyond that, the whole process of bringing a product to market cannot continue to live in isolation within the engineering walls. Vendors are beginning to address this issue today, but it will take some time before users as well as vendors determine exactly what is needed and how it can work within the business processes of a company.

AEC Forecast Assumptions

The following factors will contribute to the long-term expansion of the AEC CAD industry.

CAD Is Becoming a Business Requirement

Large design firms are growing at the expense of smaller firms, and 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.

AEC Market Penetration

A significant pool of untapped users still exists, and the relatively low market penetration of AEC CAD systems should allow steady worldwide growth during the next five years, despite constant volatility in the demand for the buildings and infrastructure to be designed.

New Features in AEC CAD Products Are Achievable

Better, lower-cost visualization tools will be in increasing demand as sales and communication tools. Data and database functions are growing in importance in AEC design, creating opportunities to sell users significant new functionality. Some vendors will create products that foster communications in the entire design, construction, and maintenance process—products that will increase the payoff in CAD investments.

The following trends will inhibit growth in AEC.

Design Is Only Part of the Problem

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 not well-addressed by AEC systems today. Design tools can only thrive in the AEC structure when they address more of the entire business problem. Cooperation and commitment to the problem from multiple vendors will allow Dataquest to increase the forecast growth rate further.

Downturn in Germany

The German construction industry, which has been the driving force behind the high growth in AEC of recent years, has come to an abrupt halt. Although there are spots in Europe that are investing in AEC solutions, Germany plays such a dominant role that it will drag down the overall European growth for AEC.

GIS/Mapping Forecast Assumptions

The following sections identify those factors that will promote growth in the worldwide GIS market.

Impact of Windows NT

Intergraph's move to Windows NT at the expense of UNIX will quickly make PC-based operating systems the dominant revenue stream in North America. In the long term, the GIS UNIX market is highly subject to erosion by Windows NT because of its appeal of better integration of GIS and Windows-based productivity tools—an appealing prospect to many GIS users.

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, or have only entry-level systems in terms of value delivered.

New Technologies

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, 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. Finally, database companies themselves are gaining a better understanding of spatial analysis, a key factor in spreading the use of GIS systems over a broader area.

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

Long-term expansion of the GIS market will be constrained by the following factors.

High Cost of Entry Remains a Barrier

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."

Price Pressures Inhibit Growth

Price pressure will hold down total GIS revenue. Innovation is the only way to maintain prices in any software industry, and GIS vendors will struggle in their attempt to create compelling new applications and improved investment payoff for customers.

Electronic Design Automation Forecast Assumptions

The EDA industry continued its strong software growth in 1996, coming in at 19.8 percent over 1995. This year will see the end of the first design cycle after the semiconductor downturn. This may be indicated by a slow quarter, but will soon recover and result in another 20 percent growth for 1997. Dataquest continues to expect a slowdown after the second design cycle is completed in early 1999.

Electronic CAE

CAE came in even stronger than expected, driving CAE growth to 23.5 percent in 1996. This was driven by both North America and Japan. What the industry is seeing in North America is the beginning of the reengineering of the upper mainstream users as they get ready for system level integration (SLI). Recently, Japan has been written off as a nation of manufacturers rather than designers; but this is completely undeserved. The designing progress Japan has made in the last 18 months is nothing short of remarkable. But anyone with a history in this business has grown to expect that of Japan. Both regional trends will continue in 1997.

In Europe, the economic situation will play a big role. The growth in independent electronic design centers is a significant driver. A lot of these are starting up in Europe with a secondary goal of selling intellectual property. The telecommunications market will continue to push EDA sales, especially in the mobile communications and switching and transmission sectors. Networking, automotive, and consumer markets (especially digital set-top boxes) are fast-growing areas. Most of these need mixed-signal solutions, as well as DSP and RF design efforts. Dataquest anticipates significant growth in those EDA sectors that support these applications and technologies.

IC Layout

This was the unpleasant surprise. North America came in at 17.3 percent growth—12 percent below expectations. Japan, although Dataquest didn't expect much, came in at 3.6 percent growth, almost 14 percent below expectations. Dataquest expects this to be a one-year-only phenomenon—the semiconductor industry has already started its recovery.

PCB Design

The PCB design market came in almost exactly on target at 8.4 percent growth. NT is continuing its penetration of this market, and Dataquest expects the market to continue to grow at a 10.1 percent five-year compound annual growth rate.

Table 3 shows the revenue history and forecast of all applications, while Table 4 shows the revenue growth history and forecast of all applications.

Forecast Methodology

Fundamental to the way Dataquest conducts its research is the underlying philosophy that the best data and analyses come from a well-balanced program. This program includes the following:

- Balance between primary and secondary collection techniques
- Balance between supply-side and demand-side analysis
- Balance between focused, industry-specific research and coordinated, "big-picture" analysis aided by integration of data from the more than 25 separate high-technology industries Dataquest covers
- Balance between the perspectives of experienced industry professionals and rigorous, disciplined techniques of seasoned market researchers

Dataquest also analyzes trends in the macro environment, which can have major influences on both supply-side and demand-side forecasting. In addition to demographics, analysts look at gross national product (GNP) growth, interest rate fluctuation, business expectations, and capital spending plans. In the geopolitical arena, the group looks at trade issues, political stability or lack thereof, tariffs, nontariff barriers, and such factors as the effect on Europe of the events of 1996.

Figure 1 shows the CAD/CAM/CAE and GIS forecasting model. The overall forecasting process uses a combination of techniques such as time series and technological modeling. Market estimates and forecasts are derived using the following research techniques:

- Segment forecasting—Individual forecasts are derived for each application segment tracked by the CAD/CAM/CAE and GIS group. Specifically, each application, segmented by region and platform, is forecast and rolled up. In this way, each application segment incorporates its own set of unique assumptions.

Table 3
CAD/CAM/CAE/GIS Software Revenue History and Forecast (Millions of U.S. Dollars)

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Worldwide, All Operating Systems	5,296	6,313	7,134	8,071	9,180	10,098	11,397	12,968	12.7
Worldwide by Operating System									
UNIX	3,713	4,277	4,815	5,302	5,803	6,168	6,608	7,105	8.1
Windows NT	118	352	624	1,080	1,645	2,143	2,941	3,946	44.6
Personal Computer	1,270	1,502	1,531	1,567	1,645	1,730	1,812	1,893	4.3
Host/Proprietary	194	182	165	122	87	56	36	24	-31.8
All Operating Systems by Region									
North America	1,855	2,140	2,498	2,889	3,321	3,667	4,216	4,854	14.2
Europe	1,691	2,080	2,261	2,455	2,713	2,964	3,247	3,593	9.7
Japan	1,398	1,627	1,827	2,061	2,334	2,522	2,812	3,168	11.6
Asia/Pacific	265	356	432	537	667	786	946	1,155	21.7
Rest of World	87	110	117	130	145	158	177	198	11.2

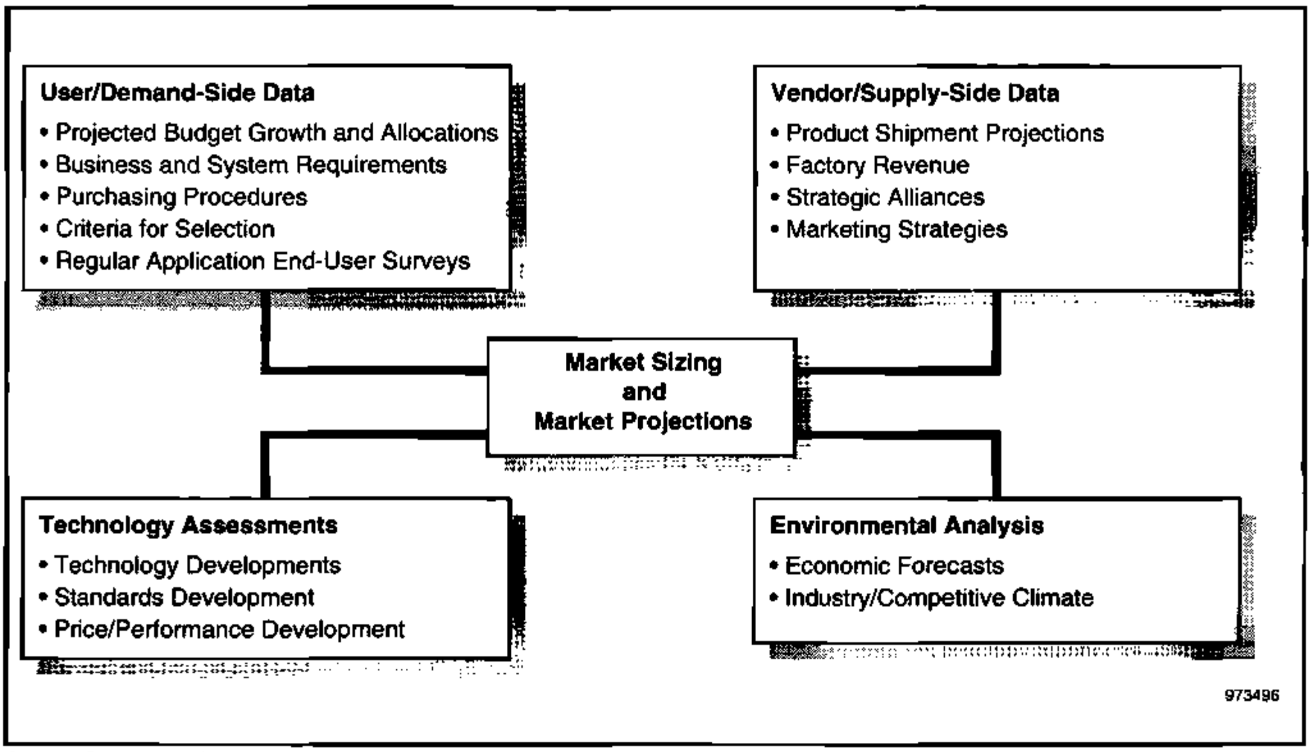
Source: Dataquest (April 1997)

Table 4
Year-to-Year CAD/CAM/CAE/GIS Software Revenue Growth Rate History and Forecast (Percent)

	1995	1996	1997	1998	1999	2000	2001
Worldwide, All Operating Systems	19.2	13.0	13.1	13.7	10.0	12.9	13.8
Worldwide by Operating System							
UNIX	15.2	12.6	10.1	9.4	6.3	7.1	7.5
Windows NT	199.0	77.1	73.1	52.3	30.3	37.2	34.2
Personal Computer	18.2	1.9	2.3	5.0	5.2	4.7	4.5
Host/Proprietary	-6.3	-9.7	-25.7	-29.0	-34.9	-35.8	-33.0
All Operating Systems by Region							
North America	15.4	16.7	15.7	15.0	10.4	15.0	15.1
Europe	23.0	8.7	8.6	10.5	9.3	9.5	10.7
Japan	16.4	12.3	12.8	13.3	8.1	11.5	12.7
Asia/Pacific	34.3	21.5	24.3	24.1	18.0	20.3	22.1
Rest of World	26.8	5.9	11.3	12.0	9.2	11.5	11.9

Source: Dataquest (April 1997)

Figure 1
CAD/CAM/CAE and GIS Forecasting Model



Source: Dataquest (April 1997)

- Demand-based analysis—Market growth is tracked and forecast in terms of the present and anticipated demand of current and future users. This requires the development of a total available market model and a satisfied available market figure to assess the levels of penetration accurately. Dataquest analysts also factor in the acceptance or ability for users to consume new technology.
- Capacity-based analysis—This method involves identifying future shipment volume constraints. These constraints, or "ceilings," can be the result of component availability, manufacturing capacity, or distribution capacity. In any case, capacity limitations are capable of keeping shipments below the demand level.

Changes to the Forecast Database

Dataquest's forecasting model will be undergoing changes over the course of this year. The first set of changes are reflected here in the mechanical CAD/CAM/CAE, AEC, and GIS market forecasts. Within the forecasting model, there are numerous assumption changes that better reflect the reality in the changing CAD/CAM/CAE/AEC and GIS worlds. These changes include updating the hardware retirement model and altering the average selling prices (ASPs) for software, service, and hardware. Dataquest will continue to refine these assumptions over the next five months, at which time Dataquest will publish its forecast update. At the same time, Dataquest will implement assumption changes to the electronic design automation market forecast.

Segmentation Definitions

Operating Systems

The following defines the operating systems:

- UNIX—Includes all UNIX variants and older workstation operating systems
- Host—Includes minicomputer and mainframe operating systems in which external workstations' functions are dependent on a host computer
- Windows NT—A Microsoft operating system
- PC—Includes DOS, Windows, Windows 95, OS/2, and Apple operating systems

Line Items

Line item definitions are as follows:

- Average selling price (ASP)—The average price of a product, inclusive of any discounts
- CPU revenue—The portion of revenue derived from a system sale that is related to the value of the CPU
- CPU shipment—The number of CPUs delivered
- CPU installed base—The total number of CPUs in active, day-to-day use
- Unit shipment—The number of products delivered (that is, seats)
- Seats—The number of possible simultaneous users
- Installed seats—The total number of seats in active, day-to-day use
- Hardware revenue—The sum of the revenue from the hardware system components: CPU revenue, terminal revenue, and peripherals revenue
- Peripherals revenue—The value of all the peripherals from turnkey sale (typically input and output devices)
- Terminal revenue—Revenue derived from the sale of terminals used to graphically create, analyze, or manipulate designs; applicable only to the host systems
- Software revenue—Revenue derived from the sale of application software
- Service revenue—Revenue derived from the service and support of CAD/CAM/CAE or GIS systems; subcategorized as software service and hardware service
- Total factory revenue—The amount of money received for goods measured in U.S. dollars; the sum of hardware, software, and service revenue

Table A-1
CAD/CAM/CAE/GIS Software History and Forecast—Top-Level Mechanical Forecast, Worldwide, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Software Revenue ($M)									
Worldwide, All Operating Systems	2,439	2,964	3,431	3,875	4,321	4,749	5,169	5,657	10.5
Worldwide Revenue by Operating System									
UNIX	1,798	2,174	2,457	2,688	2,890	3,079	3,236	3,396	6.7
Windows NT	41	115	274	494	729	963	1,214	1,526	41.0
Personal Computer	468	559	600	620	647	671	694	716	3.6
Host/Proprietary	131	117	99	73	56	37	25	18	-29.1
All Operating Systems Revenue by Region									
North America	735	827	977	1,098	1,219	1,346	1,476	1,615	10.6
Europe	833	1,072	1,220	1,359	1,512	1,660	1,816	2,027	10.7
Japan	747	894	1,017	1,150	1,268	1,362	1,441	1,526	8.5
Asia/Pacific	94	132	174	221	270	326	375	424	19.5
Rest of World	30	39	43	47	52	55	60	65	8.9
Year-to-Year Software Revenue Growth Rate (%)									
Worldwide, All Operating Systems	-	21.5	15.7	12.9	11.5	9.9	8.8	9.4	-
Worldwide Growth by Operating System									
UNIX	-	20.9	13.0	9.4	7.5	6.5	5.1	5.0	-
Windows NT	-	176.7	139.3	79.9	47.6	32.2	26.1	25.7	-
Personal Computer	-	19.3	7.5	3.3	4.3	3.6	3.4	3.3	-
Host/Proprietary	-	-10.5	-15.1	-26.6	-23.4	-33.9	-31.6	-29.4	-
All Operating Systems Growth by Region									
North America	-	12.6	18.0	12.4	11.1	10.4	9.7	9.4	-
Europe	-	28.7	13.9	11.4	11.2	9.8	9.4	11.6	-
Japan	-	19.6	13.8	13.1	10.3	7.4	5.8	5.9	-
Asia/Pacific	-	40.3	32.0	27.1	22.2	20.6	15.1	12.8	-
Rest of World	-	30.7	8.5	10.1	10.4	6.0	9.7	8.4	-

Source: Dataquest (April 1997)

Table B-1
CAD/CAM/CAE/GIS Software History and Forecast—Detail Mechanical Forecast, Worldwide, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	294,034	341,152	372,270	395,800	425,700	450,900	479,100	508,200	6
Seats	305,048	350,216	381,331	404,900	431,800	456,500	483,100	511,300	6
Year-to-Year Increase (%)	7	15	9	6	7	6	6	6	-
Installed Base									
CPUs	822,123	933,154	1,044,073	1,145,000	1,247,600	1,356,100	1,468,700	1,583,200	9
Seats	886,593	987,668	1,091,201	1,187,500	1,284,100	1,387,600	1,494,900	1,604,600	8
Year-to-Year Increase (%)	11	11	10	9	8	8	8	7	-
Revenue Data ($M)									
CPU Revenue	3,481	3,952	4,346	4,619	4,871	5,112	5,384	5,660	5
Terminal Revenue	203	154	136	133	96	63	41	27	-28
Peripheral Revenue	286	342	353	354	349	337	327	316	-2
Total Hardware Revenue	3,970	4,443	4,698	5,106	5,316	5,513	5,751	6,003	5
Year-to-Year Increase (%)	12	12	6	9	4	4	4	4	-
Software Revenue	2,439	2,964	3,431	3,875	4,321	4,749	5,169	5,657	11
Year-to-Year Increase (%)	9	22	16	13	12	10	9	9	-
Software Service Revenue	940	1,109	1,263	1,418	1,564	1,703	1,833	1,979	9
Hardware Service Revenue	704	880	1,042	1,109	1,196	1,278	1,372	1,472	7
Total Service Revenue	1,645	1,987	2,296	2,527	2,760	2,981	3,206	3,451	8
Year-to-Year Increase (%)	14	21	16	10	9	8	8	8	-
Total Factory Revenue	8,054	9,386	10,415	11,509	12,397	13,243	14,126	15,110	8
Year-to-Year Increase (%)	11	17	11	11	8	7	7	7	-

Source: Dataquest (April 1997)

Table B-2
CAD/CAM/CAE/GIS Software History and Forecast—Detail Mechanical Forecast, Worldwide, UNIX

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	109,001	124,650	132,634	138,800	144,200	149,500	155,100	160,600	4
Seats	109,001	124,650	132,634	138,800	144,200	149,500	155,100	160,600	4
Year-to-Year Increase (%)	16	14	6	5	4	4	4	4	-
Installed Base									
CPUs	319,835	374,137	422,795	463,900	503,300	550,300	601,000	651,300	9
Seats	319,835	374,137	422,795	463,900	503,300	550,300	601,000	651,300	9
Year-to-Year Increase (%)	19	17	13	10	8	9	9	8	-
Revenue Data ($M)									
CPU Revenue	2,448	2,897	3,075	3,242	3,390	3,526	3,657	3,766	4
Terminal Revenue	-	-	-	-	-	-	-	-	NA
Peripheral Revenue	217	259	259	256	248	238	225	212	-4
Total Hardware Revenue	2,665	3,152	3,330	3,498	3,638	3,764	3,882	3,978	4
Year-to-Year Increase (%)	16	18	6	5	4	3	3	2	-
Software Revenue	1,798	2,174	2,457	2,688	2,890	3,079	3,236	3,396	7
Year-to-Year Increase (%)	15	21	13	9	8	7	5	5	-
Software Service Revenue	773	912	1,015	1,117	1,203	1,286	1,352	1,418	7
Hardware Service Revenue	557	741	875	940	1,017	1,093	1,170	1,243	7
Total Service Revenue	1,330	1,652	1,889	2,058	2,220	2,379	2,522	2,661	7
Year-to-Year Increase (%)	16	24	14	9	8	7	6	6	-
Total Factory Revenue	5,793	6,971	7,667	8,244	8,748	9,222	9,639	10,035	6
Year-to-Year Increase (%)	16	20	10	8	6	5	5	4	-

NA = Not applicable
Source: Dataquest (April 1997)

Table B-3
CAD/CAM/CAE/GIS Software History and Forecast—Detail Mechanical Forecast, Worldwide, NT/Hybrid

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	2,262	5,940	14,435	24,600	34,000	42,200	51,100	61,600	34
Seats	2,262	5,940	14,435	24,600	34,000	42,200	51,100	61,600	34
Year-to-Year Increase (%)	3,053	163	143	71	38	24	21	21	-
Installed Base									
CPUs	2,327	8,019	21,160	41,900	66,800	92,500	118,300	145,600	47
Seats	2,327	8,019	21,160	41,900	66,800	92,500	118,300	145,600	47
Year-to-Year Increase (%)	3,143	245	164	98	60	38	28	23	-
Revenue Data ($M)									
CPU Revenue	28	69	165	300	425	541	682	839	38
Terminal Revenue	-	-	-	-	-	-	-	-	NA
Peripheral Revenue	4	6	9	14	19	22	26	30	29
Total Hardware Revenue	33	74	174	314	444	563	709	870	38
Year-to-Year Increase (%)	3,883	128	134	81	42	27	26	23	-
Software Revenue	41	115	274	494	729	963	1,214	1,526	41
Year-to-Year Increase (%)	2,715	177	139	80	48	32	26	26	-
Software Service Revenue	15	31	70	127	189	255	325	411	43
Hardware Service Revenue	11	9	28	44	67	91	121	155	41
Total Service Revenue	26	40	98	171	256	346	446	566	42
Year-to-Year Increase (%)	15,512	52	147	75	50	35	29	27	-
Total Factory Revenue	100	228	546	979	1,429	1,872	2,369	2,962	40
Year-to-Year Increase (%)	3,974	128	139	79	46	31	27	25	-

NA = Not applicable
Source: Dataquest (April 1997)

Table B-4
CAD/CAM/CAE/GIS Software History and Forecast—Detail Mechanical Forecast, Worldwide, Personal Computer

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	179,134	207,827	222,415	231,700	245,700	259,200	272,800	285,900	5
Seats	179,137	208,010	222,554	231,700	245,700	259,200	272,800	285,900	5
Year-to-Year Increase (%)	3	16	7	4	6	5	5	5	-
Installed Base									
CPUs	480,224	534,078	585,350	628,000	668,100	706,900	745,300	783,800	6
Seats	480,224	534,078	585,350	628,000	668,100	706,900	745,300	783,800	6
Year-to-Year Increase (%)	10	11	10	7	6	6	5	5	-
Revenue Data ($M)									
CPU Revenue	611	710	781	832	883	934	974	1,009	5
Terminal Revenue	-	-	-	-	-	-	-	-	NA
Peripheral Revenue	46	48	48	51	54	58	61	63	6
Total Hardware Revenue	658	756	828	883	937	992	1,035	1,072	5
Year-to-Year Increase (%)	18	15	9	7	6	6	4	4	-
Software Revenue	468	559	600	620	647	671	694	716	4
Year-to-Year Increase (%)	5	19	7	3	4	4	3	3	-
Software Service Revenue	68	82	91	92	97	102	105	108	3
Hardware Service Revenue	30	34	38	42	44	47	49	51	6
Total Service Revenue	98	116	130	134	142	149	154	159	4
Year-to-Year Increase (%)	1	18	11	3	6	5	4	3	-
Total Factory Revenue	1,224	1,430	1,555	1,637	1,726	1,811	1,882	1,947	5
Year-to-Year Increase (%)	12	17	9	5	5	5	4	3	-

NA = Not applicable
Source: Dataquest (April 1997)

Table B-5
CAD/CAM/CAE/GIS Software History and Forecast—Detail Mechanical Forecast, Worldwide, Host/Proprietary

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	3,637	2,735	2,786	700	1,800	100	100	100	-51
Seats	14,649	11,616	11,707	9,700	7,900	5,700	4,100	3,200	-23
Year-to-Year Increase (%)	-12	-21	1	-17	-19	-28	-28	-22	-
Installed Base									
CPUs	19,737	16,919	14,768	11,200	9,300	6,500	4,100	2,400	-30
Seats	84,208	71,433	61,896	53,800	45,900	37,900	30,200	23,800	-17
Year-to-Year Increase (%)	-12	-15	-13	-13	-15	-17	-20	-21	-
Revenue Data ($M)									
CPU Revenue	393	277	325	245	173	111	71	45	-33
Terminal Revenue	203	154	136	133	96	63	41	27	-28
Peripheral Revenue	18	30	37	33	27	20	14	10	-23
Total Hardware Revenue	615	460	367	411	296	194	126	82	-26
Year-to-Year Increase (%)	-13	-25	-20	12	-28	-34	-35	-35	-
Software Revenue	131	117	99	73	56	37	25	18	-29
Year-to-Year Increase (%)	-45	-11	-15	-27	-23	-34	-32	-29	-
Software Service Revenue	84	83	88	82	75	61	52	42	-14
Hardware Service Revenue	106	96	100	83	67	47	32	24	-25
Total Service Revenue	191	180	180	165	142	108	84	65	-18
Year-to-Year Increase (%)	0	-6	0	-9	-14	-24	-22	-22	-
Total Factory Revenue	936	757	646	649	494	339	235	166	-24
Year-to-Year Increase (%)	-18	-19	-15	0	-24	-31	-31	-30	-

Source: Dataquest (April 1997)

Table B-6
CAD/CAM/CAE/GIS Software History and Forecast—Detail Mechanical Forecast, North America, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	109,610	115,515	121,915	128,800	137,100	145,100	153,700	162,200	6
Seats	112,599	117,212	123,423	130,000	137,800	145,600	154,100	162,500	6
Year-to-Year Increase (%)	5	4	5	5	6	6	6	5	-
Installed Base									
CPUs	307,471	334,693	359,091	382,100	408,400	440,300	475,400	511,600	7
Seats	329,387	351,499	371,893	391,800	415,500	445,300	479,000	514,200	7
Year-to-Year Increase (%)	9	7	6	5	6	7	8	7	-
Revenue Data ($M)									
CPU Revenue	951	1,023	1,133	1,184	1,251	1,332	1,431	1,524	6
Terminal Revenue	49	33	26	16	9	5	4	2	-37
Peripheral Revenue	28	32	33	31	29	29	28	28	-3
Total Hardware Revenue	1,027	1,087	1,166	1,231	1,289	1,366	1,464	1,555	6
Year-to-Year Increase (%)	8	6	7	6	5	6	7	6	-
Software Revenue	735	827	977	1,098	1,219	1,346	1,476	1,615	11
Year-to-Year Increase (%)	6	13	18	12	11	10	10	9	-
Software Service Revenue	269	295	349	393	436	485	534	584	11
Hardware Service Revenue	194	228	279	291	316	346	383	420	9
Total Service Revenue	464	523	627	684	752	831	917	1,005	10
Year-to-Year Increase (%)	16	13	20	9	10	10	10	10	-
Total Factory Revenue	2,225	2,436	2,768	3,012	3,261	3,543	3,857	4,174	9
Year-to-Year Increase (%)	9	9	14	9	8	9	9	8	-

Source: Dataquest (April 1997)

Table B-7
CAD/CAM/CAE/GIS Software History and Forecast—Detail Mechanical Forecast, Europe, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	96,049	117,780	120,405	124,600	132,500	138,300	145,900	155,400	5
Seats	100,110	121,445	124,005	128,300	135,100	140,700	147,600	156,600	5
Year-to-Year Increase (%)	6	21	2	3	5	4	5	6	-
Installed Base									
CPUs	288,987	322,411	350,944	375,200	400,900	428,800	459,000	492,500	7
Seats	312,738	342,817	368,951	391,800	415,500	441,700	469,800	501,300	6
Year-to-Year Increase (%)	5	10	8	6	6	6	6	7	-
Revenue Data ($M)									
CPU Revenue	1,177	1,375	1,487	1,551	1,620	1,682	1,777	1,897	5
Terminal Revenue	84	58	49	51	40	25	15	9	-28
Peripheral Revenue	61	91	102	100	97	92	89	86	-3
Total Hardware Revenue	1,322	1,518	1,590	1,701	1,758	1,798	1,881	1,992	5
Year-to-Year Increase (%)	7	15	5	7	3	2	5	6	-
Software Revenue	833	1,072	1,220	1,359	1,512	1,660	1,816	2,027	11
Year-to-Year Increase (%)	7	29	14	11	11	10	9	12	-
Software Service Revenue	342	417	459	506	555	600	647	707	9
Hardware Service Revenue	246	308	362	378	404	426	459	498	7
Total Service Revenue	588	724	817	884	959	1,026	1,106	1,205	8
Year-to-Year Increase (%)	14	23	13	8	9	7	8	9	-
Total Factory Revenue	2,743	3,308	3,619	3,944	4,229	4,484	4,802	5,224	8
Year-to-Year Increase (%)	8	21	9	9	7	6	7	9	-

Source: Dataquest (April 1997)

Table B-8
CAD/CAM/CAE/GIS Software History and Forecast—Detail Mechanical Forecast, Japan, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	64,288	77,310	97,523	106,700	116,100	123,800	131,900	139,400	7
Seats	67,371	80,076	100,136	108,900	117,500	124,800	132,500	139,900	7
Year-to-Year Increase (%)	8	19	25	9	8	6	6	6	-
Installed Base									
CPUs	172,155	205,073	248,975	290,400	328,400	363,800	396,900	427,500	11
Seats	187,318	218,773	261,272	301,500	337,800	371,400	402,800	432,000	11
Year-to-Year Increase (%)	17	17	19	15	12	10	8	7	-
Revenue Data ($M)									
CPU Revenue	1,177	1,312	1,441	1,551	1,632	1,691	1,730	1,761	4
Terminal Revenue	57	47	41	35	22	13	7	5	-36
Peripheral Revenue	184	199	200	204	202	197	189	182	-2
Total Hardware Revenue	1,418	1,560	1,639	1,790	1,856	1,901	1,927	1,947	4
Year-to-Year Increase (%)	16	10	5	9	4	2	1	1	-
Software Revenue	747	894	1,017	1,150	1,268	1,362	1,441	1,526	8
Year-to-Year Increase (%)	12	20	14	13	10	7	6	6	-
Software Service Revenue	282	337	381	425	459	484	499	516	6
Hardware Service Revenue	232	293	332	357	381	399	411	423	5
Total Service Revenue	514	630	711	782	840	884	911	939	6
Year-to-Year Increase (%)	11	23	13	10	7	5	3	3	-
Total Factory Revenue	2,679	3,084	3,367	3,722	3,965	4,147	4,278	4,413	6
Year-to-Year Increase (%)	14	15	9	11	7	5	3	3	-

Source: Dataquest (April 1997)

Table B-9
CAD/CAM/CAE/GIS Software History and Forecast—Detail Mechanical Forecast, Asia/Pacific, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	17,500	22,818	24,741	27,500	31,100	34,300	37,500	40,400	10
Seats	18,174	23,576	25,892	29,300	32,400	35,800	38,700	41,400	10
Year-to-Year Increase (%)	28	30	10	13	11	10	8	7	-
Installed Base									
CPUs	37,662	51,561	63,359	73,800	84,500	96,100	108,100	119,900	14
Seats	39,872	53,984	66,372	78,000	89,200	101,200	113,300	124,900	13
Year-to-Year Increase (%)	43	35	23	17	14	13	12	10	-
Revenue Data ($M)									
CPU Revenue	135	191	232	277	309	346	379	408	12
Terminal Revenue	12	14	19	30	24	19	14	10	-12
Peripheral Revenue	11	15	13	15	15	16	16	15	3
Total Hardware Revenue	158	220	244	322	348	380	409	433	12
Year-to-Year Increase (%)	40	39	11	32	8	9	7	6	-
Software Revenue	94	132	174	221	270	326	375	424	19
Year-to-Year Increase (%)	30	40	32	27	22	21	15	13	-
Software Service Revenue	37	47	61	80	97	117	134	150	20
Hardware Service Revenue	25	40	56	69	79	90	101	111	14
Total Service Revenue	62	87	116	149	176	207	235	261	18
Year-to-Year Increase (%)	37	42	33	28	18	18	13	11	-
Total Factory Revenue	313	439	534	693	794	914	1,019	1,118	16
Year-to-Year Increase (%)	36	40	22	30	15	15	12	10	-

Source: Dataquest (April 1997)

Table B-10
CAD/CAM/CAE/GIS Software History and Forecast—Detail Mechanical Forecast, Rest of World, All Operating Systems

	1994	1995	1996	1997	1998	1999	2000	2001	CAGR (%) 1996-2001
Hardware Shipment Data									
Shipments									
CPUs	6,587	7,730	7,686	8,200	8,800	9,400	10,200	10,800	7
Seats	6,795	7,908	7,875	8,400	9,000	9,600	10,300	10,900	7
Year-to-Year Increase (%)	12	16	0	7	7	6	7	6	-
Installed Base									
CPUs	15,848	19,416	21,703	23,500	25,200	27,200	29,400	31,600	8
Seats	17,278	20,594	22,713	24,400	26,100	27,900	30,000	32,200	7
Year-to-Year Increase (%)	24	19	10	7	7	7	8	7	-
Revenue Data ($M)									
CPU Revenue	41	52	53	56	59	61	66	70	6
Terminal Revenue	2	2	2	2	1	1	1	1	-18
Peripheral Revenue	3	4	5	5	5	5	5	5	0
Total Hardware Revenue	46	58	58	62	65	67	71	75	5
Year-to-Year Increase (%)	15	27	0	7	5	3	6	5	-
Software Revenue	30	39	43	47	52	55	60	65	9
Year-to-Year Increase (%)	10	31	9	10	10	6	10	8	-
Software Service Revenue	10	12	13	15	16	17	19	21	9
Hardware Service Revenue	7	10	12	14	15	16	18	21	11
Total Service Revenue	18	23	26	28	32	34	38	41	10
Year-to-Year Increase (%)	13	31	12	10	12	7	12	9	-
Total Factory Revenue	93	120	127	138	149	156	169	182	7
Year-to-Year Increase (%)	13	29	5	9	8	5	9	7	-

Source: Dataquest (April 1997)

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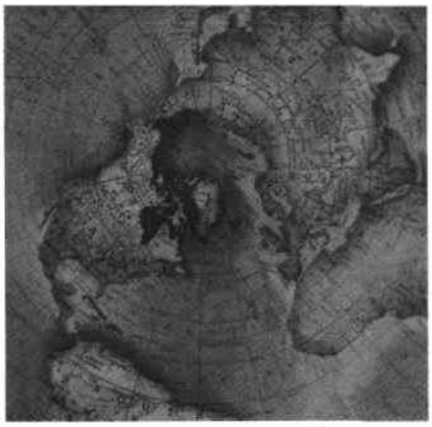

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Mechanical CAD/CAM/CAE Worldwide Market Share

Market Statistics

Program: Mechanical CAD/CAM/CAE Worldwide
Product Code: CMEC-WW-MS-9701
Publication Date: March 10, 1997
Filing: Market Statistics

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Mechanical CAD/CAM/CAE Worldwide Market Share

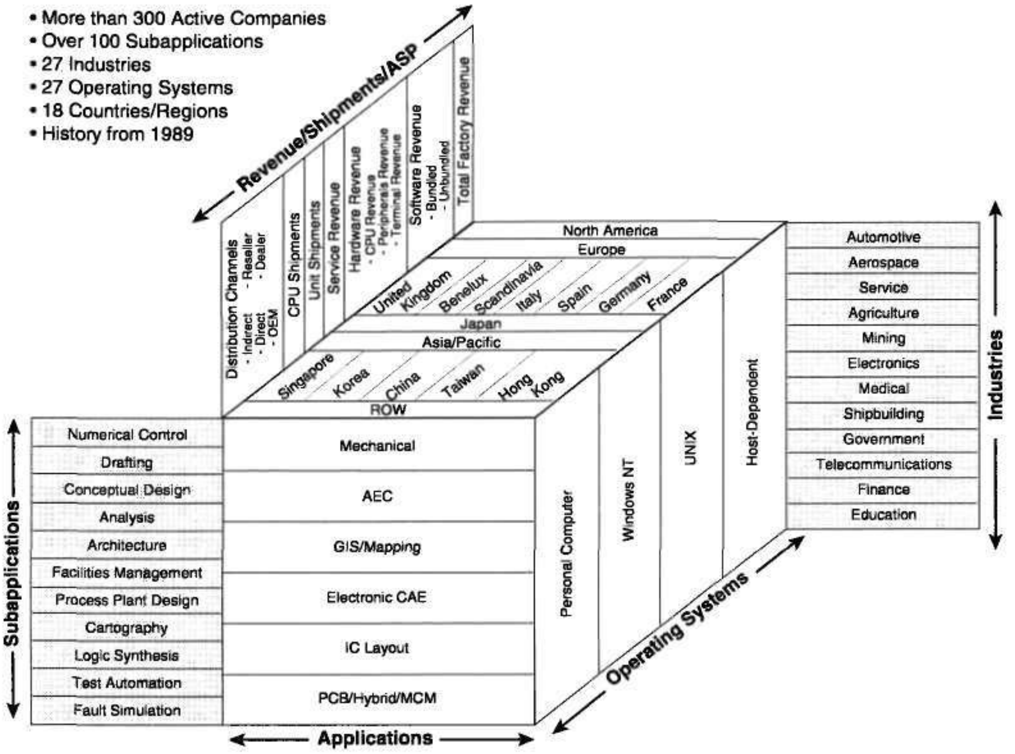
Introduction

CAD/CAM/CAE/GIS systems have dramatically changed the methods by which designers and production managers originate and implement products. CAD and CAE systems allow designers to create, draft, analyze, test, and manipulate products on a screen in two and three dimensions. As CAD/CAM/CAE/GIS systems continue to decrease in cost, they become more available and cost-justifiable to new users.

In order to provide a comprehensive view of the CAD/CAM/CAE/GIS industry, Dataquest's CAD/CAM/CAE/GIS group maintains a large database of industry information. The type of information contained in the database is depicted in Figure 1.

Table 1 summarizes the performance in various segments of the CAD/CAM/CAE/GIS markets in 1996 versus 1995.

Figure 1
CAD/CAM/CAE/GIS Market Database



Source: Dataquest (February 1997)

Table 1
All CAD Applications, Market Summary, 1995 to 1996 (Revenue in Millions of Dollars)

	Software Revenue ($M)		Growth (%)	Hardware Revenue ($M)		Growth (%)	Total Factory Revenue ($M)		Growth (%)	Unit Seat Shipments		Growth (%)
	1995	1996	1995-1996	1995	1996	1995-1996	1995	1996	1995-1996	1995	1996	1995-1996
Applications												
Mechanical	2,957.59	3,420.48	15.65	4,653.37	4,951.28	6.40	9,589.67	10,617.18	10.71	344,590.42	379,028.43	9.99
AEC	945.46	939.78	-0.60	1,403.27	1,304.58	-7.03	2,762.87	2,679.84	-3.01	243,684.51	227,422.68	-6.67
GIS/Mapping	810.32	853.15	5.29	1,196.20	1,199.90	0.31	2,569.10	2,675.71	4.15	127,652.81	129,280.16	1.27
Electronic CAE	1,037.10	1,281.19	23.54	1,150.50	1,301.08	13.09	3,006.30	3,587.00	19.32	106,320.90	107,509.83	1.12
IC Layout	286.72	336.27	17.28	344.34	372.75	8.25	930.49	1,072.98	15.31	14,983.66	16,452.69	9.80
PCB/MCM/Hybrid	270.33	293.04	8.40	342.51	355.92	3.92	836.01	875.02	4.67	26,606.96	28,674.02	7.77
Electronic Design Automation	1,594.14	1,910.51	19.85	1,837.35	2,029.76	10.47	4,772.81	5,535.01	15.97	147,911.53	152,636.54	3.19
All Applications	6,307.50	7,123.92	12.94	9,090.20	9,485.51	4.35	19,694.44	21,507.74	9.21	863,839.27	888,367.80	2.84
Regions												
North America	2,138.51	2,495.93	16.71	2,986.53	3,075.74	2.99	6,666.27	7,406.82	11.11	355,130.43	354,384.70	-0.21
Europe	2,073.76	2,253.62	8.67	2,998.78	3,041.33	1.42	6,457.47	6,787.83	5.12	295,541.27	289,154.15	-2.16
Japan	1,626.47	1,826.04	12.27	2,577.63	2,797.06	8.51	5,306.92	5,871.52	10.64	136,313.84	164,811.78	20.91
Asia/Pacific	358.76	433.42	20.81	393.59	427.64	8.65	954.35	1,109.95	16.30	56,533.32	59,177.19	4.68
Rest of World	110.01	116.65	6.04	133.69	144.89	8.38	309.43	334.79	8.20	20,320.41	20,875.31	2.73
Worldwide	6,307.50	7,123.92	12.94	9,090.20	9,485.51	4.35	19,694.44	21,507.74	9.21	863,839.27	888,367.80	2.84
Operating Systems												
UNIX	4,270.78	4,805.54	12.52	6,221.78	6,546.35	5.22	13,969.42	15,303.19	9.55	250,448.69	264,796.45	5.73
Host/Proprietary	182.14	164.56	-9.65	645.61	517.30	-19.88	1,128.55	979.24	-13.23	5,425.68	5,334.89	-1.67
NT/Hybrid	352.24	624.87	77.40	361.05	552.23	52.95	923.03	1,508.12	63.39	25,958.39	41,345.63	59.28
Personal Computer	1,502.35	1,528.95	1.77	1,861.75	1,869.64	0.42	3,673.45	3,717.20	1.19	582,006.51	576,890.83	-0.88
All Operating Systems	6,307.50	7,123.92	12.94	9,090.20	9,485.51	4.35	19,694.44	21,507.74	9.21	863,839.27	888,367.80	2.84

Source: Dataquest (February 1997)

About This Document

This document contains Dataquest's detailed market share information on the CAD/CAM/CAE/GIS industry. Numbers presented in this book represent Dataquest's best estimate of the CAD/CAM/CAE/GIS markets at this time. Each vendor surveyed is given the opportunity to self-report revenue information for the company (see the Market Share Methodology section for a detailed explanation of how market numbers are compiled and scrubbed). The following list contains descriptions of the companies included in the Market Share books. See Tables 2 and 3 for changes in the companies tracked from our 1995 report. Companies deleted or added to our database are also listed in this chapter.

- Mechanical applications—All companies in database with mechanical revenue
- GIS and AEC applications—All companies in the database with GIS revenue and all companies in database with AEC revenue. We also have added GIS data companies.
- Electronic design automation applications—All companies in the database with EDA (electronic CAE, IC layout, PCB/hybrid/MCM) revenue
- Europe—All companies with European revenue
- Asia—All companies with Asian revenue

We no longer publish top-level market statistics for the entire CAD/CAM/CAE/GIS industry. This data is available by calling Daya Nadamuni at (408) 468-8290. More detailed data on these markets may be requested through our client inquiry service.

This document represents our market share of 1996 shipments and revenue.

Table 2
Companies Renamed Since 1995

Original Company Name	New Company Name
AT&T	Lucent Technologies
CADWORKS	Drawbase Software
Contec	Applied Simulation Technology
Data I/O	Synario Design Automation
GRAFTEK	First Cadcam Inc.

Source: Dataquest (February 1997)

Table 3
Companies (or CAD Portions of Companies) Sold/Merged in 1995

Original Company Name	Acquired by/Merged with
Camax	SDRC
High Level Design Systems	Cadence Design Systems
HoSoft	Applicon
Meta-Software	Avant!
Royal Digital Centers	Mentor Graphics
Strategic Mapping	ESRI
TYDAC Technology	PCI Group
UniCAD	Cooper & Chyan Technology

Source: Dataquest (February 1997)

Companies deleted from our database since 1995 are as follows:

- Altium
- Bionic Knight
- Carrier Corporation
- Cimplex
- Evolution Computing
- Motorola
- Pacsoft
- Sinus Software

Companies added to our database since 1995 are as follows:

- 3D/Eye Inc.
- BCT GmbH
- Compact Software
- ConsenSys Software Corporation
- Control Data
- ESI Group
- Incases
- Interactive Image Technology
- Knights Technology
- Logic Vision
- Rubicad
- Sente
- SolidWorks
- Synplicity
- Virtual Chips

Dataquest's policy is to continually update its market information, for current and past years, with any new data received in order to arrive at the most accurate market representation possible.

Segmentation Definitions

This section lists the definitions specific to this document. The following paragraphs define the segments.

Applications

Mechanical

The mechanical segment refers to computer-aided tools used by engineers, designers, analysts, technicians, and draftspeople working predominantly in the discrete manufacturing industries, but includes government and education. Common design applications include conceptual design, industrial design, structural or thermal analysis, detail design, and electromechanical design. Common manufacturing applications include tool and fixture design and numerical control part programming. Product data management and application development environments are also included in this segment.

Architecture, Engineering, and Construction (AEC)

The AEC segment covers the use of computer-aided tools by architects, contractors, plant engineers, civil engineers, and other people associated with these disciplines to aid in designing and managing buildings, industrial plants, ships, and other types of nondiscrete entities.

Geographic Information Systems (GIS)/Mapping

GIS is computer-based technology, and the segment comprises hardware, software, and data used to capture, edit, display, and analyze spatial (tagged by location) information.

Electronic Design Automation (EDA)

The EDA segment covers computer-based tools used to automate the design of an electronic product, including printed circuit boards, ICs, and systems. EDA includes ECAE, IC layout, and PCB/hybrid/MCM, as follows:

- Electronic computer-aided engineering (ECAE)—These are computer-aided tools used in the engineering or design phase of electronic products (as opposed to the physical layout phase of the product). Examples of electronic CAE applications are schematic capture and simulation.
- IC layout—This is a software application tool used to create and validate the physical implementation of an IC. The IC layout category comprises polygon editors, symbolic editors, placement and routing (gate array, cell, and block), and design verification tools (DRC/ERC/logic-to-layout).
- PCB/hybrid/MCM—This segment covers products used to create the placement and routing of the traces and components laid out on a printed circuit board. Also included in this category are thermal analysis tools.

Regions

The following paragraphs define the regions.

- North America
  - United States—Includes the 48 contiguous states, Washington, D.C., Alaska, Hawaii, and Puerto Rico
  - Canada
  - Mexico
- Europe
  - Western Europe—Includes Austria, Benelux (Belgium, the Netherlands, Luxembourg), France, Germany, Greece, Ireland, Italy, Scandinavia (Denmark, Finland, Norway, Sweden), Portugal, Spain, Switzerland, Turkey, and the United Kingdom
  - Rest of Western Europe—Andorra, Cyprus, Faeroe Islands, Gibraltar, Greenland, Guernsey, Iceland, Jersey, Liechtenstein, Malta, Monaco, San Marino, and Vatican City
  - Central and Eastern Europe—Includes Albania, Armenia, Azerbaijan, Belarus, Bosnia, Bulgaria, Croatia, Czech Republic, Estonia, Federal Republic of Yugoslavia (including Serbia and Montenegro), Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Macedonia, Moldova, Poland, Romania, Russia (as far as the Urals), Slovakia, Slovenia, Tajikistan, Turkmenistan, Ukraine, and Uzbekistan
- Japan
- Asia/Pacific—Includes Australia, Bangladesh, Brunei, Cambodia, China, Hong Kong, India, Indonesia, Korea, Laos, Malaysia, Maldives, Myanmar, Nepal, New Zealand, Pakistan, the Philippines, Singapore, Sri Lanka, Taiwan, Thailand, and Vietnam
- Rest of World—Includes Africa, the Caribbean, the Middle East, Oceania, and South America

Operating Systems

Dataquest defines the operating systems as follows:

- UNIX—Includes all UNIX variants and older workstation operating systems
- Host—Includes minicomputer and mainframe operating systems in which the functions of external workstations are dependent on a host computer
- Windows NT—A Microsoft operating system
- PC—Includes DOS, Windows 3.x, Windows 95, and Apple operating systems

Metrics

The following paragraphs define measurements:

- Total distribution revenue—The total amount of money received by a company for all goods and services sold into the CAD/CAM/CAE/GIS market. It is the sum of factory revenue, OEM revenue, and reseller revenue.
- Total factory revenue—The amount of money received by a manufacturer for its goods and services measured in U.S. dollars. Total factory revenue does not include revenue that a company may receive from products that are sold to another company for resale (OEM revenue). Total factory revenue is the sum of hardware revenue, software revenue, and service revenue.
- Hardware revenue—Derived from the sales of CPUs (including operating systems), terminals (for host-dependent systems), and peripherals
- Software revenue—Derived from the sales of bundled (part of a turnkey system) and unbundled applications software that exists on a company's standard price list. It does not include operating systems revenue, which is part of the hardware revenue.
- Service revenue—Derived from the service and support of CAD/CAM/CAE/GIS systems. Service revenue can be calculated in the market share tables by subtracting hardware and software revenue from total factory revenue. Service revenue includes the following:
  - Applications development—Adding new functionality through design and development of new customized CAD/CAM/CAE/GIS software applications, or the modification, enhancement, or customization of existing software applications
  - Consulting—Including an assessment of a company's CAD/CAM/CAE/GIS business IT needs and formulation of a plan based on needs identification
  - Integration services—Planning, implementing, migrating, and integrating software products
  - Maintenance—Fees for hardware and software
  - Management and operations services—Includes help desk, education and training, disaster recovery, vaulting, facilities management, configuration management, and relocation services
  - Service bureau—Includes construction of database, data conversion, product design, analysis, or manufacturing
- Unit shipment—Defined as the number of seats delivered (number of possible simultaneous users of product delivered), excluding OEM shipments. CPU shipments are defined as the number of CPUs delivered, which is the same as unit shipments for all platforms but host-dependent platforms.
- Distribution channels are defined as follows:
  - Direct—Sales direct to the end user
  - Indirect—Sales to resellers, from which dealer revenue is calculated

- Dealer revenue—Dealer revenue is based on a multiplier of indirect revenue. Dealer revenue always exists for every vendor with indirect sales, and it is always equal to, or greater than, indirect revenue. Calculation of these dealer multipliers vary by vendor, by region, and by platform
- OEM—A channel through which vendors sell their finished product to other companies for resale through an agreement. Once sold, the product is usually modified slightly, relabeled, and rebranded by the new original equipment manufacturer, and then resold directly to the end user or through an indirect channel. Revenue as sold by that final vendor (who, from the perspective of the original component supplier, is also popularly known as the OEM) is then credited as revenue to the final supplier
- Reseller—The revenue a named company in the CAD/CAM/CAE/GIS database receives for selling another company's product, such as Intergraph's revenue from Bentley Microstation products, IBM's revenue for reselling MicroCADAM, or Fujitsu's revenue for reselling software from several U.S. vendors

The application of these distribution channel definitions to software revenue allows us to calculate vendor market share based on a combination of any of the above bulleted items. Typical reporting metrics for market share will be:

- Company software revenue is the sum of revenue from the direct, indirect, OEM, and reseller channels for any given company
- Product software revenue is the sum of revenue from the direct and indirect channels for any given company
- End-user spending is the sum of revenue from the direct, dealer, OEM, and reseller channels for any given company

To avoid double counting the market, market size for company software revenue is the sum of revenue from the direct and indirect channels, and market size for end-user spending is the sum of revenue from the direct and dealer channels. Table 4 and Table 5 provide views of the market, including market share by product software revenue and company software revenue for the entire CAD market. We will be reporting end-user spending in our June market share update.

This reporting scheme means that the sum of vendor revenue (and market shares) will total to more than the sum of the market. We have used similar reporting for European and Asian clients for years, in response to the realities of market requirements. We believe the best way to accurately report market opportunities and positioning worldwide is through this method. Advantages to this approach include:

- We do not double count any total market opportunity, and we will continue to avoid overstating the actual revenue available, which will help our clients make the most reasonable investments.

- The high level of activity of vendors who are active in multiple channels will show up in market share tables, again without double counting revenue. For example, it will be possible to understand the status of Bentley Systems vis-à-vis Intergraph. We can report Bentley's company software revenue, end-user spending for Bentley products (some of which will be sold by Intergraph), Intergraph's sales from Intergraph products, Intergraph reseller sales from Bentley products, and sales made by Intergraph's own dealers. In general, this model will allow us to better detail market contributions by companies with complex business models, such as Fujitsu, IBM, and NEC.

Market Share Methodology

Dataquest uses both primary and secondary sources to produce our market share data. In the fourth quarter of each year and second quarter of the subsequent year, we survey all participants in each industry. Each vendor is offered the opportunity to self-report the information required. Although there is a primary contact for each company, large companies are surveyed across product lines and across geographic regions. Thus, there is a corresponding increase in the number of contacts at large companies. (Dataquest maintains a large contact database on all sources of information.) Examples of the job titles of people contacted for information are the following:

- President and CEO
- Vice president and general manager
- Vice president of marketing
- Vice president, strategic product planning
- Director of strategic planning
- Director of marketing
- Director of market development
- Manager, CAD/CAM/CAE/GIS marketing programs
- Market research analyst

The Audit Process

Data supplied by vendors is evaluated against information drawn from many sources, including the following:

- Revenue published by major industry participants
- Estimates made by knowledgeable and reliable industry spokespersons
- Government data or trade association data
- Published product literature and price lists
- Interviews with knowledgeable manufacturers, distributors, and users
- Relevant economic data
- Information and data from online data banks
- Articles in both the general and trade press

- Annual reports, Securities and Exchange Commission documents, and credit reports
- Company publications and press releases
- Reports from financial analysts
- User studies
- Reseller and supplier reports and reports from a vendor's competitors

Dataquest also sums vendor revenue across other industries covered by Dataquest to make sure that revenue is not credited twice, and checks with multiple sources at one company to cross-check data on that company.

Dataquest analysts have many years of experience in how to apply the tools described to get the most accurate information possible on a particular company (such as what to use when and what industry averages are). We believe that the estimates presented here are the most accurate and meaningful generally available today. It is the CAD/CAM/CAE/GIS group's policy to continually update our market information for any year, based on any new data received, in order to arrive at the most accurate market representation possible.

Dataquest's CAD/CAM/CAE/GIS market numbers are often higher than those reported by other sources. We survey worldwide, which involves more vendors, higher total market revenue, lower market share per vendor, and a more accurate market picture—which is particularly useful when comparing regions or applications.

Reporting Changes

Beginning with our March 4, 1996, publication, we published market share data that reports OEM revenue for all regions. Also, for the first time in the United States our market share tables included companies that resell products from other vendors as well as their own products (these are primarily Japanese companies), and companies that sell products primarily to other vendors (such as Dassault). In the past, this reporting was standard only in our products for Japan, Europe, and Asia/Pacific. We believe that this reporting accurately reflects the activity of all the vendors in the CAD/CAM/CAE and GIS market. To prevent double counting of the market, we will continue to count the total market size by excluding OEM and reseller revenue. As a result, the sum of the individual software vendors will be greater than the total market size in all market share tables. On an inquiry basis, we can produce market share tables that exclude OEM revenue, or report only OEM revenue.

These reporting changes primarily reflect our efforts to both accurately depict markets while accounting for revenue by distribution channel. Dataquest's CAD/CAM/CAE/GIS database was first developed in the turnkey era of CAD/CAM, when channel reporting was relatively unimportant. Today, of course, worldwide distribution and PC-based products require us to better report revenue by channel. While our existing database does account for much of this information, we believe improvements are necessary.

Table 4
Top Product Software Revenue, Software Companies, Worldwide, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	Growth (%)	Market Share (%) 1996
1	IBM	358.4	461.4	540.4	17.1	7.6
2	Parametric Technology	206.5	321.2	495.0	54.1	6.9
3	Autodesk	438.6	511.3	482.5	-5.6	6.8
4	Cadence	202.7	262.9	342.2	30.2	4.8
5	Intergraph	318.4	295.6	281.3	-4.8	3.9
6	Synopsys	142.7	193.5	245.1	26.7	3.4
7	Mentor Graphics	175.9	183.3	207.9	13.5	2.9
8	Computervision	163.1	163.7	194.9	19.1	2.7
9	EDS Unigraphics	135.1	152.9	190.6	24.7	2.7
10	Fujitsu	135.1	151.4	160.5	6.0	2.3
11	MicroCADAM	91.7	129.2	152.0	17.6	2.1
12	Structural Dynamics Research Corporation	115.4	131.2	148.0	12.8	2.1
13	ESRI	109.4	124.1	133.9	7.9	1.9
14	Hewlett-Packard	108.9	114.9	128.3	11.6	1.8
15	NEC	103.4	109.9	128.1	16.6	1.8
16	MacNeal-Schwendler	93.6	117.6	120.2	2.3	1.7
17	Bentley Systems	4.2	81.3	107.0	31.6	1.5
18	Hitachi	88.9	94.5	105.1	11.2	1.5
19	Landmark Graphics	72.5	89.9	98.3	9.3	1.4
20	Matra Datavision	75.6	87.4	93.9	7.4	1.3
21	Quickturn Design Systems	59.0	70.7	90.3	27.6	1.3
22	Zuken-Redac	67.7	72.4	88.2	21.8	1.2
23	Avant!	29.2	47.9	80.3	67.9	1.1
24	Nihon Unisys	69.9	77.1	79.3	3.0	1.1
25	Toshiba	78.1	88.5	78.0	-11.9	1.1
	All North American Companies	3,833.5	4,646.6	5,387.3	15.9	75.6
	All European Companies	674.3	781.5	815.6	4.4	11.4
	All Asian Companies	789.8	879.4	921.0	4.7	12.9
	All Companies	5,297.6	6,307.5	7,123.9	12.9	100.0

Source: Dataquest (February 1997)

Table 5
Top Company Software Revenue, Software Companies, Worldwide, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company Name	1994	1995	1996	Growth (%)	Market Share (%) 1996
1	IBM	411.5	527.6	619.2	17.3	8.7
2	Parametric Technology	209.8	321.2	495.0	54.1	6.9
3	Autodesk	438.9	516.4	487.2	-5.7	6.8
4	Cadence	205.7	267.0	347.9	30.3	4.9
5	Intergraph	318.4	345.8	334.8	-3.2	4.7
6	Synopsys	142.7	193.5	245.1	26.7	3.4
7	Dassault	157.1	194.5	233.2	19.9	3.3
8	Fujitsu	182.1	210.8	225.0	6.7	3.2
9	Mentor Graphics	175.9	185.0	210.2	13.6	3.0
10	Computervision	163.1	163.7	194.9	19.1	2.7
11	EDS Unigraphics	138.2	156.2	194.3	24.4	2.7
12	MicroCADAM	91.7	129.2	152.0	17.7	2.1
13	Structural Dynamics Research Corporation	115.4	131.2	148.0	12.8	2.1
14	ESRI	109.4	124.1	133.9	7.9	1.9
15	Hewlett-Packard	108.9	114.9	128.3	11.6	1.8
16	NEC	103.4	109.9	128.1	16.6	1.8
17	MacNeal-Schwendler	93.6	117.6	120.2	2.3	1.7
18	Info. Services Int'l. Dentsu*	66.0	85.2	117.2	37.6	1.6
19	Bentley Systems	26.0	81.2	107.0	31.7	1.5
20	Hitachi	88.9	94.5	105.1	11.2	1.5
21	Landmark Graphics	72.5	89.9	98.3	9.3	1.4
22	Matra Datavision	75.6	87.4	93.9	7.4	1.3
23	Quickturn Design Systems	59.0	70.7	90.3	27.6	1.3
24	Zuken-Redac	67.7	72.4	88.2	21.8	1.2
25	Toshiba*	78.1	97.3	85.7	-11.9	1.2
	All North American Companies	3,833.5	4,646.6	5,387.3	15.9	75.6
	All European Companies	674.3	781.5	815.6	4.4	11.4
	All Asian Companies	789.8	879.4	921.0	4.7	12.9
	All Companies	5,297.6	6,307.5	7,123.9	12.9	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (February 1997)

A Final Note

The tables we choose to publish in statistics books are those we believe useful for the greatest number of clients. However, given the rich dynamics in distribution channels, it is not possible to understand the full opportunity from a single viewpoint. On request, we are happy to deliver alternative views of the market, as detailed tables—we do prefer to deliver these as Excel workbooks via e-mail. Any client needing an electronic version of our market statistics should contact Daya Nadamuni via e-mail at daya.nadamuni@dataquest.com. Our ongoing commitment is to maintain an accurate and complete model of the entire CAD/CAM/CAE/GIS market, worldwide, and we welcome your input.

Publishing Schedule

We publish market share and forecasting twice each year for each, allowing for both timely distribution of data and thorough analysis and forecasting. Our annual delivery schedule is as follows:

- Market share 1996 is presented in this report.
- A five-year forecast for CAD/CAM/CAE/GIS will be available to clients by March 31.
- Final updated market share tables, based on additional data collection and analysis, will be available to clients by June 30. At this time we will finalize our 1996 market share data, including country-level data, end-user spending, industry-level data, and subapplication information. At this point, the market share database is frozen and will not be changed until the end of the year. For the next six months, supplementary market data will be based on this final market data.
- We will provide complete final forecast tables by September 30. These tables take into consideration changes in the market share during the previous six months.

Table A-1
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Worldwide, All Operating Systems

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	IBM	368.3	491.5	580.2	18.0	17.0
2	Parametric Technology	209.8	321.2	495.0	54.1	14.5
3	Dassault	154.2	190.6	228.6	19.9	6.7
4	Autodesk	176.0	210.2	204.9	-2.5	6.0
5	EDS Unigraphics	138.2	156.2	194.3	24.4	5.7
6	Computervision	148.2	149.1	177.4	19.0	5.2
7	MicroCADAM	91.7	129.2	152.0	17.7	4.4
8	Structural Dynamics Research Corporation	115.4	131.2	148.0	12.8	4.3
9	Info. Services Int'l. Dentsu*	66.0	85.2	117.2	37.6	3.4
10	MacNeal-Schwendler	90.8	114.0	116.6	2.3	3.4
11	Fujitsu	83.7	97.0	107.3	10.7	3.1
12	Matra Datavision	75.6	87.4	93.9	7.4	2.7
13	Hewlett-Packard	74.5	79.0	90.2	14.2	2.6
14	NEC	61.7	72.9	87.7	20.2	2.6
15	Hitachi	66.7	70.9	79.9	12.7	2.3
16	Toshiba*	54.5	66.7	62.5	-6.3	1.8
17	Nihon Unisys	48.1	52.8	54.4	3.0	1.6
18	Intergraph	61.1	54.0	50.2	-7.0	1.5
19	Ansys	32.5	37.4	44.3	18.5	1.3
20	Hitachi Zosen Info Systems	34.5	38.7	39.7	2.5	1.2
21	C. Itoh Techno-Science*	34.6	30.8	34.4	11.7	1.0
22	Hakuto*	23.6	29.8	34.0	14.0	1.0
23	ISD Software	10.5	14.5	28.2	94.4	0.8
24	Tecnomatix Technology	13.0	20.1	26.3	31.1	0.8
25	Sherpa Corp.	18.8	20.6	26.2	27.2	0.8
26	Marubeni Hytech*	18.3	19.9	23.0	15.3	0.7
27	Delcam International	11.6	16.7	21.8	30.9	0.6
28	Applicon	19.3	21.5	21.8	1.3	0.6
29	Sumisho Electronics*	18.4	18.8	21.6	14.5	0.6
30	ADRA Systems	18.0	19.0	21.1	11.2	0.6
	All North American Companies	1,723.3	2,142.1	2,557.8	19.4	74.8
	All European Companies	288.2	334.0	347.2	3.9	10.1
	All Asian Companies	428.4	481.5	515.6	7.1	15.1
	All Companies	2,439.9	2,957.6	3,420.5	15.7	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (February 1997)

Table A-2
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Worldwide, UNIX

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	IBM	278.3	402.7	509.7	26.6	20.8
2	Parametric Technology	188.9	269.8	386.1	43.1	15.8
3	Dassault	115.5	146.4	201.1	37.4	8.2
4	EDS Unigraphics	138.2	156.2	175.1	12.1	7.2
5	Computervision	141.3	142.5	169.5	18.9	6.9
6	Structural Dynamics Research Corporation	109.4	123.0	141.0	14.7	5.8
7	Info. Services Int'l. Dentsu*	62.7	80.9	111.3	37.6	4.5
8	MacNeal-Schwendler	59.9	86.6	85.9	-0.8	3.5
9	Matra Datavision	74.0	75.5	81.0	7.3	3.3
10	Fujitsu	56.1	65.0	72.7	11.9	3.0
11	Hitachi	53.9	57.3	66.1	15.3	2.7
12	Hewlett-Packard	69.7	59.3	65.6	10.7	2.7
13	Nihon Unisys	43.8	51.8	53.6	3.5	2.2
14	NEC	42.0	43.7	50.4	15.3	2.1
15	MicroCADAM	36.7	51.7	45.6	-11.8	1.9
16	Toshiba*	39.6	50.0	42.5	-15.0	1.7
17	Hitachi Zosen Info Systems	34.5	38.7	38.9	0.4	1.6
18	Ansys	22.1	28.1	33.3	18.7	1.4
19	C. Itoh Techno-Science*	30.9	28.4	32.7	15.3	1.3
20	Intergraph	37.9	52.2	32.7	-37.5	1.3
21	Tecnomatix Technology	13.0	20.1	26.3	31.1	1.1
22	Sherpa Corp.	18.8	20.4	26.0	27.3	1.1
23	Marubeni Hytech*	18.3	19.9	23.0	15.3	0.9
24	Delcam International	11.0	16.0	21.2	32.2	0.9
25	Hakuto*	14.1	17.9	20.6	15.3	0.8
26	Tokyo Electron*	16.0	17.4	20.0	15.3	0.8
27	Seiko*	18.0	19.7	19.0	-3.5	0.8
28	MARC	15.5	18.2	19.0	4.5	0.8
29	Applicon	18.7	17.3	17.2	-0.5	0.7
30	ICEM Technologies	10.9	15.3	17.0	11.5	0.7
	All North American Companies	1,251.5	1,565.3	1,847.7	18.0	75.5
	All European Companies	205.2	227.7	216.5	-4.9	8.8
	All Asian Companies	341.7	374.5	384.3	2.6	15.7
	All Companies	1,798.4	2,167.5	2,448.5	13.0	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (February 1997)

Table A-3
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Worldwide, NT/Hybrid

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	Parametric Technology	20.6	51.4	108.9	111.9	39.7
2	EDS Unigraphics	-	-	19.2	NA	7.0
3	MicroCADAM	4.6	6.4	18.2	182.8	6.6
4	Intergraph	13.6	1.8	17.6	899.5	6.4
5	ISD Software	-	-	15.3	NA	5.6
6	NEC	-	5.2	10.4	100.0	3.8
7	Matra Datavision	-	9.6	10.3	6.8	3.8
8	Bentley Systems	1.5	4.6	6.8	47.2	2.5
9	SolidWorks Corporation	-	-	6.3	NA	2.3
10	Autodesk	-	-	6.1	NA	2.2
11	Toshiba Engineering*	-	-	5.8	NA	2.1
12	Omron	-	5.8	5.8	-0.6	2.1
13	Ansys	-	4.5	5.7	27.5	2.1
14	Hewlett-Packard	-	3.2	5.6	72.4	2.0
15	Wacom	-	4.9	5.5	12.8	2.0
16	Structural Dynamics Research Corporation	-	4.8	5.1	6.5	1.9
17	CAD Distribution	0.1	3.5	4.8	37.5	1.7
18	Mutoh Industries*	2.5	2.3	4.7	100.0	1.7
19	Spatial Technology	2.5	2.1	3.6	70.9	1.3
20	Graphtec Engineering	-	-	2.6	NA	0.9
21	BCT GMBH	-	0.4	2.5	500.6	0.9
22	DP Technology	-	1.0	1.9	96.1	0.7
23	3D/Eye Inc.	-	-	1.8	NA	0.6
24	CAD Lab	-	0.7	1.6	129.0	0.6
25	MCS	-	1.4	1.5	7.5	0.5
26	MacNeal-Schwendler	-	1.1	1.3	18.0	0.5
27	Mechanical Dynamics	-	-	1.2	NA	0.5
28	MARC	-	-	1.2	NA	0.4
29	B.A. Intelligence Networks	-	0.7	1.2	75.4	0.4
30	CGTech	0.6	1.0	1.1	14.2	0.4
	All North American Companies	39.9	83.1	208.9	151.4	76.1
	All European Companies	1.5	15.7	36.9	135.6	13.5
	All Asian Companies	-	15.9	28.5	79.4	10.4
	All Companies	41.4	114.6	274.3	139.3	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
NA = Not applicable
Source: Dataquest (February 1997)

Table A-4
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Worldwide, Personal Computer

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	Autodesk	165.6	199.6	193.8	-2.9	32.4
2	MicroCADAM	50.4	71.1	88.2	24.1	14.7
3	NEC	19.7	24.0	26.9	12.0	4.5
4	Fujitsu	20.9	24.2	26.9	11.0	4.5
5	Toshiba*	14.9	16.7	20.0	20.0	3.3
6	Hewlett-Packard	4.9	16.5	19.0	15.3	3.2
7	Andor*	17.6	15.9	17.8	12.0	3.0
8	Hakuto*	9.4	11.9	13.4	12.0	2.2
9	Cimatron	5.1	9.3	12.5	33.7	2.1
10	Hitachi	9.6	10.2	11.4	12.0	1.9
11	Design Automation	7.0	11.6	11.2	-3.0	1.9
12	Investronica SA	10.6	11.1	10.6	-3.8	1.8
13	Tebis	5.1	8.0	8.9	11.1	1.5
14	CNC Software	7.6	8.4	8.7	3.7	1.4
15	Wiechers Datentechnik	8.2	7.6	8.3	9.6	1.4
16	MCS	9.0	7.5	8.1	8.3	1.3
17	Computervision	6.9	6.6	7.8	19.0	1.3
18	CADKEY	6.8	7.5	7.2	-3.9	1.2
19	Bentley Systems	2.1	6.6	6.4	-2.7	1.1
20	Formtek	5.2	5.7	6.2	8.7	1.0
21	Algor Interactive Systems	4.1	6.0	6.1	1.4	1.0
22	CAD Lab	3.4	5.4	5.9	9.3	1.0
23	Ashlar	5.8	5.7	5.9	4.2	1.0
24	Info. Services Int'l. Dentsu*	3.3	4.3	5.9	37.6	1.0
25	Serbi	5.0	5.9	5.6	-4.1	0.9
26	Viagrafix	5.5	5.6	5.4	-2.5	0.9
27	Surfware	2.7	5.0	5.4	8.1	0.9
28	ADRA Systems	5.1	5.1	5.4	4.8	0.9
29	PAFEC	1.3	2.4	5.2	115.3	0.9
30	Sumisho Electronics*	5.2	4.6	5.1	12.0	0.9
	All North American Companies	319.5	391.6	414.8	5.9	69.3
	All European Companies	77.7	87.6	91.5	4.5	15.3
	All Asian Companies	72.1	79.2	92.1	16.2	15.4
	All Companies	469.3	558.4	598.4	7.2	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (February 1997)

Table A-5
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Worldwide Host/Proprietary

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	IBM	90.0	88.8	70.5	-20.6	71.0
2	Dassault	38.7	44.2	27.4	-38.0	27.6
3	MacNeal-Schwendler	30.9	25.1	25.6	2.1	25.8
4	Fujitsu	6.7	7.8	7.7	-0.8	7.7
5	Hitachi	3.1	3.3	2.3	-30.0	2.3
6	Mechanical Dynamics	2.1	1.9	1.7	-9.0	1.7
7	C. Itoh Techno-Science*	3.6	2.4	1.7	-30.0	1.7
8	Ansys	3.3	1.5	1.3	-14.7	1.3
9	Exapt	6.1	4.5	1.3	-71.8	1.3
10	Mitsubishi Electric*	1.5	1.2	0.9	-30.0	0.9
11	Nihon Unisys	4.3	1.1	0.8	-22.3	0.8
12	Toyo Information Systems*	0.9	0.8	0.6	-30.0	0.6
13	Kubota Computer	0.9	0.8	0.5	-33.1	0.5
14	Whessoe Computing Systems	0.6	0.5	0.4	-17.3	0.4
15	Computational Mechanics	0.5	0.5	0.4	-32.5	0.4
16	debis Systemhaus	0.2	0.2	0.3	11.0	0.3
17	Sherpa Corporation	-	0.2	0.2	18.8	0.2
18	Century Research Center	0.4	0.3	0.2	-30.0	0.2
19	Altair Computing	-	-	0.2	NA	0.2
20	Access Corp.	0.5	0.4	0.2	-49.8	0.2
21	Framasoft	0.4	0.4	0.2	-62.4	0.2
22	CIMTEK	0.2	0.1	0.1	-8.4	0.1
23	Cimtel	0	0	0	-16.4	0
24	Technodia*	0	0	0	-30.0	0
25	First Cadcam Inc.	0.4	0.3	-	-100.0	-
	All North American Companies	112.4	102.1	86.4	-15.4	87.0
	All European Companies	3.9	3.1	2.3	-25.0	2.3
	All Asian Companies	14.5	11.9	10.6	-10.4	10.7
	All Companies	130.8	117.1	99.3	-15.1	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
NA = Not applicable
Source: Dataquest (February 1997)

Table A-6
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, North America, All Operating Systems

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	Parametric Technology	114.7	160.6	217.8	35.6	22.4
2	EDS Unigraphics	91.2	95.3	116.6	22.4	12.0
3	IBM	86.4	93.4	106.8	14.3	11.0
4	Autodesk	83.6	81.5	75.9	-6.8	7.8
5	Structural Dynamics Research Corporation	52.0	60.2	68.4	13.5	7.0
6	Dassault	43.2	47.6	61.7	29.5	6.3
7	MacNeal-Schwendler	48.3	50.0	50.2	0.2	5.1
8	Computervision	30.8	28.6	34.0	19.0	3.5
9	Intergraph	33.1	24.8	22.6	-9.0	2.3
10	Hewlett-Packard	11.2	11.9	21.2	78.9	2.2
11	Ansys	17.2	17.3	20.8	20.6	2.1
12	Sherpa Corporation	10.3	13.4	15.7	17.2	1.6
13	MicroCADAM	5.0	9.0	10.6	17.6	1.1
14	Concentra	8.1	8.0	10.5	31.5	1.1
15	Formtek	9.2	10.0	10.5	4.7	1.1
16	Algor Interactive Systems	6.5	9.7	10.4	7.3	1.1
17	Alias Research	7.9	8.6	9.7	13.0	1.0
18	Gerber Systems	7.1	8.3	9.4	13.0	1.0
19	MCS	8.3	8.6	9.2	7.6	0.9
20	ADRA Systems	9.4	8.1	8.9	10.4	0.9
21	Applicon	8.8	8.3	8.8	5.5	0.9
22	Tecnomatix Technology	6.8	7.4	8.6	16.5	0.9
23	Altair Computing	4.3	6.0	8.3	38.3	0.9
24	Deneb Robotics	5.6	6.5	7.3	13.0	0.8
25	Mechanical Dynamics	6.3	4.7	6.2	32.2	0.6
26	CADKEY	5.4	5.8	6.0	3.5	0.6
27	CGTech	3.0	5.5	5.8	5.9	0.6
28	CNC Software	5.1	5.6	5.8	3.5	0.6
29	Bentley Systems	1.8	5.5	5.4	-1.5	0.6
30	SolidWorks Corporation	-	-	5.2	NA	0.5
	All North American Companies	718.6	805.5	950.4	18.0	97.5
	All European Companies	14.8	18.6	22.3	20.2	2.3
	All Asian Companies	1.2	1.6	1.8	8.1	0.2
	All Companies	734.6	825.7	974.5	18.0	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
NA = Not applicable
Source: Dataquest (February 1997)

Table A-7
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, North America, UNIX

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	Parametric Technology	103.3	134.9	169.9	25.9	24.2
2	EDS Unigraphics	91.2	95.3	105.0	10.2	14.9
3	IBM	56.0	75.7	94.3	24.6	13.4
4	Structural Dynamics Research Corporation	48.1	55.1	65.1	18.1	9.3
5	Dassault	32.3	36.6	54.3	48.4	7.7
6	MacNeal-Schwendler	31.9	38.0	36.9	-2.7	5.3
7	Computervision	29.2	27.3	32.5	18.9	4.6
8	Ansys	11.7	12.9	15.7	20.9	2.2
9	Sherpa Corporation	10.3	13.3	15.6	17.3	2.2
10	Hewlett-Packard	10.4	8.9	15.4	73.4	2.2
11	Intergraph	20.6	24.0	14.7	-38.8	2.1
12	Concentra	8.1	8.0	10.5	31.5	1.5
13	Alias Research	7.9	8.6	9.7	13.0	1.4
14	Gerber Systems	7.1	8.3	9.4	13.0	1.3
15	Tecnomatix Technology	6.8	7.4	8.6	16.5	1.2
16	Altair Computing	4.2	5.9	7.9	34.1	1.1
17	Formtek	6.4	7.0	7.4	4.7	1.0
18	Deneb Robotics	5.6	6.5	7.3	13.0	1.0
19	Applicon	8.5	6.6	6.9	4.9	1.0
20	ADRA Systems	6.8	5.9	6.7	13.0	0.9
21	ICEM Technologies	3.8	4.5	5.1	13.0	0.7
22	Mechanical Dynamics	5.1	3.8	4.8	25.7	0.7
23	Algor Interactive Systems	2.6	3.9	4.4	13.0	0.6
24	Matra Datavision	5.2	3.8	4.1	7.3	0.6
25	Delcam International	1.8	3.2	4.0	25.6	0.6
26	CGTech	2.1	3.9	4.0	4.4	0.6
27	CIMLINC	2.6	3.4	3.9	13.0	0.6
28	Spatial Technology	2.8	2.4	3.4	42.4	0.5
29	Cadis Software	0.4	1.1	3.3	205.6	0.5
30	MCS	2.5	3.0	3.2	6.9	0.5
	All North American Companies	508.2	591.1	684.1	15.7	97.3
	All European Companies	11.8	14.7	17.1	16.5	2.4
	All Asian Companies	1.0	1.4	1.6	13.0	0.2
	All Companies	521.1	607.2	702.9	15.8	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (February 1997)

Table A-8
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, North America, NT/Hybrid

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	Parametric Technology	11.2	25.7	47.9	86.5	52.4
2	EDS Unigraphics	-	-	11.5	NA	12.6
3	Intergraph	7.3	0.8	7.9	874.0	8.6
4	SolidWorks Corporation	-	-	4.7	NA	5.1
5	Ansys	-	2.1	2.7	29.7	2.9
6	Bentley Systems	0.7	2.1	2.6	27.0	2.9
7	Structural Dynamics Research Corporation	-	3.0	2.3	-20.9	2.6
8	Autodesk	-	-	2.3	NA	2.5
9	Spatial Technology	1.5	1.3	1.8	42.4	2.0
10	3D/Eye Inc.	-	-	1.8	NA	1.9
11	DP Technology	-	0.8	1.5	100.0	1.7
12	Hewlett-Packard	-	0.5	1.3	170.1	1.4
13	MicroCADAM	0.3	0.5	1.3	182.4	1.4
14	MCS	-	0.9	0.9	6.9	1.0
15	CGTech	0.3	0.6	0.6	16.5	0.7
16	MacNeal-Schwendler	-	0.5	0.6	15.1	0.6
17	Matra Datavision	-	0.5	0.5	6.8	0.6
18	Mechanical Dynamics	-	-	0.5	NA	0.5
19	NOVASOFT Systems	-	0.2	0.5	100.0	0.5
20	B.A. Intelligence Networks	-	0.2	0.4	100.0	0.5
21	SRAC	-	0.4	0.4	-6.8	0.4
22	MARC	-	-	0.2	NA	0.2
23	CIMLINC	-	0.1	0.2	100.0	0.2
24	CONSENS	-	0.1	0.2	60.0	0.2
25	Delcam International	-	-	0.1	NA	0.1
26	Altair Computing	-	-	0.1	NA	0.1
27	Research Engineers—Civilsoft	0	0.1	0.1	39.8	0.1
28	ISD Software	-	-	0	NA	0
	All North American Companies	19.4	38.2	90.8	137.5	99.3
	All European Companies	0.1	0.5	0.7	37.2	0.7
	All Asian Companies	-	-	-	NA	-
	All Companies	19.5	38.7	91.4	136.2	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
NA = Not applicable
Source: Dataquest (February 1997)

Table A-9
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, North America, Personal Computer

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	Autodesk	78.6	76.6	71.4	-6.8	45.4
2	MicroCADAM	2.8	5.0	6.2	24.1	3.9
3	Algor Interactive Systems	3.9	5.8	6.0	3.5	3.8
4	CADKEY	5.4	5.8	6.0	3.5	3.8
5	CNC Software	5.1	5.6	5.8	3.5	3.7
6	Viagrafix	4.9	5.0	5.1	3.5	3.3
7	MCS	5.8	4.7	5.1	8.3	3.2
8	Hewlett-Packard	0.7	2.5	4.5	80.6	2.8
9	Surfware	1.9	3.6	3.8	6.5	2.4
10	Formtek	2.8	3.0	3.2	4.7	2.0
11	Ashlar	3.5	3.0	3.1	4.2	2.0
12	Gibbs and Associates	1.9	2.2	2.5	13.6	1.6
13	Bentley Systems	1.0	3.0	2.5	-16.1	1.6
14	ADRA Systems	2.7	2.2	2.3	3.5	1.4
15	SRAC	1.5	1.5	2.2	42.9	1.4
16	DP Technology	1.6	1.9	2.0	3.5	1.3
17	Pathtrace Engineering Systems	1.4	1.5	2.0	30.8	1.2
18	Workgroup Tech.	-	1.8	1.9	3.5	1.2
19	Ansys	3.8	1.6	1.9	20.9	1.2
20	Applicon	0.3	1.7	1.8	8.3	1.2
21	3D/Eye Inc.	-	-	1.8	NA	1.1
22	MacNeal-Schwendler	-	0.6	1.6	193.8	1.0
23	Cimatron	0.5	0.9	1.6	73.8	1.0
24	Computervision	1.5	1.3	1.5	19.0	1.0
25	Variation Systems Analysis	1.1	1.3	1.3	3.5	0.8
26	CGTech	0.6	1.1	1.2	5.9	0.7
27	Engineering Mechanics	3.0	1.0	1.1	3.5	0.7
28	GRAPHSOFT	0.7	1.0	1.1	4.2	0.7
29	Boothroyd Dewhurst	0.9	1.0	1.0	-1.4	0.6
30	NOVASOFT Systems	0.1	1.0	1.0	3.5	0.6
	All North American Companies	145.6	148.6	152.7	2.8	97.2
	All European Companies	2.7	3.2	4.4	38.3	2.8
	All Asian Companies	0.1	0.1	0.1	3.5	0
	All Companies	148.3	151.8	157.1	3.5	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
NA = Not applicable
Source: Dataquest (February 1997)

Table A-10
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, North America, Host/Proprietary

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	IBM	30.4	17.8	12.5	-29.6	54.2
2	MacNeal-Schwendler	16.4	11.0	11.0	0.1	47.7
3	Dassault	10.8	11.1	7.4	-33.0	32.1
4	Mechanical Dynamics	0.9	0.7	0.7	-3.1	3.0
5	Ansys	1.7	0.7	0.6	-13.1	2.6
6	Access Corporation	0.4	0.4	0.2	-50.0	0.8
7	Altair Computing	-	-	0.2	NA	0.7
8	Sherpa Corporation	-	0.1	0.1	9.5	0.6
9	Computational Mechanics	0.2	0.2	0.1	-50.0	0.4
10	Kubota Computer	0.1	0.1	0.1	-50.0	0.3
11	debis Systemhaus	-	-	0	NA	0
12	Exapt	2.0	1.5	-	-100.0	-
13	First Cadcam Inc.	0.3	0.3	-	-100.0	-
	All North American Companies	45.4	27.7	22.9	-17.3	99.2
	All European Companies	0.2	0.2	0.1	-42.1	0.5
	All Asian Companies	0.1	0.1	0.1	-50.0	0.3
	All Companies	45.7	28.0	23.1	-17.6	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
NA = Not applicable
Source: Dataquest (February 1997)

Table A-11
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Europe, All Operating Systems

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	IBM	165.9	249.5	298.4	19.6	24.6
2	Parametric Technology	68.3	109.2	173.3	58.6	14.3
3	Dassault	86.3	110.5	132.6	19.9	10.9
4	Computervision	90.9	100.1	119.1	19.0	9.8
5	Autodesk	59.9	81.3	77.9	-4.2	6.4
6	Matra Datavision	63.5	70.0	75.2	7.4	6.2
7	EDS Unigraphics	35.9	46.9	58.3	24.4	4.8
8	Structural Dynamics Research Corporation	29.8	35.8	38.5	7.5	3.2
9	Hewlett-Packard	37.3	43.5	33.4	-23.2	2.8
10	MacNeal-Schwendler	18.4	32.0	32.0	0.2	2.6
11	ISD Software	10.5	14.5	28.1	94.3	2.3
12	Intergraph	21.2	19.7	18.8	-4.4	1.6
13	ASCAD	12.1	14.9	16.4	10.6	1.4
14	Tecnomatix Technology	5.7	11.6	16.3	40.1	1.3
15	CAD Lab	11.4	13.6	15.3	12.5	1.3
16	Tebis	5.2	12.5	14.0	12.3	1.2
17	Ansys	8.5	11.9	13.8	15.3	1.1
18	MicroCADAM	7.3	10.3	12.2	17.6	1.0
19	Applicon	9.7	12.4	12.1	-1.9	1.0
20	ICEM Technologies	6.2	9.8	10.9	11.7	0.9
21	Sherpa Corp.	8.4	7.2	10.5	45.7	0.9
22	Straessle Informationssysteme	15.6	12.0	10.3	-14.2	0.8
23	Delcam International	5.6	7.7	9.6	25.2	0.8
24	Wiechers Datentechnik	8.9	8.3	8.9	7.4	0.7
25	Investronica SA	5.7	6.0	8.6	43.8	0.7
26	Radan Computational	8.2	7.6	8.0	4.5	0.7
27	ADRA Systems	4.4	6.8	7.5	9.4	0.6
28	BCT GMBH	3.0	4.2	7.2	71.6	0.6
29	Bentley Systems	1.8	5.6	6.9	23.1	0.6
30	PROCAD GmbH	3.5	5.8	6.5	12.8	0.5
	All North American Companies	587.0	794.1	930.2	17.1	76.7
	All European Companies	246.0	271.6	282.5	4.0	23.3
	All Asian Companies	-	-	-	NA	-
	All Companies	832.9	1,065.7	1,212.8	13.8	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
NA = Not applicable
Source: Dataquest (February 1997)

Table A-12
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Europe, UNIX

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	IBM	132.5	206.0	263.8	28.1	29.7
2	Parametric Technology	61.5	91.7	135.1	47.3	15.2
3	Dassault	64.7	84.9	116.7	37.4	13.1
4	Computervision	86.4	95.7	113.8	18.9	12.8
5	Matra Datavision	62.1	60.4	64.8	7.3	7.3
6	EDS Unigraphics	35.9	46.9	52.5	12.1	5.9
7	Structural Dynamics Research Corporation	29.2	34.2	36.7	7.3	4.1
8	Hewlett-Packard	34.8	32.6	24.3	-25.5	2.7
9	MacNeal-Schwendler	12.2	24.3	23.6	-2.8	2.7
10	Tecnomatix Technology	5.7	11.6	16.3	40.1	1.8
11	ASCAD	11.5	12.8	14.1	10.5	1.6
12	Intergraph	13.0	19.1	12.3	-35.7	1.4
13	ICEM Technologies	6.2	9.8	10.9	11.7	1.2
14	Sherpa Corporation	8.4	7.1	10.4	45.8	1.2
15	Ansys	5.8	9.0	10.4	15.6	1.2
16	Straessle Informationssysteme	15.6	12.0	10.3	-14.2	1.2
17	Applicon	9.5	10.0	9.6	-4.3	1.1
18	Delcam International	5.3	7.4	9.3	26.5	1.0
19	ISD Software	7.5	10.4	8.8	-15.6	1.0
20	Radan Computational	7.9	7.5	7.9	4.7	0.9
21	CAD Lab	8.0	7.5	7.9	5.3	0.9
22	Han Dataport	7.1	7.8	6.5	-17.4	0.7
23	Eigner + Partner	5.4	6.3	6.1	-3.2	0.7
24	MARC	3.8	4.5	5.7	27.2	0.6
25	PROCAD GmbH	3.1	5.2	5.7	9.9	0.6
26	ADRA Systems	3.2	5.0	5.6	12.4	0.6
27	Tebis	0.5	4.6	5.3	14.4	0.6
28	Mechanical Dynamics	3.1	3.0	4.1	34.1	0.5
29	Concentra	3.3	3.4	4.0	16.4	0.4
30	MicroCADAM	2.9	4.1	3.6	-11.8	0.4
	All North American Companies	455.8	608.0	717.4	18.0	80.6
	All European Companies	177.1	185.5	172.5	-7.0	19.4
	All Asian Companies	-	-	-	NA	-
	All Companies	633.0	793.5	889.9	12.1	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
NA = Not applicable
Source: Dataquest (February 1997)

Table A-13
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Europe, NT/Hybrid

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	Parametric Technology	6.8	17.5	38.1	118.1	38.4
2	ISD Software	-	-	15.3	NA	15.4
3	Matra Datavision	-	7.7	8.2	6.8	8.3
4	Intergraph	4.8	0.6	6.6	930.2	6.6
5	EDS Unigraphics	-	-	5.8	NA	5.8
6	CAD Distribution	0.1	3.5	4.8	37.5	4.8
7	Bentley Systems	0.7	2.1	3.4	58.7	3.4
8	BCT GMBH	-	0.4	2.5	500.6	2.5
9	Autodesk	-	-	2.3	NA	2.4
10	Hewlett-Packard	-	1.8	2.1	16.0	2.1
11	Ansys	-	1.4	1.8	24.0	1.8
12	CAD Lab	-	0.7	1.5	126.7	1.6
13	MicroCADAM	0.4	0.5	1.5	182.4	1.5
14	Structural Dynamics Research Corporation	-	1.0	1.3	38.1	1.3
15	ASCAD	-	0.9	1.0	14.1	1.0
16	Spatial Technology	0.5	0.4	0.9	113.7	0.9
17	SolidWorks Corporation	-	-	0.9	NA	0.9
18	PROCAD GmbH	0.3	0.6	0.8	39.0	0.8
19	B.A. Intelligence Networks	-	0.3	0.4	36.0	0.4
20	Mechanical Dynamics	-	-	0.4	NA	0.4
21	MacNeal-Schwendler	-	0.3	0.4	15.0	0.4
22	MARC	-	-	0.4	NA	0.4
23	MCS	-	0.3	0.3	6.9	0.3
24	Delcam International	-	-	0.3	NA	0.3
25	CGTech	0.2	0.2	0.2	20.1	0.2
26	DP Technology	-	0.1	0.1	40.7	0.1
27	SRAC	-	0.2	0.1	-34.4	0.1
28	CIMLINC	-	0	0	36.3	0
29	Research Engineers—Civilsoft	-	0	0	1298.0	0
30	NOVASOFT Systems	-	0.1	-	-100.0	-
	All North American Companies	12.2	26.4	64.7	145.6	65.3
	All European Companies	0.8	13.7	34.5	150.7	34.7
	All Asian Companies	-	-	-	NA	-
	All Companies	13.0	40.1	99.2	147.3	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
NA = Not applicable
Source: Dataquest (February 1997)

Table A-14
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Europe, Personal Computer

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	Autodesk	56.3	78.2	74.1	-5.2	40.0
2	Tebis	4.7	7.9	8.8	11.1	4.7
3	Investronica SA	5.7	6.0	8.6	43.8	4.6
4	Wiechers Datentechnik	8.1	7.5	8.1	7.4	4.4
5	MicroCADAM	4.0	5.7	7.1	24.1	3.8
6	Hewlett-Packard	2.4	9.1	7.0	-22.4	3.8
7	CAD Lab	3.4	5.4	5.9	8.2	3.2
8	Serbi	5.0	5.9	5.6	-4.1	3.0
9	Computervision	4.5	4.4	5.2	19.0	2.8
10	BCT GMBH	3.0	3.8	4.7	23.9	2.5
11	ISD Software	3.0	4.0	4.0	-0.1	2.2
12	Cimatron	1.6	3.4	4.0	18.9	2.2
13	Whessoe Computing Systems	3.5	3.8	3.9	1.8	2.1
14	PAFEC	1.3	-	3.6	NA	2.0
15	Bentley Systems	1.0	3.0	3.2	4.9	1.7
16	Ziegler Informatics	4.9	3.3	3.1	-3.2	1.7
17	Anilam Electronics	2.8	2.6	2.7	3.0	1.5
18	Applicon	0.3	2.4	2.6	8.3	1.4
19	Pathtrace Engineering Systems	1.5	1.6	2.1	31.0	1.1
20	Matra Datavision	1.4	1.8	2.1	15.3	1.1
21	Just In Time Systems	1.9	2.5	2.1	-17.8	1.1
22	ADRA Systems	1.2	1.8	1.9	1.3	1.0
23	Kloeckner-Moeller	1.9	1.7	1.7	0.5	0.9
24	MCS	1.8	1.5	1.6	8.3	0.9
25	RoboCAD Solutions	2.2	1.9	1.6	-14.5	0.9
26	Vero International Software	1.4	1.7	1.6	-8.1	0.9
27	Formtek	1.2	1.4	1.5	13.2	0.8
28	ABB Industria*	1.3	1.4	1.4	0	0.8
29	ASCAD	0.6	1.2	1.3	10.0	0.7
30	Ansys	1.9	1.1	1.2	15.6	0.7
	All North American Companies	83.3	115.8	111.9	-3.4	60.3
	All European Companies	64.7	69.8	73.6	5.5	39.7
	All Asian Companies	-	-	-	NA	-
	All Companies	148.0	185.6	185.5	0	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
NA = Not applicable
Source: Dataquest (February 1997)

Table A-15
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Europe, Host/Proprietary

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	IBM	33.5	43.6	34.5	-20.7	90.4
2	Dassault	21.7	25.6	15.9	-38.0	41.6
3	MacNeal-Schwendler	6.3	7.0	7.0	0	18.4
4	Exapt	4.0	3.0	1.3	-57.4	3.3
5	Mechanical Dynamics	0.6	0.6	0.6	3.5	1.5
6	Ansys	0.8	0.5	0.4	-16.9	1.0
7	Whessoe Computing Systems	0.4	0.3	0.3	-15.4	0.7
8	debis Systemhaus	0.2	0.2	0.3	6.4	0.7
9	Computational Mechanics	0.2	0.2	0.2	-12.5	0.6
10	Framasoft	0.4	0.4	0.2	-62.8	0.4
11	Sherpa Corporation	-	0.1	0.1	36.1	0.3
12	CIMTEK	0.2	0.1	0.1	-8.4	0.2
13	Cimtel	0	0	0	-16.4	0.1
14	Access Corporation	0	0	0	-44.3	0
15	First Cadcam Inc.	0	0	-	-100.0	-
	All North American Companies	35.6	43.9	36.2	-17.6	94.7
	All European Companies	3.4	2.6	2.0	-22.5	5.3
	All Asian Companies	-	-	-	NA	-
	All Companies	39.0	46.5	38.2	-17.8	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
NA = Not applicable
Source: Dataquest (February 1997)

Table A-16
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Japan, All Operating Systems

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	MicroCADAM	75.2	104.7	123.1	17.6	12.1
2	Info. Services Int'l. Dentsu*	66.0	85.2	117.2	37.6	11.5
3	IBM	76.4	101.3	112.9	11.4	11.1
4	Fujitsu	83.7	97.0	107.3	10.7	10.6
5	NEC	61.7	72.9	87.7	20.2	8.6
6	Hitachi	66.7	70.9	79.9	12.7	7.9
7	Parametric Technology	26.3	41.8	71.1	70.2	7.0
8	Toshiba*	54.5	66.7	62.5	-6.3	6.2
9	Nihon Unisys	48.1	52.8	54.4	3.0	5.4
10	Hitachi Zosen Info Systems	34.2	38.3	39.3	2.5	3.9
11	Hewlett-Packard	22.4	22.9	34.7	51.6	3.4
12	C. Itoh Techno-Science*	34.6	30.8	34.4	11.7	3.4
13	Hakuto*	23.6	29.8	34.0	14.0	3.3
14	Structural Dynamics Research Corporation	25.6	26.7	32.3	20.8	3.2
15	MacNeal-Schwendler	22.3	29.6	31.4	6.1	3.1
16	Marubeni Hytech*	18.3	19.9	23.0	15.3	2.3
17	Autodesk	10.7	20.2	22.0	9.1	2.2
18	Sumisho Electronics*	18.4	18.8	21.6	14.5	2.1
19	Dassault	13.9	19.1	20.6	7.9	2.0
20	Tokyo Electron*	16.0	17.4	20.0	15.3	2.0
21	Seiko*	18.0	19.7	19.0	-3.5	1.9
22	Andor*	17.6	15.9	17.8	12.0	1.8
23	Mutoh Industries*	14.2	13.1	17.0	29.5	1.7
24	Computervision	22.3	13.9	16.5	19.0	1.6
25	Mitsui Engineering	12.9	14.0	16.1	15.2	1.6
26	Design Automation	6.1	10.0	11.2	12.0	1.1
27	Toshiba Engineering*	10.9	11.6	11.1	-4.3	1.1
28	MARC	9.6	11.1	10.2	-8.1	1.0
29	Adam Net	6.9	7.5	9.0	20.9	0.9
30	Toyo Information Systems*	7.6	8.1	9.0	10.7	0.9
	All North American Companies	313.4	400.4	488.6	22.0	48.1
	All European Companies	9.7	17.5	16.1	-8.3	1.6
	All Asian Companies	424.3	475.8	511.8	7.6	50.3
	All Companies	747.4	893.7	1,016.5	13.7	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (February 1997)

Table A-17
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Japan, UNIX

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	Info. Services Int'l. Dentsu*	62.7	80.9	111.3	37.6	15.6
2	IBM	56.8	82.1	98.4	19.9	13.8
3	Fujitsu	56.1	65.0	72.7	11.9	10.2
4	Hitachi	53.9	57.3	66.1	15.3	9.3
5	Parametric Technology	23.7	35.1	55.4	58.1	7.8
6	Nihon Unisys	43.8	51.8	53.6	3.5	7.5
7	NEC	42.0	43.7	50.4	15.3	7.1
8	Toshiba*	39.6	50.0	42.5	-15.0	6.0
9	Hitachi Zosen Info Systems	34.2	38.3	38.5	0.4	5.4
10	MicroCADAM	30.1	41.9	36.9	-11.8	5.2
11	C. Itoh Techno-Science*	30.9	28.4	32.7	15.3	4.6
12	Structural Dynamics Research Corporation	25.1	26.1	30.8	17.9	4.3
13	Hewlett-Packard	20.9	17.2	25.3	46.9	3.5
14	MacNeal-Schwendler	14.7	22.5	23.2	2.9	3.3
15	Marubeni Hytech*	18.3	19.9	23.0	15.3	3.2
16	Hakuto*	14.1	17.9	20.6	15.3	2.9
17	Tokyo Electron*	16.0	17.4	20.0	15.3	2.8
18	Seiko*	18.0	19.7	19.0	-3.5	2.7
19	Dassault	10.4	14.6	18.1	23.7	2.5
20	Sumisho Electronics*	13.1	14.2	16.4	15.3	2.3
21	Computervision	21.6	13.3	15.8	18.9	2.2
22	Mitsui Engineering	12.4	13.5	15.5	15.3	2.2
23	MARC	9.6	11.1	9.5	-14.5	1.3
24	Mutoh Industries*	7.8	7.3	8.4	15.3	1.2
25	Toyo Information Systems*	6.7	7.3	8.4	15.3	1.2
26	Adam Net	6.7	7.2	8.2	14.2	1.2
27	Kubota Computer	6.0	6.6	7.6	15.3	1.1
28	Sharp*	6.1	8.3	6.5	-22.2	0.9
29	Nihon Itek*	5.1	5.5	6.4	15.3	0.9
30	Toshiba Engineering*	10.9	11.6	5.3	-54.4	0.7
	All North American Companies	220.4	272.8	320.7	17.5	45.1
	All European Companies	8.0	12.4	10.5	-15.9	1.5
	All Asian Companies	338.7	370.2	380.7	2.8	53.5
	All Companies	567.1	655.4	711.8	8.6	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (February 1997)

Table A-18
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Japan, NT/Hybrid

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	Parametric Technology	2.6	6.7	15.6	134.1	23.1
2	MicroCADAM	3.8	5.2	14.8	182.4	21.8
3	NEC	-	5.2	10.4	100.0	15.3
4	Toshiba Engineering*	-	-	5.8	NA	8.6
5	Omron	-	5.8	5.8	-0.6	8.5
6	Wacom	-	4.9	5.5	12.8	8.1
7	Mutoh Industries*	2.5	2.3	4.7	100.0	6.9
8	Graphtec Engineering	-	-	2.6	NA	3.8
9	Hewlett-Packard	-	0.9	2.2	128.9	3.2
10	Structural Dynamics Research Corporation	-	0.4	1.1	195.6	1.6
11	Spatial Technology	0.3	0.3	0.8	202.4	1.2
12	Intergraph	0.6	0.1	0.8	902.7	1.2
13	Ansys	-	0.6	0.8	27.2	1.2
14	Autodesk	-	-	0.7	NA	1.0
15	Matra Datavision	-	0.6	0.6	6.8	0.9
16	MARC	-	-	0.6	NA	0.9
17	EDS Unigraphics	-	-	0.6	NA	0.9
18	SolidWorks Corporation	-	-	0.4	NA	0.6
19	MacNeal-Schwendler	-	0.3	0.4	21.8	0.5
20	Mechanical Dynamics	-	-	0.2	NA	0.4
21	CGTech	0.1	0.2	0.2	20.1	0.4
22	Bentley Systems	0	0	0.2	407.3	0.3
23	SRAC	-	0.1	0.1	-42.6	0.1
24	Delcam International	-	-	0	NA	0.1
25	MCS	-	0	0	6.9	0.1
26	Altair Computing	-	-	0	NA	0
	All North American Companies	7.1	14.6	38.6	163.7	56.9
	All European Companies	0.1	0.6	0.7	14.8	1.0
	All Asian Companies	-	15.9	28.5	79.4	42.1
	All Companies	7.2	31.1	67.8	117.8	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
NA = Not applicable
Source: Dataquest (February 1997)

Table A-19
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Japan, Personal Computer

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	MicroCADAM	41.3	57.6	71.4	24.1	34.5
2	NEC	19.7	24.0	26.9	12.0	13.0
3	Fujitsu	20.9	24.2	26.9	11.0	13.0
4	Autodesk	10.2	19.2	20.9	9.2	10.1
5	Toshiba*	14.9	16.7	20.0	20.0	9.7
6	Andor*	17.6	15.9	17.8	12.0	8.6
7	Hakuto*	9.4	11.9	13.4	12.0	6.5
8	Hitachi	9.6	10.2	11.4	12.0	5.5
9	Design Automation	6.1	10.0	11.2	12.0	5.4
10	Hewlett-Packard	1.5	4.8	7.3	53.1	3.5
11	Info. Services Int'l. Dentsu*	3.3	4.3	5.9	37.6	2.8
12	Sumisho Electronics*	5.2	4.6	5.1	12.0	2.5
13	Kozo Keikaku Engineering*	3.7	3.3	4.2	27.8	2.0
14	Mutoh Industries*	3.8	3.5	4.0	12.0	1.9
15	Graphtec Engineering	-	-	2.6	NA	1.2
16	Argo Graphics*	1.9	2.0	2.3	12.0	1.1
17	Cimatron	0.3	0.7	1.9	150.7	0.9
18	Mitsubishi Electric*	1.8	1.7	1.9	12.0	0.9
19	Ashlar	1.2	1.6	1.7	4.2	0.8
20	Anilam Electronics	1.1	1.2	1.3	12.0	0.6
21	Uchida Yoko	-	0.8	1.3	60.6	0.6
22	MacNeal-Schwendler	-	0.3	1.0	211.0	0.5
23	ADRA Systems	0.9	0.8	0.9	12.0	0.4
24	Surfware	0.1	0.3	0.8	224.0	0.4
25	Workgroup Tech.	-	0.7	0.8	12.0	0.4
26	Hitachi Zosen Info Systems	-	-	0.8	NA	0.4
27	Wacom	4.7	1.1	0.8	-30.7	0.4
28	Adam Net	0.2	0.2	0.8	227.9	0.4
29	CADKEY	0.6	0.7	0.8	12.0	0.4
30	Computervision	0.7	0.6	0.7	19.0	0.4
	All North American Companies	61.1	89.9	110.2	22.5	53.2
	All European Companies	1.5	4.4	4.9	10.9	2.4
	All Asian Companies	71.2	77.9	92.0	18.1	44.4
	All Companies	133.8	172.3	207.1	20.2	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
NA = Not applicable
Source: Dataquest (February 1997)

Table A-20
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Japan, Host/Proprietary

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	IBM	19.6	19.3	14.5	-24.7	48.6
2	Fujitsu	6.7	7.8	7.7	-0.8	25.8
3	MacNeal-Schwendler	7.6	6.5	6.9	5.9	23.1
4	Dassault	3.5	4.4	2.5	-44.2	8.3
5	Hitachi	3.1	3.3	2.3	-30.0	7.8
6	C. Itoh Techno-Science*	3.6	2.4	1.7	-30.0	5.7
7	Mitsubishi Electric*	1.5	1.2	0.9	-30.0	2.9
8	Nihon Unisys	4.3	1.1	0.8	-22.3	2.8
9	Toyo Information Systems*	0.9	0.8	0.6	-30.0	1.9
10	Kubota Computer	0.7	0.6	0.4	-30.0	1.5
11	Mechanical Dynamics	0.4	0.5	0.3	-24.7	1.1
12	Century Research Center	0.4	0.3	0.2	-30.0	0.7
13	Ansys	0.5	0.2	0.2	-14.7	0.6
14	Whessoe Computing Systems	0.1	0.1	0.1	-30.0	0.2
15	Technodia*	0	0	0	-30.0	0.1
16	Altair Computing	-	-	0	NA	0.1
17	Computational Mechanics	0.1	0	0	-30.0	0.1
18	Framasoft	0	0	0	-53.5	0
19	First Cadcam Inc.	0.1	0.1	-	-100.0	-
	All North American Companies	24.8	23.0	19.2	-16.5	64.4
	All European Companies	0.2	0.1	0.1	-38.0	0.3
	All Asian Companies	14.4	11.7	10.6	-10.0	35.4
	All Companies	39.4	34.9	29.9	-14.4	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
NA = Not applicable
Source: Dataquest (February 1997)

Table A-21
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Asia/Pacific, All Operating Systems

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	IBM	29.0	37.5	49.8	32.9	28.6
2	Parametric Technology	0.1	9.6	32.9	241.1	18.9
3	Autodesk	16.0	23.0	25.0	8.9	14.4
4	Dassault	10.8	13.3	13.7	2.8	7.9
5	EDS Unigraphics	8.3	9.4	11.7	24.4	6.7
6	Structural Dynamics Research Corporation	7.6	8.3	8.9	7.3	5.1
7	Matra Datavision	2.6	7.0	7.5	7.4	4.3
8	Computervision	2.8	4.6	5.5	19.0	3.2
9	MicroCADAM	3.0	3.9	4.6	17.9	2.6
10	Delcam International	2.3	2.8	3.9	38.4	2.3
11	MacNeal-Schwendler	1.8	2.4	3.0	25.7	1.7
12	Ansys	1.3	2.2	2.7	18.4	1.5
13	Cimatron	1.1	1.7	2.1	22.0	1.2
14	Formtek	0.7	0.8	2.1	171.6	1.2
15	Intergraph	2.4	2.1	1.9	-7.0	1.1
16	MCS	1.3	1.8	1.9	7.6	1.1
17	Sharp*	1.5	2.1	1.6	-22.2	0.9
18	Gerber Systems	1.1	1.2	1.5	21.0	0.9
19	Straessle Informationssysteme	1.1	1.6	1.4	-14.2	0.8
20	ADRA Systems	0.7	1.1	1.4	19.3	0.8
21	Bentley Systems	0.3	0.8	1.0	18.7	0.6
22	PAFEC	-	-	0.9	NA	0.5
23	Mechanical Dynamics	1.0	1.0	0.9	-7.7	0.5
24	Hewlett-Packard	3.7	0.8	0.9	14.2	0.5
25	Investronica SA	3.8	3.9	0.8	-79.5	0.5
26	MARC	-	-	0.8	NA	0.5
27	Concentra	0.1	0.3	0.7	178.3	0.4
28	CNC Software	0.5	0.6	0.7	16.8	0.4
29	B.A. Intelligence Networks	0.4	0.4	0.6	51.2	0.4
30	Altair Computing	0.3	0.4	0.5	27.6	0.3
	All North American Companies	79.6	111.2	154.2	38.6	88.6
	All European Companies	12.3	17.8	17.7	-0.3	10.2
	All Asian Companies	2.9	4.1	2.2	-46.7	1.3
	All Companies	94.8	133.1	174.0	30.8	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
NA = Not applicable
Source: Dataquest (February 1997)

Table A-22
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Asia/Pacific, UNIX

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	IBM	24.3	31.0	42.8	38.4	36.2
2	Parametric Technology	0.1	8.1	25.6	216.7	21.7
3	Dassault	8.1	10.2	12.1	17.8	10.2
4	EDS Unigraphics	8.3	9.4	10.5	12.1	8.9
5	Structural Dynamics Research Corporation	6.9	7.5	8.5	12.2	7.2
6	Matra Datavision	2.6	6.0	6.5	7.3	5.5
7	Computervision	2.7	4.4	5.3	18.9	4.5
8	Delcam International	2.2	2.7	3.8	40.0	3.2
9	MacNeal-Schwendler	1.2	1.8	2.2	21.7	1.9
10	Ansys	0.9	1.7	2.0	18.6	1.7
11	Sharp*	1.5	2.1	1.6	-22.2	1.4
12	Gerber Systems	1.1	1.2	1.5	21.0	1.3
13	Formtek	0.5	0.5	1.4	171.6	1.2
14	MicroCADAM	1.2	1.6	1.4	-11.8	1.2
15	Straessle Informationssysteme	1.1	1.6	1.4	-14.2	1.2
16	Intergraph	1.5	2.0	1.3	-37.5	1.1
17	ADRA Systems	0.5	0.8	1.0	20.0	0.8
18	MARC	-	-	0.8	NA	0.6
19	Autodesk	1.0	1.4	0.7	-46.1	0.6
20	Mechanical Dynamics	0.8	0.8	0.7	-12.1	0.6
21	Concentra	0.1	0.3	0.7	178.3	0.6
22	MCS	0.4	0.6	0.7	6.9	0.6
23	Hewlett-Packard	3.5	0.6	0.7	10.7	0.6
24	Altair Computing	0.3	0.4	0.5	21.2	0.4
25	Hitachi Zosen Info Systems	0.3	0.4	0.4	0.4	0.3
26	PAFEC	-	-	0.3	NA	0.3
27	CIMLINC	-	0.3	0.3	15.6	0.2
28	CSAR Corporation	-	0.2	0.2	53.2	0.2
29	CAD Centre	0.1	0.1	0.2	95.1	0.2
30	Applicon	0.2	0.2	0.2	4.9	0.2
	All North American Companies	52.5	73.0	103.8	42.1	87.8
	All European Companies	6.3	10.8	12.3	13.8	10.4
	All Asian Companies	2.0	2.8	2.2	-23.6	1.8
	All Companies	60.8	86.7	118.2	36.4	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
NA = Not applicable
Source: Dataquest (February 1997)

Table A-23
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Asia/Pacific, NT/Hybrid

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	Parametric Technology	0	1.5	7.2	369.0	53.4
2	EDS Unigraphics	-	-	1.2	NA	8.5
3	Matra Datavision	-	0.8	0.8	6.8	6.1
4	Autodesk	-	-	0.7	NA	5.5
5	Intergraph	0.5	0.1	0.7	902.7	5.0
6	MicroCADAM	0.1	0.2	0.5	197.2	4.0
7	Bentley Systems	0.1	0.3	0.5	52.3	3.6
8	Ansys	-	0.3	0.3	27.2	2.5
9	SolidWorks Corporation	-	-	0.3	NA	2.3
10	Structural Dynamics Research Corporation	-	0.4	0.3	-29.2	2.2
11	B.A. Intelligence Networks	-	0.1	0.3	160.0	1.9
12	MCS	-	0.2	0.2	6.9	1.4
13	DP Technology	-	0.1	0.2	158.5	1.3
14	Delcam International	-	-	0.1	NA	0.8
15	Mechanical Dynamics	-	-	0.1	NA	0.5
16	Spatial Technology	0.1	0.1	0.1	-31.6	0.5
17	Hewlett-Packard	-	0	0.1	72.4	0.4
18	MARC	-	-	0	NA	0.4
19	SRAC	-	-	0	NA	0.3
20	MacNeal-Schwendler	-	0	0	84.6	0.3
21	CAD Lab	-	-	0	NA	0.1
22	Research Engineers—Civilsoft	-	0	0	1,298.0	0.1
23	Altair Computing	-	-	0	NA	0
24	CGTech	0	0	0	-88.3	0
	All North American Companies	0.7	3.3	12.6	284.2	92.9
	All European Companies	0.2	0.8	1.0	24.2	7.1
	All Asian Companies	-	-	-	NA	-
	All Companies	0.9	4.0	13.5	234.7	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
NA = Not applicable
Source: Dataquest (February 1997)

Table A-24
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Asia/Pacific, Personal Computer

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	Autodesk	15.1	21.6	23.5	8.9	65.8
2	MicroCADAM	1.6	2.1	2.6	24.1	7.4
3	Cimatron	0.8	1.4	1.9	33.7	5.2
4	MCS	0.9	1.0	1.0	8.3	2.9
5	Investronica SA	3.8	3.9	0.8	-79.5	2.3
6	CNC Software	0.5	0.6	0.7	16.8	1.9
7	PAFEC	-	-	0.6	NA	1.8
8	Formtek	0.2	0.2	0.6	171.6	1.7
9	Bentley Systems	0.1	0.5	0.5	0.6	1.3
10	Vero International Software	0.2	0.3	0.4	21.5	1.1
11	Just In Time Systems	-	-	0.4	NA	1.0
12	ADRA Systems	0.2	0.3	0.4	17.5	1.0
13	B.A. Intelligence Networks	0.2	0.2	0.3	14.5	0.8
14	Computervision	0.1	0.2	0.2	19.0	0.7
15	Ansys	0.3	0.2	0.2	18.6	0.7
16	Surfware	0.3	0.5	0.2	-56.8	0.6
17	Matra Datavision	0.1	0.2	0.2	15.3	0.6
18	SRAC	0.1	-	0.2	NA	0.6
19	DP Technology	0.1	0.2	0.2	13.8	0.5
20	Hewlett-Packard	0.2	0.2	0.2	15.3	0.5
21	Structural Dynamics Research Corporation	0.7	0.3	0.1	-62.1	0.3
22	Research Engineers—Civilsoft	0.1	0.1	0.1	39.8	0.3
23	Ashlar	-	0.1	0.1	4.2	0.3
24	MacNeal-Schwendler	-	0	0.1	267.6	0.3
25	CAD Lab	-	-	0.1	NA	0.2
26	Applicon	0	0	0	8.3	0.1
27	Algor Interactive Systems	0	0	0	33.1	0.1
28	RoboCAD Solutions	0	0	0	33.1	0.1
29	Pathtrace Engineering Systems	0	0	0	165.1	0.1
30	SolidWorks Corporation	-	-	0	NA	0.1
	All North American Companies	21.5	28.8	31.3	8.8	87.6
	All European Companies	5.8	6.1	4.4	-27.8	12.4
	All Asian Companies	0.9	1.2	0	-99.4	0
	All Companies	28.2	36.2	35.7	-1.1	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
NA = Not applicable
Source: Dataquest (February 1997)

Table A-25
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Asia/Pacific, Host/Proprietary

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	IBM	4.8	6.5	7.0	6.6	107.0
2	Dassault	2.7	3.1	1.6	-46.8	25.3
3	MacNeal-Schwendler	0.6	0.5	0.7	25.2	10.1
4	Mechanical Dynamics	0.2	0.2	0.1	-32.2	1.6
5	Ansys	0.1	0.1	0.1	-15.7	1.1
6	Altair Computing	-	-	0	NA	0.2
7	Framasoft	-	0	0	-7.4	0
8	Computational Mechanics	0	0	-	-100.0	-
	All North American Companies	4.8	6.1	6.5	6.3	100.0
	All European Companies	0.1	0	0	-95.0	0
	All Asian Companies	-	-	-	NA	-
	All Companies	4.9	6.2	6.5	5.7	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
NA = Not applicable
Source: Dataquest (February 1997)

Table A-26
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Rest of World, All Operating Systems

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	IBM	10.6	9.7	12.3	26.4	28.6
2	Engineering Mechanics	-	4.5	5.2	15.4	12.2
3	Intergraph	1.5	4.9	4.5	-7.0	10.5
4	Autodesk	5.8	4.3	4.1	-3.9	9.6
5	Cimatron	2.8	3.5	3.4	-1.6	8.0
6	Delcam International	1.1	2.2	2.6	21.1	6.1
7	Computervision	1.4	2.0	2.3	19.0	5.4
8	EDS Unigraphics	1.4	1.6	1.9	24.2	4.5
9	MicroCADAM	1.1	1.3	1.5	17.2	3.5
10	NOVASOFT Systems	0.4	1.0	1.1	15.6	2.6
11	Matra Datavision	-	0.9	0.9	7.4	2.2
12	Ansys	1.0	0.7	0.9	19.4	2.0
13	Formtek	0.7	0.8	0.8	8.6	1.9
14	Investronica SA	0.5	0.5	0.6	4.0	1.3
15	CNC Software	0.5	0.5	0.5	6.5	1.2
16	Whessoe Computing Systems	0.4	0.5	0.5	6.0	1.1
17	CADKEY	0.3	0.4	0.4	6.5	1.0
18	Straessle Informationssysteme	-	0.3	0.3	-14.2	0.7
19	Viagrafix	0.2	0.2	0.2	6.5	0.4
20	DP Technology	-	0.1	0.2	15.3	0.4
21	B.A. Intelligence Networks	0.1	0.1	0.2	14.4	0.4
22	Computational Mechanics	0.1	0.1	0.1	10.3	0.3
23	Tebis	-	0.1	0.1	12.3	0.3
24	MCS	-	0.1	0.1	13.7	0.3
25	Bentley Systems	0	0.1	0.1	21.0	0.3
26	Surfware	0.1	0.1	0.1	13.7	0.3
27	SRAC	0.1	0.1	0.1	-24.9	0.2
28	ADRA Systems	0.2	0.1	0.1	17.5	0.2
29	CGTech	0.1	0.1	0.1	8.0	0.2
30	CAD Centre	0	0	0.1	265.8	0.2
	All North American Companies	24.7	30.9	34.3	11.1	80.0
	All European Companies	5.4	8.5	8.6	0.7	20.0
	All Asian Companies	-	-	-	NA	-
	All Companies	30.1	39.4	42.9	8.9	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
NA = Not applicable
Source: Dataquest (February 1997)

Table A-27
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Rest of World, UNIX

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	IBM	8.9	8.0	10.3	28.5	39.9
2	Engineering Mechanics	-	3.0	3.6	20.0	13.9
3	Intergraph	0.9	4.7	2.9	-37.5	11.4
4	Delcam International	1.1	2.1	2.5	22.0	9.8
5	Computervision	1.3	1.9	2.2	18.9	8.6
6	EDS Unigraphics	1.4	1.6	1.8	12.1	6.8
7	Matra Datavision	-	0.8	0.8	7.3	3.1
8	Ansys	0.7	0.6	0.7	18.6	2.6
9	NOVASOFT Systems	0.3	0.5	0.6	20.0	2.2
10	Formtek	0.5	0.5	0.6	8.6	2.2
11	MicroCADAM	0.5	0.5	0.5	-11.8	1.8
12	Cimatron	0.4	0.6	0.3	-47.9	1.2
13	Straessle Informationssysteme	-	0.3	0.3	-14.2	1.1
14	Autodesk	0.3	0.3	0.1	-52.0	0.5
15	CAD Centre	0	0	0.1	260.1	0.4
16	Computational Mechanics	0.1	0.1	0.1	20.0	0.4
17	ADRA Systems	0.2	0.1	0.1	20.0	0.3
18	CGTech	0	0.1	0.1	2.5	0.3
19	Whessoe Computing Systems	0	0	0.1	20.0	0.2
20	Tebis	-	0	0.1	14.4	0.2
21	DP Technology	-	0	0.1	20.0	0.2
22	MCS	-	0	0.1	6.9	0.2
23	First Cadcam Inc.	0	0	0	23.0	0.1
24	SRAC	0	0	0	-29.3	0.1
25	Algor Interactive Systems	0	0	0	20.0	0.1
26	B.A. Intelligence Networks	0.1	0	0	20.0	0.1
27	Bentley Systems	-	0	0	-24.3	0
28	Siemens Nixdorf Info systeme	0.4	0.4	-	-100.0	-
29	Mechanical Dynamics	0.1	0.1	-	-100.0	-
30	Spatial Technology	0.1	0.1	-	-100.0	-
	All North American Companies	14.5	20.4	21.7	6.6	84.0
	All European Companies	2.0	4.3	4.1	-3.4	16.0
	All Asian Companies	-	-	-	NA	-
	All Companies	16.4	24.6	25.8	4.8	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
NA = Not applicable
Source: Dataquest (February 1997)

Table A-28
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Rest of World, NT/Hybrid

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	Intergraph	0.3	0.2	1.6	902.7	65.6
2	EDS Unigraphics	-	-	0.2	NA	7.8
3	MicroCADAM	0.1	0.1	0.2	182.4	7.2
4	NOVASOFT Systems	-	0.1	0.1	30.0	5.2
5	Autodesk	-	-	0.1	NA	5.1
6	Ansys	-	0.1	0.1	38.2	4.7
7	Matra Datavision	-	0.1	0.1	6.8	4.3
8	Delcam International	-	-	0.1	NA	3.2
9	Bentley Systems	0	0	0.1	56.1	2.8
10	B.A. Intelligence Networks	-	0	0	30.0	1.8
11	DP Technology	-	0	0	30.0	1.5
12	MCS	-	-	0	NA	0.3
13	CGTech	0	-	0	NA	0.2
14	SRAC	-	0	0	-75.4	0.2
15	Structural Dynamics Research Corporation	-	0	-	-100.0	-
16	Spatial Technology	0.1	0	-	-100.0	-
	All North American Companies	0.4	0.6	2.2	281.5	92.5
	All European Companies	0.4	0.1	0.2	88.5	7.5
	All Asian Companies	-	-	-	NA	-
	All Companies	0.8	0.7	2.4	254.1	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
NA = Not applicable
Source: Dataquest (February 1997)

Table A-29
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Rest of World, Personal Computer

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	Autodesk	5.5	4.0	3.9	-3.9	29.7
2	Cimatron	1.9	2.9	3.1	7.8	24.1
3	Engineering Mechanics	-	1.5	1.6	6.5	12.7
4	MicroCADAM	0.6	0.7	0.9	24.1	6.8
5	Investronica SA	0.5	0.5	0.6	4.0	4.4
6	CNC Software	0.5	0.5	0.5	6.5	4.1
7	CADKEY	0.3	0.4	0.4	6.5	3.3
8	NOVASOFT Systems	0	0.4	0.4	6.5	3.2
9	Whessoe Computing Systems	0.3	0.3	0.4	6.5	2.9
10	Formtek	0.2	0.2	0.2	8.6	1.9
11	Viagrafix	0.2	0.2	0.2	6.5	1.4
12	Surfware	0.1	0.1	0.1	13.7	0.8
13	Computervision	0.1	0.1	0.1	19.0	0.8
14	Tebis	-	0.1	0.1	11.1	0.7
15	B.A. Intelligence Networks	0.1	0.1	0.1	6.5	0.7
16	MCS	-	0.1	0.1	8.3	0.6
17	DP Technology	-	0.1	0.1	6.5	0.6
18	Ansys	0.2	0.1	0.1	17.3	0.6
19	SRAC	0	0.1	0.1	-11.9	0.5
20	Bentley Systems	0	0.1	0.1	3.1	0.5
21	Superdraft	0	0	0	6.5	0.3
22	Algor Interactive Systems	0	0	0	6.5	0.3
23	Engineered Software	-	-	0	NA	0.3
24	Ziegler Informatics	0	0	0	-3.2	0.2
25	GRAPHSOFT	0	0	0	3.5	0.2
26	Matra Datavision	-	0	0	15.3	0.2
27	Research Engineers—Civilsoft	0	0	0	39.8	0.2
28	Computational Mechanics	0	0	0	6.5	0.2
29	CGTech	0	0	0	4.0	0.2
30	ADRA Systems	0.1	0	0	6.5	0.1
	All North American Companies	8.1	8.5	8.8	3.2	67.6
	All European Companies	3.0	4.1	4.2	3.0	32.4
	All Asian Companies	-	-	-	NA	-
	All Companies	11.1	12.6	13.0	3.1	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
NA = Not applicable
Source: Dataquest (February 1997)

Table A-30
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Rest of World, Host/Proprietary

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	IBM	1.7	1.7	2.0	16.2	116.8
2	Whessoe Computing Systems	0.1	0.1	0	-10.0	2.8
3	Computational Mechanics	0	0	0	-10.0	1.7
4	Ansys	0.1	0	0	-15.7	1.4
5	Mechanical Dynamics	0	0	-	-100.0	-
6	First Cadcam Inc.	-	0	-	-100.0	-
	All North American Companies	1.7	1.5	1.6	12.9	96.7
	All European Companies	0.1	0.1	0.1	-10.0	3.3
	All Asian Companies	-	-	-	NA	-
	All Companies	1.8	1.5	1.7	11.9	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
NA = Not applicable
Source: Dataquest (February 1997)

Table B-1
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
All Mechanical Software Companies, Worldwide, All Operating Systems

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
1	3D/Eye Inc.	-	-	3.5	NA	0.1
2	ABB Industria*	1.3	1.4	1.4	0	0
3	Access Corp.	0.8	0.6	0.5	-25.2	0
4	Adam Net	6.9	7.5	9.0	20.9	0.3
5	Adina R&D	8.0	9.0	10.3	15.0	0.3
6	ADRA Systems	18.0	19.0	21.1	11.2	0.6
7	Algor Interactive Systems	6.8	10.0	10.5	5.2	0.3
8	Alias Research	13.1	17.3	12.7	-26.2	0.4
9	Altair Computing	5.7	8.0	10.0	25.1	0.3
10	Andor*	17.6	15.9	17.8	12.0	0.5
11	Anilam Electronics	4.1	3.8	4.1	5.8	0.1
12	Ansys	32.5	37.4	44.3	18.5	1.3
13	Applicon	19.3	21.5	21.8	1.3	0.6
14	Argo Graphics*	3.6	3.8	4.3	13.5	0.1
15	ASCAD	12.1	14.9	16.4	10.6	0.5
16	Ashlar	5.8	5.7	5.9	4.2	0.2
17	Auto-Trol	4.4	4.1	4.6	12.1	0.1
18	Autodesk	176.0	210.2	204.9	-2.5	6.0
19	B.A. Intelligence Networks	2.6	2.7	3.3	21.9	0.1
20	BCT GMBH	3.0	4.2	7.2	71.6	0.2
21	Bentley Systems	3.9	12.2	13.9	14.2	0.4
22	Boothroyd Dewhurst	1.4	1.6	1.6	-0.6	0
23	C. Itoh Techno-Science*	34.6	30.8	34.4	11.7	1.0
24	CAD Centre	0.7	0.9	1.6	78.8	0
25	CAD Distribution	3.8	5.8	5.0	-13.1	0.1
26	CAD Lab	11.4	13.6	15.5	13.7	0.5
27	Cadis Software	0.4	1.2	3.3	175.0	0.1
28	CADIX	4.2	4.7	5.1	9.4	0.1
29	CADKEY	6.8	7.5	7.2	-3.9	0.2
30	CADSI	2.1	3.1	3.2	4.8	0.1
31	CADWORKS	0.2	0.2	0.1	-44.4	0
32	Catalpa groupe Missler	1.1	1.5	1.5	1.9	0
33	Century Research Center	1.1	1.1	1.1	2.5	0
34	CGTech	6.0	10.0	10.4	4.0	0.3
35	Cimatron	7.3	11.3	13.7	22.0	0.4
36	CIMLINC	4.8	5.8	6.5	11.8	0.2
37	CIMTEK	4.1	1.2	1.6	31.0	0
38	Cimtel	0.8	1.0	1.0	4.9	0

Table B-1 (Continued)
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
All Mechanical Software Companies, Worldwide, All Operating Systems

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
39	CMstat	0.7	0.7	1.9	160.0	0.1
40	CNC Software	7.6	8.4	8.7	3.7	0.3
41	Computational Mechanics	2.1	2.1	2.1	-3.2	0.1
42	Computervision	148.2	149.1	177.4	19.0	5.2
43	Concentra	12.1	12.7	16.6	31.0	0.5
44	CONSENS	-	0.6	1.0	60.0	0
45	Control Data	-	2.3	2.8	21.7	0.1
46	CSAR Corp.	1.2	3.4	5.2	53.2	0.2
47	Dassault	154.2	190.6	228.6	19.9	6.7
48	Database Applications	0.5	0.5	0.7	50.9	0
49	debis Systemhaus	3.2	3.5	4.0	13.1	0.1
50	Delcam International	11.6	16.7	21.8	30.9	0.6
51	Deneb Robotics	8.0	9.3	8.4	-9.4	0.2
52	Design Automation	7.0	11.6	11.2	-3.0	0.3
53	DP Technology	3.7	4.8	6.0	25.2	0.2
54	EDS Unigraphics	138.2	156.2	194.3	24.4	5.7
55	Eigner + Partner	5.4	6.3	6.1	-3.2	0.2
56	Engineered Software	0.6	0.6	0.6	1.9	0
57	Engineering Computer Services*	6.9	7.9	-	-100.0	-
58	Engineering Mechanics	8.1	7.6	8.6	13.1	0.3
59	ESI Group	-	4.5	5.0	11.1	0.1
60	Exapt	7.2	5.7	2.6	-54.0	0.1
61	FHECOR*	0.5	0.6	0.6	0	0
62	First Cadcam Inc.	3.3	3.7	3.8	3.0	0.1
63	Formtek	17.4	18.9	20.6	8.7	0.6
64	Framasoft	4.7	4.7	3.9	-16.7	0.1
65	Fujitsu	83.7	97.0	107.3	10.7	3.1
66	Gerber Systems	12.1	13.1	14.9	14.0	0.4
67	Gibbs and Assoc.	1.9	2.2	2.5	13.6	0.1
68	GRAPHSOFT	1.0	1.5	1.5	3.5	0
69	Graphtec Engineering	7.9	8.6	8.6	0.5	0.3
70	Hakuto*	23.6	29.8	34.0	14.0	1.0
71	Han Dataport	7.1	7.8	6.5	-17.4	0.2
72	Hewlett-Packard	74.5	79.0	90.2	14.2	2.6
73	Hitachi	66.7	70.9	79.9	12.7	2.3
74	Hitachi Zosen Info Systems	34.5	38.7	39.7	2.5	1.2
75	IBM	368.3	491.5	580.2	18.0	17.0
76	ICEM Technologies	10.9	15.3	17.0	11.5	0.5

Table B-1 (Continued)
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
All Mechanical Software Companies, Worldwide, All Operating Systems

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
77	IMSI	0.5	0.4	0.4	4.5	0
78	Info. Services Int'l. Dentsu*	66.0	85.2	117.2	37.6	3.4
79	Intergraph	61.1	54.0	50.2	-7.0	1.5
80	Investronica SA	10.6	11.1	10.6	-3.8	0.3
81	ISD Software	10.5	14.5	28.2	94.4	0.8
82	ISKA	0.9	1.1	1.2	11.7	0
83	Just In Time Systems	1.9	2.5	2.4	-3.3	0.1
84	Kloeckner-Moeller	1.9	1.7	1.7	0.5	0
85	Kozo Keikaku Engineering*	7.4	7.3	8.4	15.0	0.2
86	Kubota Computer	8.3	8.9	9.8	10.7	0.3
87	Livermore Software Tech.	1.1	1.6	1.8	13.7	0.1
88	MacNeal-Schwendler	90.8	114.0	116.6	2.3	3.4
89	MARC	15.5	18.2	20.4	12.4	0.6
90	Marubeni Hytech*	18.3	19.9	23.0	15.3	0.7
91	Matra Datavision	75.6	87.4	93.9	7.4	2.7
92	MCS	13.0	13.6	14.7	7.7	0.4
93	Mechanical Dynamics	13.9	12.6	15.5	23.4	0.5
94	MicroCADAM	91.7	129.2	152.0	17.7	4.4
95	Mitsubishi Electric*	6.3	6.3	6.7	5.7	0.2
96	Mitsui Engineering	12.9	14.0	16.1	15.2	0.5
97	Mutoh Industries*	14.2	13.1	17.0	29.5	0.5
98	NEC	61.7	72.9	87.7	20.2	2.6
99	Nihon Itek*	5.1	5.5	6.4	15.3	0.2
100	Nihon Unisys	48.1	52.8	54.4	3.0	1.6
101	NOVASOFT Systems	2.2	4.8	3.9	-17.9	0.1
102	Omron	5.2	7.8	7.7	-0.6	0.2
103	PAFEC	5.2	6.0	7.8	30.8	0.2
104	Parametric Technology	209.8	321.2	495.0	54.1	14.5
105	Pathtrace Engineering Systems	3.0	3.2	4.1	28.9	0.1
106	PROCAD GmbH	3.5	5.8	6.5	12.8	0.2
107	Radan Computational	9.0	8.2	8.6	5.2	0.3
108	Research Engineers—Civilsoft	0.4	0.6	0.8	44.2	0
109	Ricoh	2.2	2.3	2.4	4.3	0.1
110	RoboCAD Solutions	2.3	1.9	1.6	-13.7	0
111	Seiko*	18.0	19.7	19.0	-3.5	0.6
112	Serbi	5.0	5.9	5.6	-4.1	0.2
113	Sharp*	7.6	10.4	8.1	-22.2	0.2
114	Sherpa Corporation	18.8	20.6	26.2	27.2	0.8

Table B-1 (Continued)
1996 CAD/CAM/CAE/GIS Software Market Share Table (Revenue in $M)
All Mechanical Software Companies, Worldwide, All Operating Systems

Rank	Company Name	1994	1995	1996	Growth (%) 1995-1996	Market Share (%) 1996
115	Siemens Nixdorf Info systeme	24.7	25.2	-	-100.0	-
116	Softdesk	1.2	0.9	0.9	3.6	0
117	Softronics	1.9	2.0	1.0	-50.0	0
118	SolidWorks Corporation	-	-	7.0	NA	0.2
119	Spatial Technology	7.2	6.1	10.4	71.0	0.3
120	SRAC	3.4	4.8	5.6	16.6	0.2
121	Straessle Informationssysteme	18.3	16.4	14.1	-14.2	0.4
122	Structural Dynamics Research Corporation	115.4	131.2	148.0	12.8	4.3
123	Sumisho Electronics*	18.4	18.8	21.6	14.5	0.6
124	Superdraft	1.4	1.4	1.3	-6.7	0
125	Surfware	2.7	5.0	5.4	8.1	0.2
126	Tebis	5.7	12.6	14.2	12.3	0.4
127	Technodia*	3.6	3.9	4.5	14.9	0.1
128	Tecnomatix Technology	13.0	20.1	26.3	31.1	0.8
129	Tokyo Electron*	16.0	17.4	20.0	15.3	0.6
130	Toshiba Engineering*	11.1	11.8	11.1	-5.6	0.3
131	Toshiba*	54.5	66.7	62.5	-6.3	1.8
132	Toyo Information Systems*	7.6	8.1	9.0	10.7	0.3
133	Uchida Yoko	0.3	1.4	2.2	60.0	0.1
134	Variation Systems Analysis	2.4	2.6	2.8	8.2	0.1
135	Vero International Software	1.6	2.1	2.5	21.7	0.1
136	Viagrafix	5.5	5.6	5.4	-2.5	0.2
137	Wacom	5.9	6.0	6.3	4.6	0.2
138	Whessoe Computing Systems	5.3	5.4	5.5	2.3	0.2
139	Wiechers Datentechnik	9.0	8.4	9.2	9.7	0.3
140	Workgroup Tech.	3.0	6.3	6.5	3.6	0.2
141	Yokogawa Digital Computer	0.2	0.2	0.3	15.3	0
142	Ziegler Informatics	5.0	3.3	3.2	-3.2	0.1
143	Zuken-Redac	0.7	0.5	0.6	15.3	0
	All North American Companies	1,723.3	2,142.1	2,557.8	19.4	74.8
	All European Companies	288.2	334.0	347.2	3.9	10.1
	All Asian Companies	428.4	481.5	515.6	7.1	15.1
	All Companies	2,439.9	2,957.6	3,420.5	15.7	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
NA = Not applicable
Source: Dataquest (February 1997)

Table C-1
1996 CAD/CAM/CAE/GIS Total Vendor Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Worldwide, All Operating Systems

Rank	Company Name	CPU Shipments	Software Revenue	CPU Revenue	Service Revenue	Total Distribution Revenue	1996 Share of Market (%)
1	IBM	64,226	580.2	922.4	376.4	2,033.5	19.2
2	Hewlett-Packard	44,882	90.2	836.6	239.0	1,165.9	11.0
3	Sun Microsystems	41,419	-	780.9	254.8	1,035.7	9.8
4	Digital Equipment	68,715	-	712.9	105.5	818.4	7.7
5	Parametric Technology	-	495.0	-	165.0	660.0	6.2
6	Silicon Graphics	23,606	-	582.3	64.7	647.0	6.1
7	Fujitsu	14,197	107.3	208.2	101.1	416.6	3.9
8	EDS Unigraphics	8,282	194.3	99.6	74.4	368.3	3.5
9	NEC	24,225	87.7	165.3	39.3	354.7	3.3
10	Structural Dynamics Research Corporation	-	148.0	-	137.5	285.5	2.7
11	Computervision	-	177.4	-	98.0	275.4	2.6
12	Dassault	-	228.6	-	40.0	268.6	2.5
13	Nihon Unisys	1,562	54.4	70.0	64.9	206.8	1.9
14	Autodesk	-	204.9	-	1.2	206.2	1.9
15	Hitachi	4,915	79.9	83.0	18.2	181.1	1.7
16	MicroCADAM	-	152.0	-	8.0	160.0	1.5
17	Intergraph	1,878	50.2	39.0	52.5	150.3	1.4
18	Matra Datavision	2,026	93.9	27.4	19.5	146.8	1.4
19	Info. Services Int'l. Dentsu*	603	117.2	21.7	-	138.9	1.3
20	Argo Graphics*	1,709	4.3	66.2	-	136.2	1.3
21	Sumisho Electronics*	1,307	21.6	40.2	-	129.2	1.2
22	Toshiba*	4,848	62.5	65.1	15.1	127.6	1.2
23	MacNeal-Schwendler	-	116.6	-	9.9	126.5	1.2
24	Mitsubishi Electric*	1,106	6.7	41.7	-	109.8	1.0
25	Hitachi Zosen Info Systems	751	39.7	30.3	15.3	93.8	0.9
26	Hakuto*	1,657	34.0	38.4	2.9	75.3	0.7
27	Technodia*	335	4.5	23.9	10.7	72.3	0.7
28	C. Itoh Techno-Science*	-	34.4	17.5	11.7	66.8	0.6
29	Delcam International	836	21.8	17.7	14.8	56.9	0.5
30	Mutoh Industries*	1,428	17.0	20.1	10.5	56.6	0.5
	Other Companies	109,849	-	306.9	-	306.9	2.9
	All North American Companies	197,314	2,557.8	3,119.7	1,744.8	7,596.3	71.5
	All European Companies	8,049	347.2	137.3	161.3	685.4	6.5
	All Asian Companies	63,810	515.6	1,011.9	354.5	2,028.5	19.1
	All Companies	379,021	3,420.5	4,575.7	2,260.5	10,617.1	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (February 1997)

Table C-2
1996 CAD/CAM/CAE/GIS Total Vendor Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Worldwide, UNIX

Rank	Company Name	CPU Shipments	Software Revenue	CPU Revenue	Service Revenue	Total Distribution Revenue	1996 Share of Market (%)
1	IBM	26,189	509.7	631.3	281.4	1,508.2	19.1
2	Hewlett-Packard	29,038	65.6	788.8	225.4	1,079.8	13.7
3	Sun Microsystems	41,419	-	780.9	254.8	1,035.7	13.1
4	Silicon Graphics	23,606	-	582.3	64.7	647.0	8.2
5	Parametric Technology	-	386.1	-	128.7	514.8	6.5
6	EDS Unigraphics	8,282	175.1	89.7	67.1	331.9	4.2
7	Digital Equipment	18,364	-	278.0	45.3	323.3	4.1
8	Fujitsu	6,091	72.7	160.0	68.8	301.5	3.8
9	Structural Dynamics Research Corporation	-	141.0	-	134.5	275.5	3.5
10	Computervision	-	169.5	-	93.7	263.3	3.3
11	Dassault	-	201.1	-	35.2	236.4	3.0
12	Nihon Unisys	1,558	53.6	69.5	50.0	190.3	2.4
13	NEC	5,223	50.4	71.8	20.9	185.1	2.3
14	Hitachi	3,110	66.1	68.7	15.0	149.8	1.9
15	Info. Services Int'l. Dentsu*	430	111.3	20.7	-	132.0	1.7
16	Matra Datavision	1,752	81.0	23.7	17.3	127.1	1.6
17	Sumisho Electronics*	223	16.4	31.4	-	101.8	1.3
18	Intergraph	1,017	32.7	27.0	34.4	100.5	1.3
19	Mitsubishi Electric*	578	4.0	37.8	-	96.7	1.2
20	MacNeal-Schwendler	-	85.9	-	7.5	93.4	1.2
21	Hitachi Zosen Info Systems	751	38.9	29.7	15.0	91.9	1.2
22	Toshiba*	1,450	42.5	44.3	11.3	86.8	1.1
23	Technodia*	335	4.4	23.9	10.7	72.2	0.9
24	Argo Graphics*	340	2.1	33.5	-	69.1	0.9
25	C. Itoh Techno-Science*	-	32.7	16.8	11.2	63.5	0.8
26	Delcam International	836	21.2	17.2	14.3	55.2	0.7
27	Mitsui Engineering	158	15.5	7.7	20.8	51.9	0.7
28	ICEM Technologies	770	17.0	16.8	14.8	49.5	0.6
29	MicroCADAM	-	45.6	-	2.4	48.0	0.6
30	ASCAD	918	14.1	22.6	5.2	47.0	0.6
	All North American Companies	109,576	1,847.7	2,497.2	1,465.4	5,913.1	75.0
	All European Companies	5,525	216.5	103.2	120.9	459.6	5.8
	All Asian Companies	25,039	384.3	736.0	269.8	1,507.1	19.1
	All Companies	140,140	2,448.5	3,336.4	1,856.1	7,879.8	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (February 1997)

Table C-3
1996 CAD/CAM/CAE/GIS Total Vendor Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Worldwide, NT/Hybrid

Rank	Company Name	CPU Shipments	Software Revenue	CPU Revenue	Service Revenue	Total Distribution Revenue	1996 Share of Market (%)
1	Parametric Technology	-	108.9	-	36.3	145.2	26.6
2	Digital Equipment	4,155	-	42.0	7.1	49.1	9.0
3	Intergraph	860	17.6	12.0	15.6	47.3	8.7
4	EDS Unigraphics	-	19.2	9.9	7.4	36.5	6.7
5	NEC	2,057	10.4	9.7	3.9	26.3	4.8
6	MicroCADAM	-	18.2	-	1.0	19.2	3.5
7	ISD Software	-	15.3	0.4	1.6	18.1	3.3
8	Matra Datavision	-	10.3	3.0	2.2	16.1	3.0
9	Mutoh Industries*	461	4.7	6.7	2.4	15.6	2.9
10	Hewlett-Packard	422	5.6	4.4	2.6	12.7	2.3
11	Toshiba Engineering*	282	5.8	3.6	1.7	10.6	1.9
12	Omron	154	5.8	2.8	0.7	9.3	1.7
13	SolidWorks Corporation	-	6.3	-	2.7	9.0	1.6
14	Structural Dynamics Research Corporation	-	5.1	-	2.6	7.7	1.4
15	Bentley Systems	-	6.8	-	0.8	7.6	1.4
16	Wacom	-	5.5	0.6	1.2	7.3	1.3
17	Autodesk	-	6.1	-	0	6.2	1.1
18	Ansys	-	5.7	-	0.3	6.0	1.1
19	Graphtec Engineering	-	2.6	1.9	0.4	5.5	1.0
20	CAD Distribution	-	4.8	-	0.5	5.3	1.0
21	BCT GMBH	-	2.5	0.8	0.8	4.2	0.8
22	Spatial Technology	-	3.6	-	-	3.6	0.7
23	CAD Lab	-	1.6	0.8	0.9	3.6	0.7
24	DP Technology	-	1.9	0.1	0.7	2.7	0.5
25	Mechanical Dynamics	-	1.2	0	0.9	2.1	0.4
26	3D/Eye Inc.	-	1.8	-	0.3	2.0	0.4
27	B.A. Intelligence Networks	-	1.2	-	0.6	1.8	0.3
28	MCS	-	1.5	0.1	0.3	1.8	0.3
29	Delcam International	-	0.6	0.5	0.4	1.7	0.3
30	CGTech	-	1.1	-	0.4	1.6	0.3
	Other Companies	6,035	-	65.5	-	65.5	12.0
	All North American Companies	5,437	208.9	68.5	80.7	360.3	66.0
	All European Companies	10	36.9	5.7	6.7	51.1	9.4
	All Asian Companies	2,954	28.5	25.4	10.3	68.9	12.6
	All Companies	14,435	274.3	165.0	97.8	545.7	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (February 1997)

Table C-4
1996 CAD/CAM/CAE/GIS Total Vendor Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Worldwide, Personal Computer

Rank	Company Name	CPU Shipments	Software Revenue	CPU Revenue	Service Revenue	Total Distribution Revenue	1996 Share of Market (%)
1	Autodesk	-	193.8	-	1.1	194.9	12.6
2	IBM	37,472	-	155.9	-	155.9	10.1
3	NEC	16,946	26.9	83.8	14.5	143.3	9.3
4	Digital Equipment	42,856	-	98.7	3.6	102.3	6.6
5	Fujitsu	8,105	26.9	48.2	25.3	100.5	6.5
6	MicroCADAM	-	88.2	-	4.6	92.8	6.0
7	Hewlett-Packard	15,422	19.0	43.4	11.0	73.4	4.7
8	Argo Graphics*	1,368	2.3	32.7	-	67.1	4.3
9	Investronica SA	-	10.6	10.6	7.9	42.8	2.8
10	Toshiba*	3,397	20.0	20.8	3.7	40.8	2.6
11	Hakuto*	1,176	13.4	15.4	1.2	30.0	1.9
12	Andor*	495	17.8	5.2	-	27.7	1.8
13	Sumisho Electronics*	1,083	5.1	8.8	-	27.4	1.8
14	Hitachi	1,436	11.4	12.4	2.6	26.4	1.7
15	Tebis	194	8.9	2.6	5.4	18.5	1.2
16	Cimatron	-	12.5	-	2.6	15.1	1.0
17	Design Automation	-	11.2	3.6	0.2	15.0	1.0
18	CAD Lab	423	5.9	3.3	4.0	14.4	0.9
19	Mutoh Industries*	532	4.0	5.9	1.3	13.5	0.9
20	Wiechers Datentechnik	250	8.3	2.6	1.9	12.8	0.8
21	Computervision	-	7.8	-	4.3	12.1	0.8
22	MCS	40	8.1	0.2	1.5	10.0	0.6
23	Formtek	115	6.2	0	3.7	10.0	0.6
24	Mitsubishi Electric*	517	1.9	2.8	-	8.7	0.6
25	CNC Software	-	8.7	-	-	8.7	0.6
26	ADRA Systems	-	5.4	-	2.5	7.8	0.5
27	BCT GMBH	-	4.7	1.6	1.6	7.8	0.5
28	Serbi	585	5.6	1.7	-	7.4	0.5
29	Bentley Systems	-	6.4	-	0.8	7.2	0.5
30	CADKEY	-	7.2	-	-	7.2	0.5
	Other Companies	103,815	-	241.4	-	241.4	15.6
	All North American Companies	80,132	414.8	265.6	47.5	728.2	47.1
	All European Companies	2,461	91.5	27.3	27.9	164.5	10.6
	All Asian Companies	35,419	92.1	245.3	50.9	411.3	26.6
	All Companies	221,827	598.4	779.6	126.3	1,545.4	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Company statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (February 1997)

Table C-5
1996 CAD/CAM/CAE/GIS Total Vendor Market Share Table (Revenue in $M)
Top Mechanical Software Companies, Worldwide, Host/Proprietary

Rank	Company Name	CPU Shipments	Software Revenue	CPU Revenue	Service Revenue	Total Distribution Revenue	1996 Share of Market (%)
1	IBM	565	70.5	135.2	95.0	369.5	57.2
2	Digital Equipment	3,340	-	294.1	49.6	343.7	53.2
3	Dassault	-	27.4	-	4.8	32.2	5.0
4	MacNeal-Schwendler	-	25.6	-	2.2	27.8	4.3
5	Nihon Unisys	4	0.8	0.5	14.9	16.5	2.6
6	Fujitsu	-	7.7	-	7.0	14.7	2.3
7	Hitachi	369	2.3	2.0	0.6	4.9	0.8
8	Mitsubishi Electric*	12	0.9	1.1	-	4.5	0.7
9	Exapt	49	1.3	0.9	0.5	3.7	0.6
10	C. Itoh Techno-Science*	-	1.7	0.7	0.5	3.3	0.5
11	Mechanical Dynamics	-	1.7	0	1.2	2.9	0.5
12	Intergraph	-	-	-	2.5	2.5	0.4
13	Toyo Information Systems*	12	0.6	0.7	0.2	1.7	0.3
14	Ansys	-	1.3	-	0.1	1.4	0.2
15	Kubota Computer	-	0.5	-	0.2	0.7	0.1
16	Century Research Center	1	0.2	0.1	0.1	0.6	0.1
17	Altair Computing	-	0.2	-	0.3	0.5	0.1
18	Access Corporation	-	0.2	-	0.2	0.4	0.1
19	Whessoe Computing Systems	-	0.4	-	-	0.4	0.1
20	Computational Mechanics	-	0.4	-	-	0.4	0.1
21	debis Systemhaus	-	0.3	0	0	0.4	0.1
22	Sherpa Corporation	-	0.2	-	0.1	0.4	0.1
23	Cimtel	1	0	0.1	0.2	0.3	0.0
24	Framasoft	-	0.2	-	0.1	0.3	0.0
25	CIMTEK	3	0.1	0.1	0.1	0.3	0.0
26	Technodia*	-	0	-	-	0	0.0
	All North American Companies	2,169	86.4	288.5	151.1	594.8	92.0
	All European Companies	53	2.3	1.1	5.7	10.2	1.6
	All Asian Companies	398	10.6	5.1	23.5	41.2	6.4
	All Companies	2,620	99.3	294.7	180.3	646.2	100.0

Note: Vendor data includes OEM revenue, so sum of vendors is greater than total.
*C
.ompany statistics contain VAR/distributor revenue not counted in total.
Source: Dataquest (February 1997)

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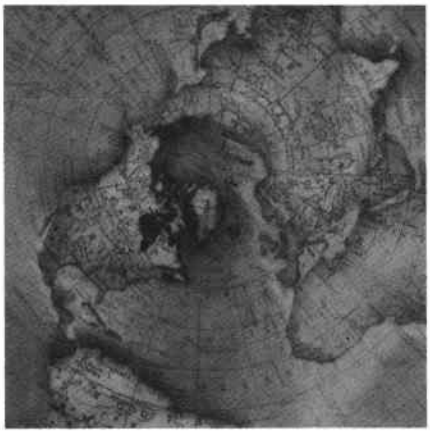

Dataquest

UNIX-Based Users in Mechanical Design: An End-User Study

User Wants and Needs

Program: Mechanical CAD/CAM/CAE Worldwide
Product Code: CMEC-WW-UW-9701
Publication Date: June 23, 1997
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Chapter 1
Executive Summary

Introduction

Each year, Dataquest's Mechanical CAD/CAM/CAE Worldwide program performs an extensive survey of mechanical designers and reports on their shifting priorities, needs, and demands. For mechanical CAD/CAM/CAE vendors to be successful, they must have a thorough understanding of their target customer base. Dataquest's research of mechanical engineers and designers provides an insightful look into their preferences, tool and vendor satisfaction, and spending plans. In particular, this survey focuses on those North American designers using primarily UNIX-based mechanical CAD packages. Dataquest's market statistics show that the mechanical market is driven primarily by UNIX-based purchases of mechanical CAD packages. In 1996 alone, UNIX-based mechanical CAD software revenue comprised nearly 75 percent of the market. As a result, this survey was designed to gain a keen understanding of this group of users who tend to spend more money on CAD systems.

Study Objectives and Methodology

This study examines users of mechanical CAD/CAM/CAE systems. This report is based on the results of a May 1997 telephone survey in North America of 198 managers and professionals deeply involved in the mechanical design process. The specific objectives of this study are the following:

- To understand the user of UNIX-based mechanical CAD/CAM/CAE systems
- To advance understanding of what these users need to be successful
- To characterize UNIX-based mechanical CAD users, their environments, and their spending expectations

Key Survey Highlights

Major findings of Dataquest's survey include the following:

- Mechanical CAD/CAM/CAE is a mature technology, with UNIX-based users having several years of experience. In some industries, mechanical CAD technology is now facing the prospect of saturation and growth by replacement seats instead of new sales.
- Unlike PC-based mechanical designers, use of both computer-aided manufacturing(CAM) and computer-aided analysis (CAE) tools is high among UNIX-based respondents, which points to a need for seamless integration among CAD, CAM, and CAE.
- For the most part, the UNIX-based mechanical designers in the survey design in 3-D. Reasons for not designing in 3-D ranged from the ability of 2-D CAD to meet needs to the high cost of 3-D CAD packages.

- The Standard for the Exchange of Product Data (STEP) standard, aimed at management of data throughout a product's life cycle, is seen as one solution to the data translation problem. STEP has been drawing the interest of the CAD community for quite some time, but this survey shows that it still has many years to go until it is widely recognized.
- According to respondents, UNIX will indeed cede some ground to Windows NT in CAD. Actual movement of UNIX-based CAD users to NT-based CAD systems will occur, but not at lightening speed. Instead, it will happen in a gradual, more predictable fashion.
- Slightly over one-half of UNIX-based respondents are expecting increased mechanical CAD/CAM/CAE software and hardware spending over the next year. On the other hand, spending for mechanical CAD/CAM/CAE service and maintenance, application development, and consulting is expected to remain at about the same levels for many respondents.
- Despite the maturity of the technology, users are still not completely satisfied with their mechanical CAD/CAM/CAE solutions. Satisfaction ratings are still less than importance ratings for all basic CAD/CAM/CAE software functionality, such as detailing and assembly design capabilities.
- Similarly, mechanical designers are not completely satisfied with their CAD vendors' service and software performance. Software stability still ranks as a top concern for UNIX-based designers, as does vendor service and support.

Dataquest Perspective

The experiences and satisfaction of UNIX-based mechanical CAD users are not significantly different from PC-based mechanical designers. Among both groups, users are quick to express dissatisfaction with their CAD/CAM/CAE solutions and their CAD vendors. Despite mechanical CAD/CAM/CAE's lengthy history, user desires are still one step above what vendors are providing. If anything, UNIX-based designers are slightly more dissatisfied than their PC-based counterparts.

Mechanical CAD/CAM/CAE technology has become indispensable to many organizations. Many of the obstacles that the technology faces today are broader in scope than just designing. Users understand the benefits of CAD but are looking beyond CAD to integration issues, design processes, and related technologies.

Mechanical CAD/CAM/CAE opportunities are diverse and proliferating, and no vendor can hope to address the needs of all potential customers. Choosing which applications to develop, which user needs to concentrate on fulfilling, and which capabilities to incorporate into future product offerings will be a challenge to all vendors and a key to further development of the mechanical CAD/CAM/CAE market.

Project Analyst: Sharon Tan

Market Research Analyst: Robert Thornhill

Chapter 2
Study Foundations and Methodology

Survey Methodology

The survey questionnaire was developed by analysts from Dataquest's Mechanical CAD/CAM/CAE Worldwide program and consisted of about 150 questions. The end-user data was gathered via a telephone survey conducted in May 1997. The results were entered into a statistical analysis package for analysis of the data. In total, 198 surveys were completed.

Any data point collected in the survey can form the basis of a cross-tabulation. Special cuts of the data (such as by computer platform used or software package) are available to Dataquest's Mechanical CAD/CAM/CAE Worldwide program clients by special request. However, the identities of the end users surveyed are strictly confidential.

Sample Criteria

In this survey, the respondents needed to meet specific criteria (namely, having a UNIX-based mechanical CAD/CAM/CAE system in development or in place) to qualify for participation. Interview candidates were generated from a variety of sources, including magazine subscriptions, in-house databases, and previous respondents to end-user surveys.

Interviewing Procedures

The 20- to 30-minute telephone surveys were conducted by trained interviewers at Dataquest's primary research facility in San Jose, California. The interviews were conducted using an online computer-aided telephone interviewing (CATI) system. The interviewing facility is equipped with monitoring stations that are used for quality control purposes throughout the data collection process.

A total of 198 interviews were completed. These completed interviews were checked, validated, and tabulated by a Dataquest Research Operations analyst. An analyst from Dataquest's Mechanical CAD/CAM/CAE Worldwide program analyzed the results and prepared the final written analysis.

Statistical Accuracy

A totally random sample size of 198 achieves the statistical significance level of 95 percent, plus or minus 7 percent. This means that 95 percent of the time, one can be certain that the results are characteristic of the population within 7 percentage points. All of the percentages in this report are estimates and are subject to the usual limitations of survey research. The sample excluded sites that did not identify a UNIX-based mechanical CAD/CAM/CAE system as their primary design package. The characteristics of noncontacted and noncooperating sites could have changed the survey results.

Definitions

Some questions asked respondents to evaluate opinion-based statements on the extent of agreement with certain statements or software vendor attributes on importance and satisfaction. These questions asked the individual to respond using a five-point scale. The following rating system ranges were used:

- From 1 for "strongly disagree" to 5 for "strongly agree"
- From 1 for "not at all important" to 5 for "very important"
- From 1 for "not at all satisfied" to 5 for "very satisfied"

The terms "mean" and "median" are used periodically in presenting survey results. These terms are defined as follows:

- Mean—The arithmetic mean, or average, of responses
- Median—The midpoint of the distribution of responses (that is, half of the responses are above and half are below this midpoint of the distribution)

Structure of the Document

The remainder of this document is organized as follows:

- Chapter 3, "Mechanical CAD Technology Today," characterizes the UNIX-based mechanical designer today. We begin by examining the use of CAD/CAM/CAE within a company, including user experience with CAD systems, CAD saturation points, file formats, and data transfer methods. We investigate 3-D design and hindrances to its more widespread use, and we question users about their prospects for the STEP standard.
- Chapter 4, "The Designer's Work Environment and Future Purchasing Plans," characterizes the environment in which the engineer works. We discuss operating system plans, CAD seat count changes, and anticipated future budgets for CAD-related hardware, software, and service. We also investigate how quickly deployment of Microsoft's Windows NT operating system will take place in the mechanical design world, according to end users.
- Chapter 5, "Mechanical Application Perceptions," reveals what designers think of the mechanical applications they use—what benefits have they seen, what CAD functionality and characteristics they seek, and what influences their purchasing decisions. Users rate the importance and satisfaction of a number of factors related to CAD/CAM/CAE and the engineering design process.
- Chapter 6, "PDM Interests" takes an exclusive look at this hot market. We characterize today's users of PDM tools, factors influencing PDM deployment, and potential for future growth.

While reading this report, it is important for the reader to keep in mind that the respondents to this survey identified a UNIX-based mechanical CAD system as their primary design system. While there are a number of PC-based users out there, this survey was specifically designed to understand the needs of the traditional high-end mechanical CAD users and to examine what this group's future CAD computing needs and spending plans are.

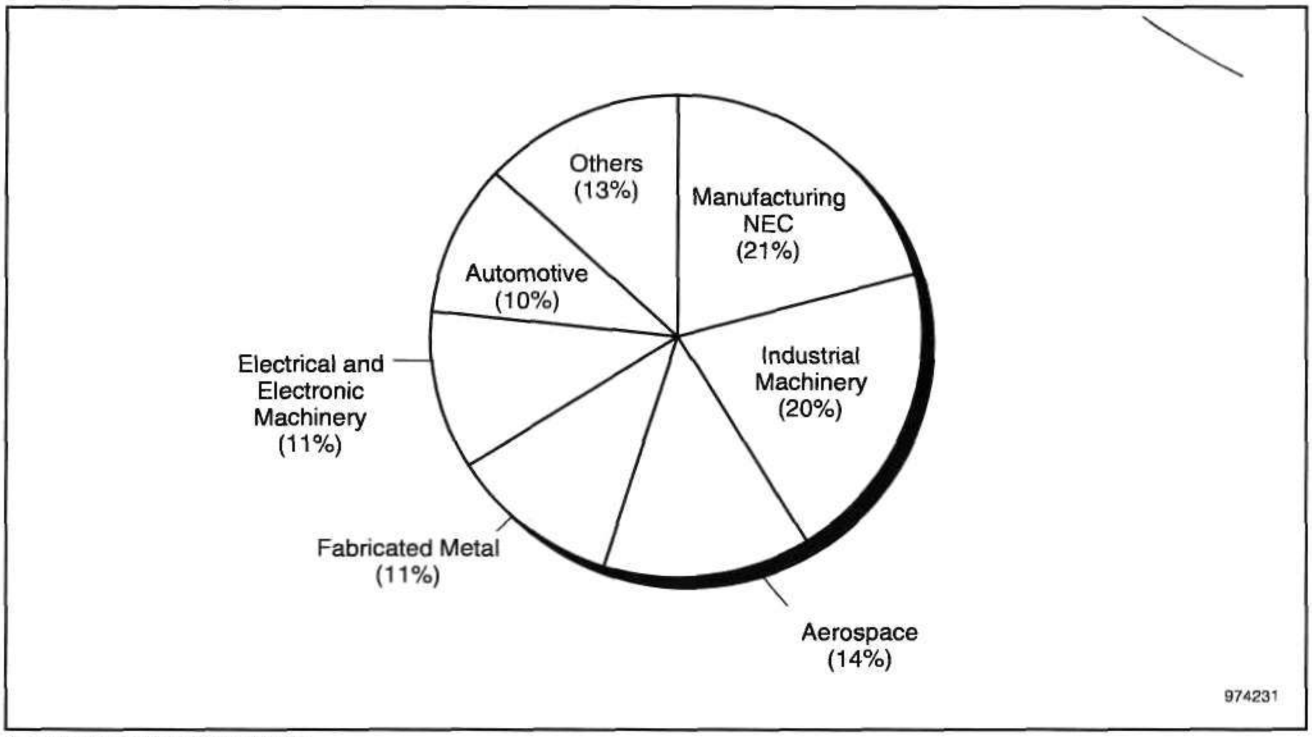
Respondent Demographics

Figure 2-1 gives the respondent breakdown by industry. The data represents a wide cross section of prominent industries in North America. The category "Manufacturing NEC" consists of those respondents in discrete manufacturing that do not fit into one of the categories in Figure 2-1. (Most of the "Manufacturing NEC" respondents were in medical manufacturing, computers, or consumer electronics; NEC means "not elsewhere classified.") The category "Others" consists of those respondents in services, government, and telecommunications. Further analysis in this report will be based on those industry classifications.

Respondent breakdown by job title is given in Figure 2-2. This survey has a high proportion of engineers and designers who use CAD/CAM/CAE tools in their daily jobs. Dataquest also surveyed a number of managers and system administrators who are knowledgeable about future CAD purchases, budgets, and spending plans. Respondent company size varied from less than 10 employees to greater than 10,000 (see Figure 2-3). Overall, respondents from this survey appear to come from larger companies than in previous surveys.

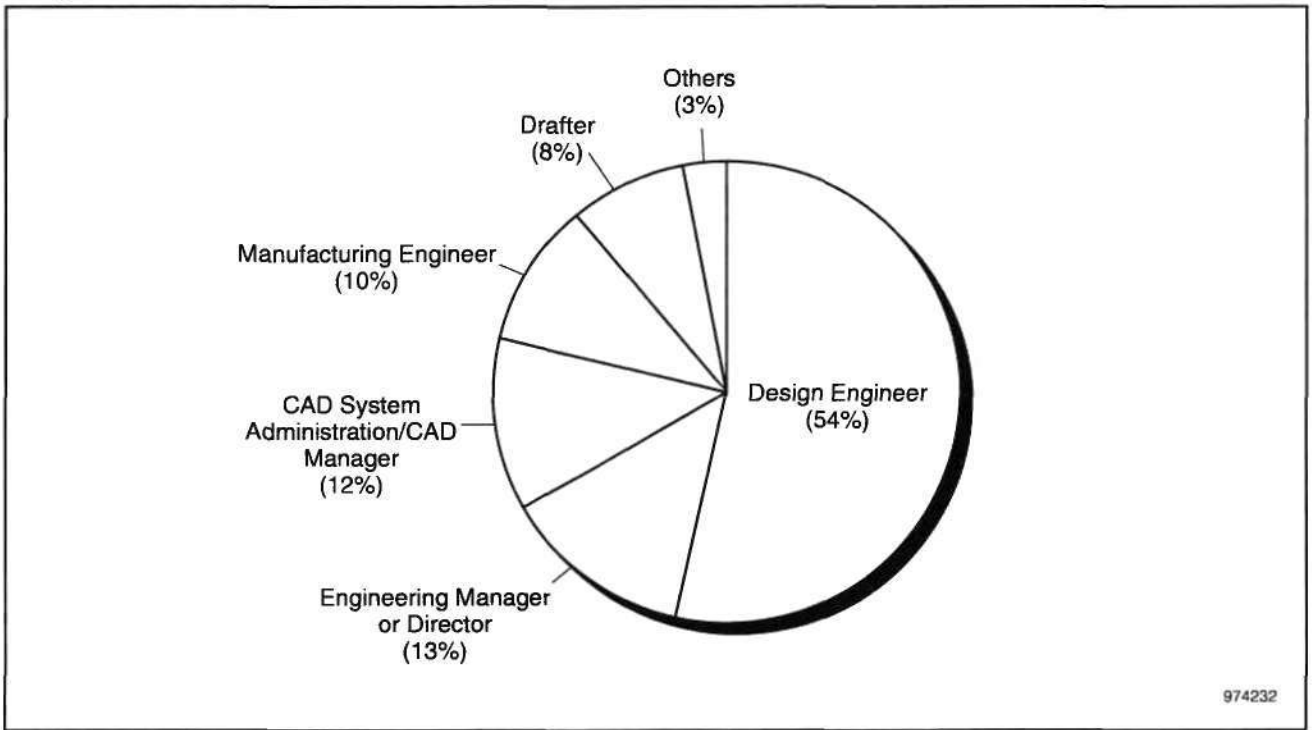
The most commonly cited primary CAD package used by respondents were those packages from Parametric Technology (49 responses), followed by EDS Unigraphics (30 responses), and SDRC (20 responses). However, because of the limited number of responses for some of the vendors, Dataquest will not present survey results segmented by CAD vendor.

Figure 2-1
Respondents by Industry



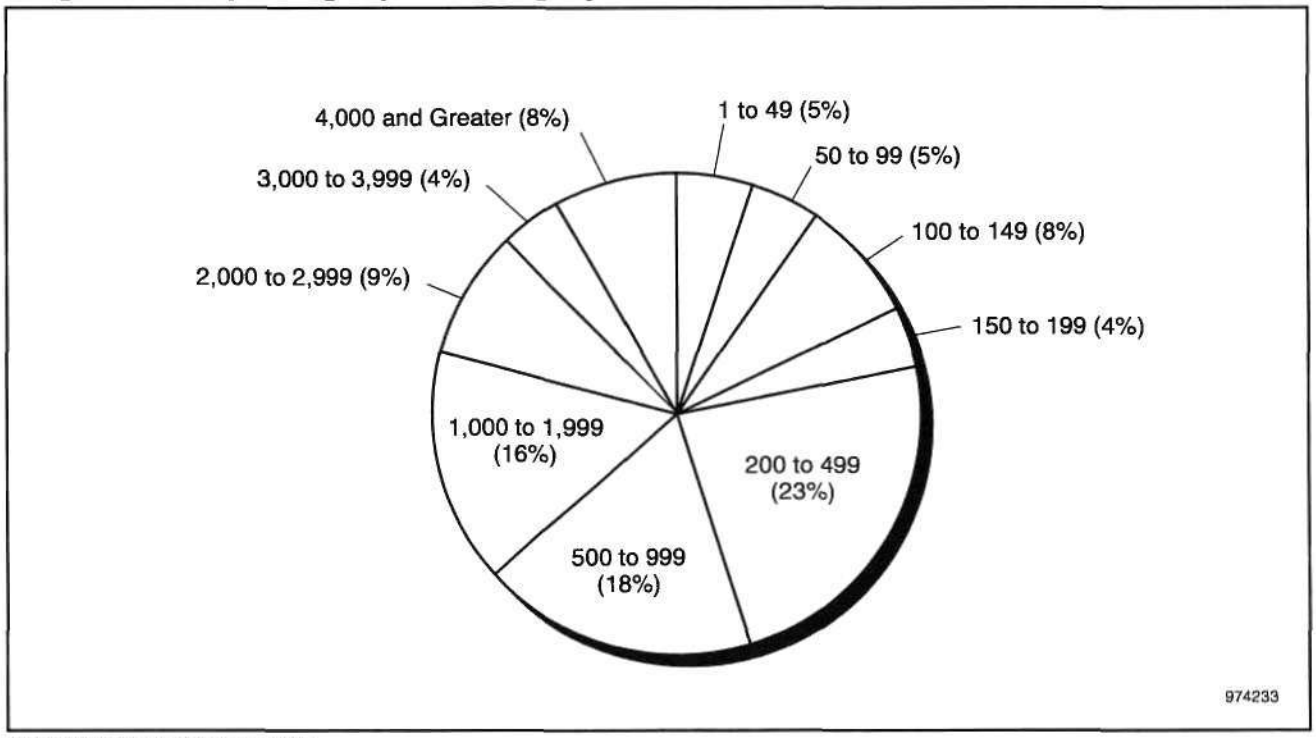
Source: Dataquest (June 1997)

Figure 2-2
Respondents by Job Title



Source: Dataquest (June 1997)

Figure 2-3
Respondents by Company Size (Employees)



Source: Dataquest (June 1997)

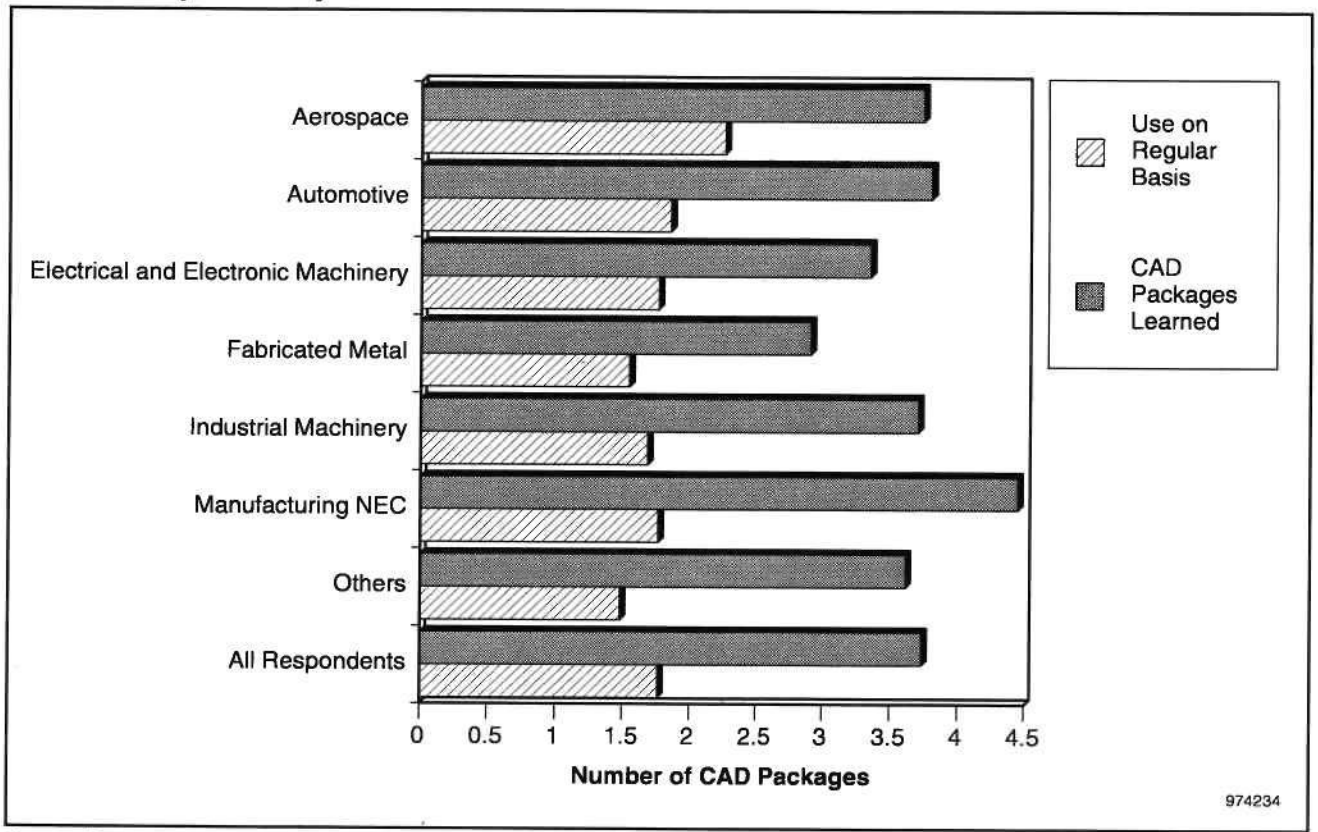
Chapter 3
Mechanical CAD Technology Today

Experience Base of Respondents

The respondent group as a whole is well-experienced with several years of hands-on use. The experience base of survey respondents was, on average, 11 years. Little variation was seen by industry. The median for years of experience was 10 years; the maximum was 30 years.

Dataquest asked respondents how many CAD packages they have learned and use on a regular basis. The results, by industry, are shown in Figure 3-1. On average, respondents have learned to use 3.7 mechanical CAD packages (with respondents in fabricated metals having learned the fewest). Respondents regularly use 1.8 CAD packages, with those in aerospace using the most.

Figure 3-1
CAD Use by Industry



Source: Dataquest (June 1997)

Is Mechanical CAD Reaching Saturation?

No doubt, mechanical CAD/CAM/CAE is a mature technology that is now facing the prospect of saturation and growth by replacement seats instead of new sales. One way to gauge the saturation point for CAD is to look at just how many people use CAD and what the total available market is for that technology. Dataquest asked respondents how many technical professionals work at their site (an indicator of the total available market for CAD), how many of these work on a CAD/CAM/CAE system, and how many would work on a CAD system under ideal circumstances (where budgets and training are not issues). The results are summarized in Figure 3-2 and Table 3-1.

For all respondents, the average number of professionals working on a CAD/CAM/CAE system was 125 professionals, and the ideal number was slightly less at 111 professionals. These two numbers imply that, among sample respondents, CAD may have reached its saturation point. However, the total number of technical professionals for all respondents was 293 professionals, more than twice the number of professionals working on CAD. Optimistic readers would interpret this as a large opportunity to put a CAD system on every technical professional's desk.

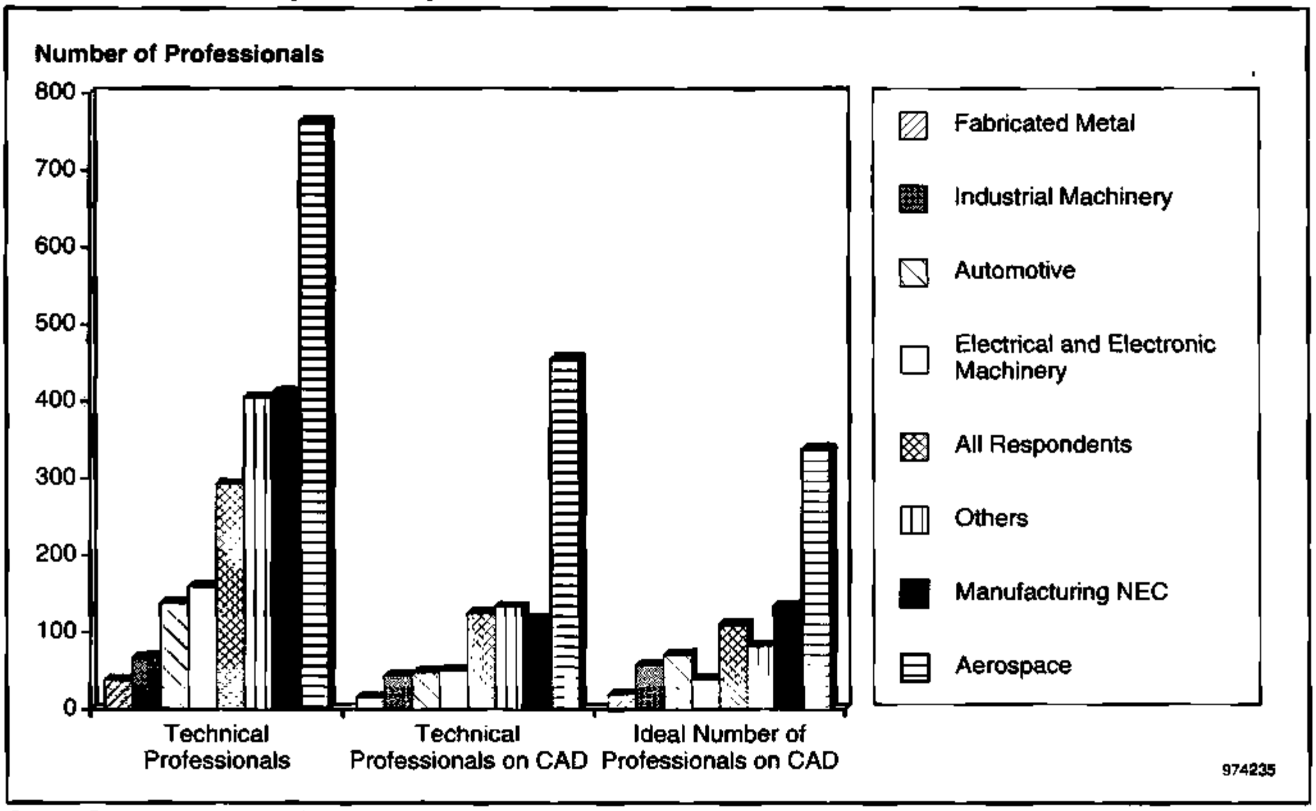
Interestingly, the data from this survey hints at CAD saturation levels in aerospace, electrical and electronic machinery, and the "Others" category (again, mostly government, services, and telecommunications). Each of these industries indicated that in an ideal situation, the number of professionals working on a CAD system would be fewer than are currently working on the system. The industry showing the greatest potential for increased CAD/CAM/CAE systems is automotive, where both the number of ideal CAD workers and the number of total technical professionals are much higher than the number currently working on a CAD system.

Customization and Integration

Customization is nothing new to users of mechanical CAD systems. Most vendors have realized this and include customization tools in their software offerings. The majority of mechanical CAD/CAM/CAE users continue to do some customization of their systems—21 percent of respondents said that they do "a lot" of customization and 61 percent said they do "some" customization, while 18 percent said they do no customization. The results are summarized by industry in Figure 3-3.

Some of this customization is because users often must integrate one CAD package with another, and this is particularly true among the high end UNIX-based CAD designers. Typically, these additional packages were used to either replace or supplement CAM and CAE functionality. About 61 percent of respondents use a CAM package and 61 percent use a CAE package in addition to their primary vendor's CAD package. As expected, the heaviest use of CAM was seen in the fabricated metal and industrial machinery industries, and the heaviest use of CAE was seen in electrical and electronic machinery and manufacturing NEC (again, primarily computers, consumer electronics, and medical). All of these industries have a high content of electrical and mechanical design.

Figure 3-2
CAD Penetration by Industry



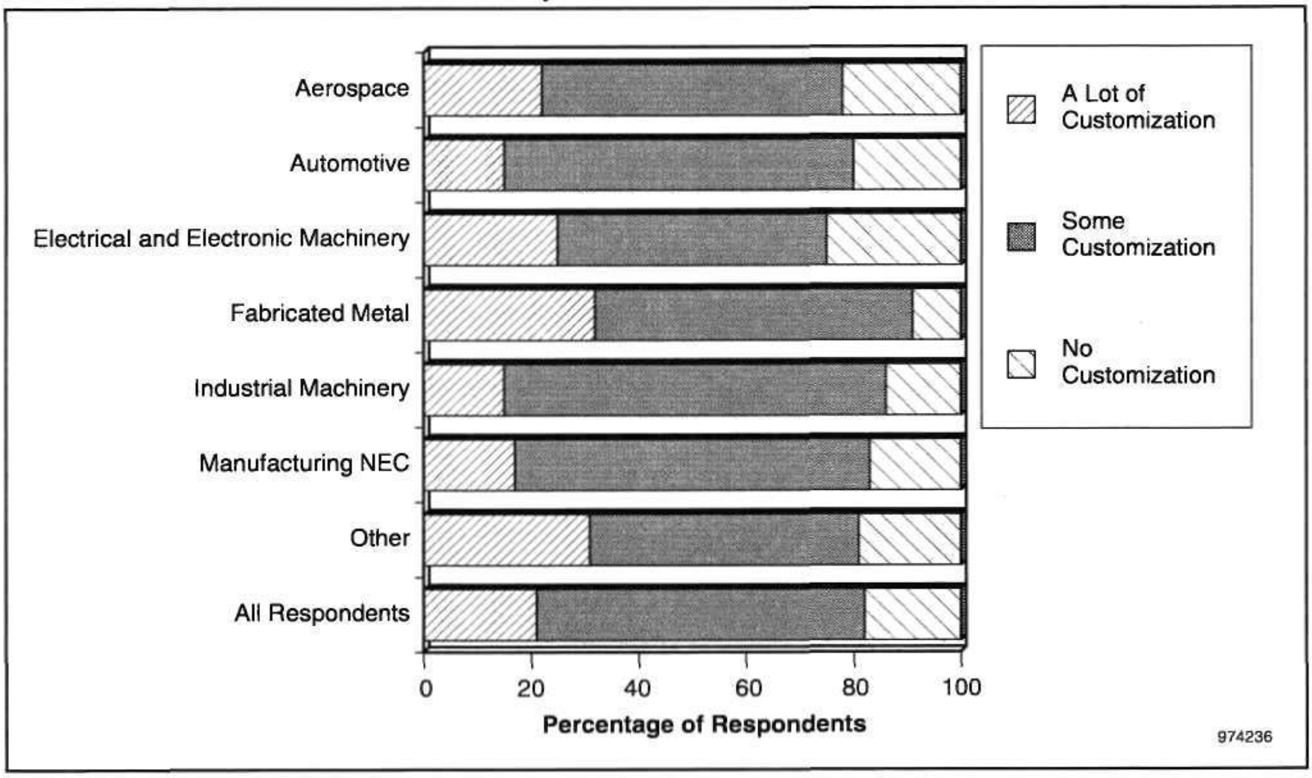
Source: Dataquest (June 1997)

Table 3-1
CAD Penetration by Industry

	Technical Professionals	Technical Professionals on CAD	Ideal Number of Technical Professionals on CAD
Aerospace	763	455	338
Automotive	139	48	71
Electrical and Electronic Machinery	160	51	39
Fabricated Metal	38	15	19
Industrial Machinery	68	44	58
Manufacturing NEC	411	117	134
Others	406	134	83
All Respondents	293	125	111

Source: Dataquest (June 1997)

Figure 3-3
Customization of CAD/CAM/CAE Systems



Source: Dataquest (June 1997)

New Designs or Modifications

Not all discretely manufactured products are based on completely new designs. On the contrary, mechanical designers and engineers must spend some of their time modifying existing parts and assemblies instead of designing new parts from scratch. We asked respondents what is the proportion of new parts designed to existing parts that are modified. On average, 53 percent of parts and assemblies are modifications and 47 percent are completely new designs. The amount of modifications done points to a need to preserve legacy data in a form that will be accessible in the future.

Designing in 3-D versus 2-D

For the most part, the UNIX-based mechanical designers in this survey design in 3-D. Details by industry are given in Table 3-2. Aerospace users report significantly higher use of 3-D design than other industries; in fact, 85 percent of these respondents consider 3-D their main form of design and tend to use more of the 3-D functionality that is available to them. At the other end of the spectrum, slightly more than one-half of those designers in fabricated metals consider 3-D their primary design method, and this group of users only uses 55 percent of the 3-D functionality available in their systems. Surprisingly, only 55 percent of automotive respondents stated that their main design method is 3-D. This figure is much lower than results from previous end-user surveys. However, as expected, the amount of 3-D functionality they use is above the average for all respondents.

Table 3-2
Is 3-D Design the Main Method of Design?

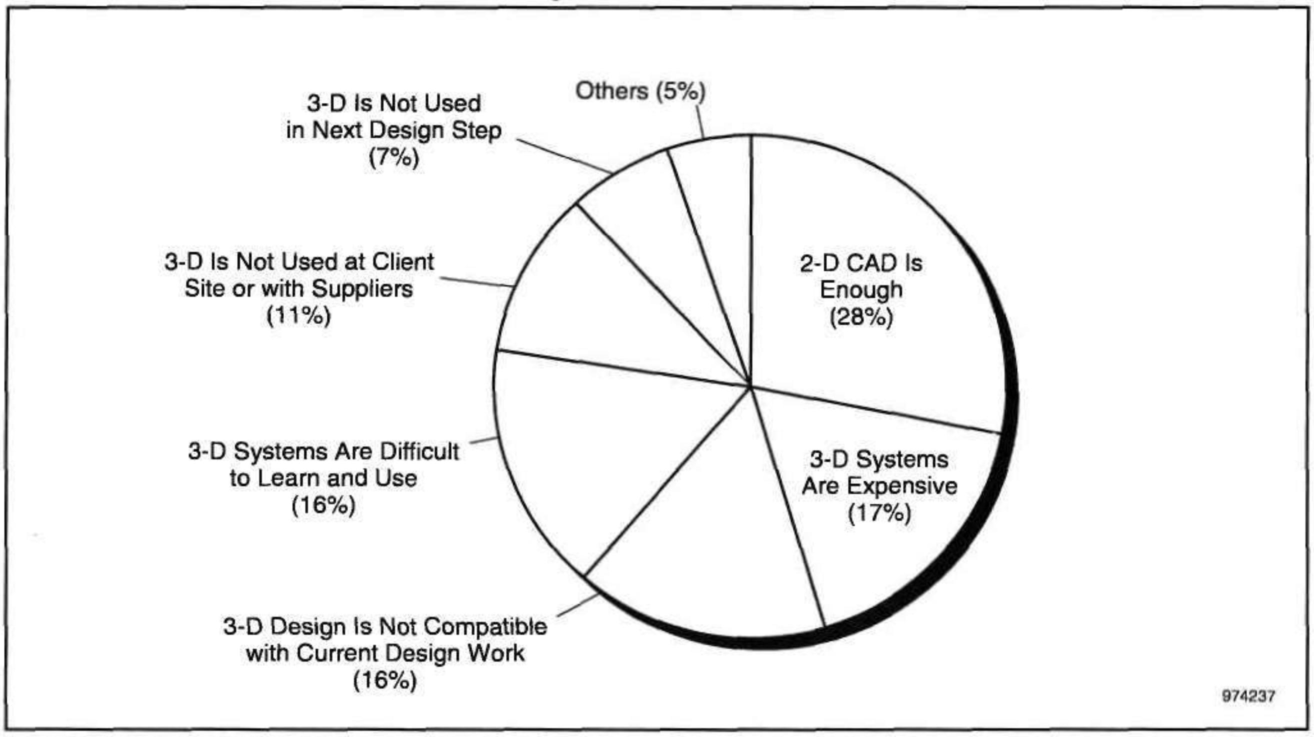
	Yes (%)	No (%)	Percentage of 3-D Functions Used
Aerospace	85	15	73
Automotive	55	45	71
Electrical and Electronic Machinery	71	29	60
Fabricated Metal	55	45	55
Industrial Machinery	65	35	62
Manufacturing NEC	76	24	66
Others	77	23	70
All Respondents	70	30	66

Source: Dataquest (June 1997)

Reasons for Staying with 2-D

Of those users who do not consider 3-D to be their main form of design, Dataquest asked if it would become the main form by 1999. Fifty-seven percent of these respondents said yes, 37 percent said no, and the remainder did not know. Users cited many reasons for not planning to change to 3-D CAD by 1999. By far, the most commonly cited reason was that 2-D CAD is enough to meet their needs. All reasons are summarized in Figure 3-4. Interestingly, despite the proliferation of relatively inexpensive (compared to UNIX-based packages) 3-D CAD packages with graphical user interfaces and multimedia-based learning tools, there is still the perception out there that 3-D CAD systems are expensive and difficult to learn and use.

Figure 3-4
Reasons for Not Moving to 3-D Design Methods



Note: Multiple responses allowed
Source: Dataquest (June 1997)

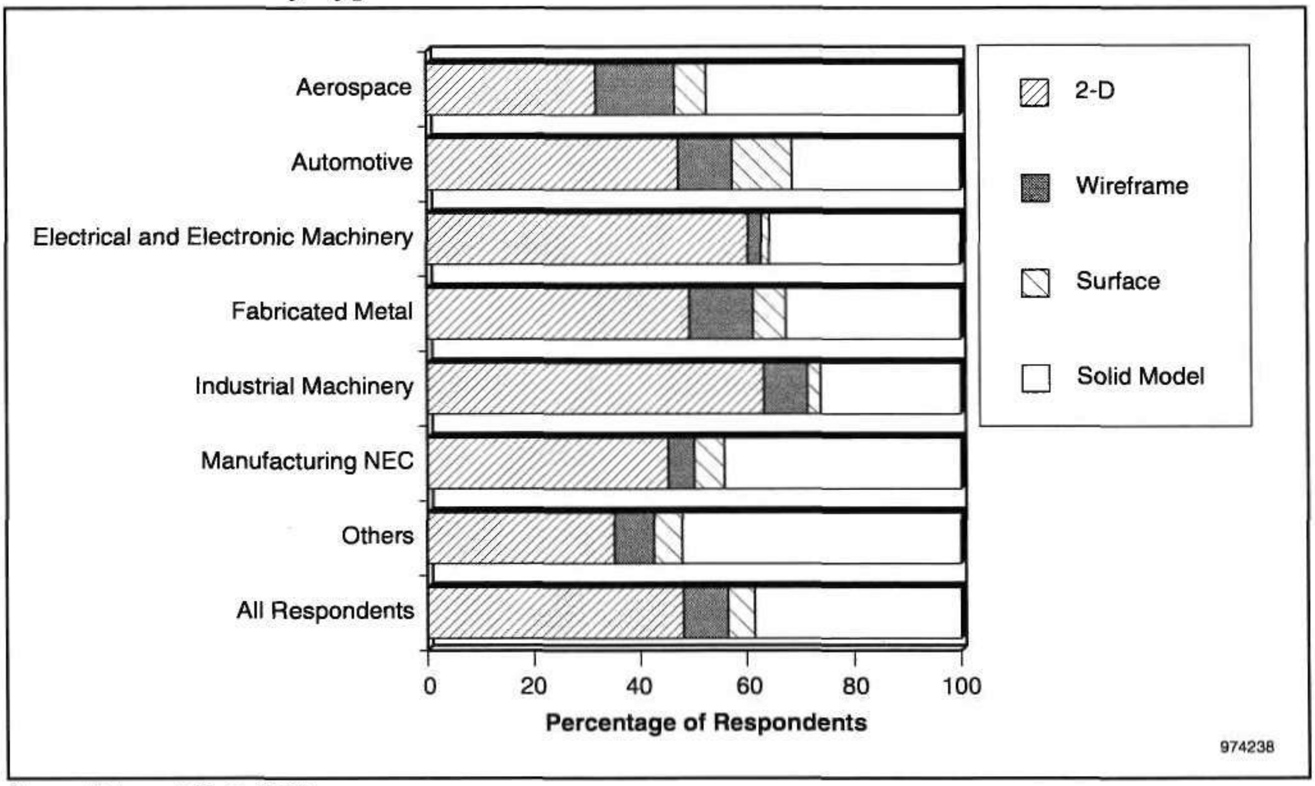
CAD File Types

The mix of data file types is key to gaining an understanding of the level of use of various modeling technologies, including 3-D, and also points to the level of graphics performance necessary to view and edit design data as it is retrieved. Figure 3-5 shows the mix of files stored by modeling technology and industry. All respondents have a mix of 2-D or 3-D wire frame, surface, and solid model files. Despite the high percentage of respondents indicating 3-D design as their primary design method, data is most commonly stored as 2-D files, particularly in industrial machinery and electrical and electronic machinery. Those in automotive have a particular need to store files as surface models, as shown in Figure 3-5.

Methods for Transferring Design Files

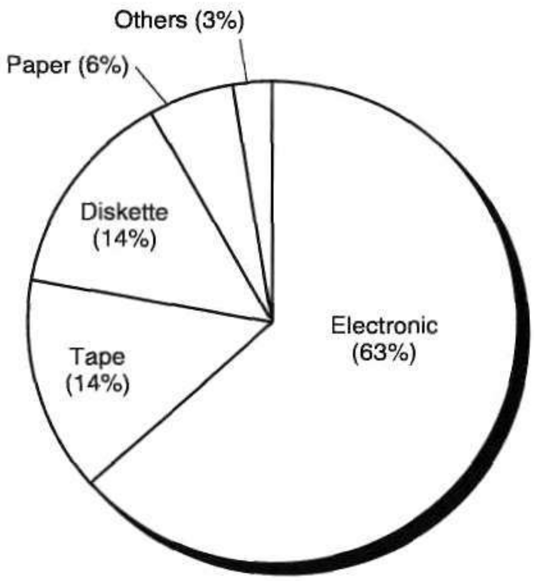
Despite the relative sophistication of the survey sample, file transfer methods appear to be one step behind. Dataquest asked respondents to identify the main method for transferring design files from one system to another. While electronic methods dominate (such as through the Internet or via a direct link with a supplier or other site), files are still being transferred the manual way (on paper) or via "sneakernet" (on diskette). The results for all respondents are given in Figure 3-6.

Figure 3-5
Data Files Stored by Type



Source: Dataquest (June 1997)

Figure 3-6
Primary Method for Transferring Design Files



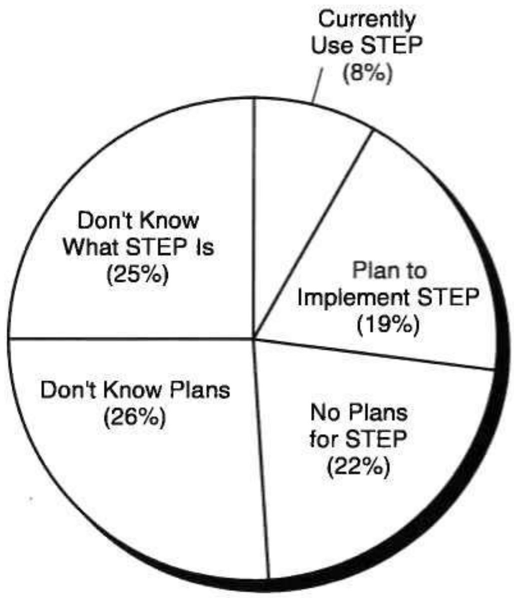
Source: Dataquest (June 1997)

The STEP Standard

Data translation issues are one of the topics that surface in nearly all of Dataquest's CAD surveys. Users want the ability to transfer data between different CAD/CAM/CAE systems with a minimum of fuss and rework. The Standard for the Exchange of Product Data standard, aimed at management of data throughout a product's life cycle, is seen as one solution to the data translation problem. STEP has been drawing the interest of the CAD community for quite some time, but this survey shows that it still has many years to go until it is widely accepted and used.

Specifically, Dataquest asked users what their plans for the STEP standard are. The results are given in Figure 3-7. The highest rates of STEP use or plans are among designers in the automotive industry. This comes as no surprise, as much of the STEP development has been spearheaded by efforts in the automotive arena. These users also showed among the greatest awareness of STEP; only 20 percent did not know what STEP is. Respondents in industrial machinery reported the highest "no plans for STEP," and those in fabricated metal reported the least awareness of the STEP standard. In any case, the lack of awareness of STEP is still quite high for all industries. This mirrors the results in Dataquest's 1995 European end-user survey, where standards are generally given more consideration than they are in North America.

Figure 3-7
STEP Plans



Source: Dataquest (June 1997)

Collaborative Engineering

Just this year, the industry has seen concurrent or simultaneous engineering being replaced by collaborative engineering as the hot topic—at least among CAD vendors. Dataquest decided to investigate, from a CAD user's perspective, if the term "collaborative engineering" was a familiar one. (Respondents were not asked for a definition of collaborative engineering.) The results are displayed in Table 3-3.

While respondents in previous surveys were overwhelmingly familiar with the term "concurrent engineering," awareness of collaborative engineering is sharply lower. Less than half of the respondents were familiar with the term. In particular, those most familiar with the term came from the automotive and "Others" categories; those least familiar with the term were from fabricated metal, industrial machinery, and aerospace. It is surprising that so few aerospace respondents were familiar with the term. Automotive and aerospace users tend to be more advanced in their use of CAD and are often involved in large projects that encompass many groups of designers and lengthy design cycles—hence the need for some sort of collaborative engineering. At the other end of the spectrum, those users in fabricated metal tend to be designing discrete parts in smaller workgroups and the need for collaborative engineering principles here is undoubtedly less urgent. Dataquest would expect to eventually see a high awareness of collaborative engineering among industries that involve multiple disciplines (such as in consumer electronics, where electrical and mechanical disciplines must work together).

Table 3-3
Familiarity with Collaborative Engineering

	Familiar with Term (%)	Not Familiar with Term (%)
Aerospace	33	67
Automotive	70	30
Electrical and Electronic Machinery	48	53
Fabricated Metal	35	65
Industrial Machinery	36	64
Manufacturing NEC	48	53
Others	62	38
All Respondents	47	53

Source: Dataquest (June 1997)

The World Wide Web

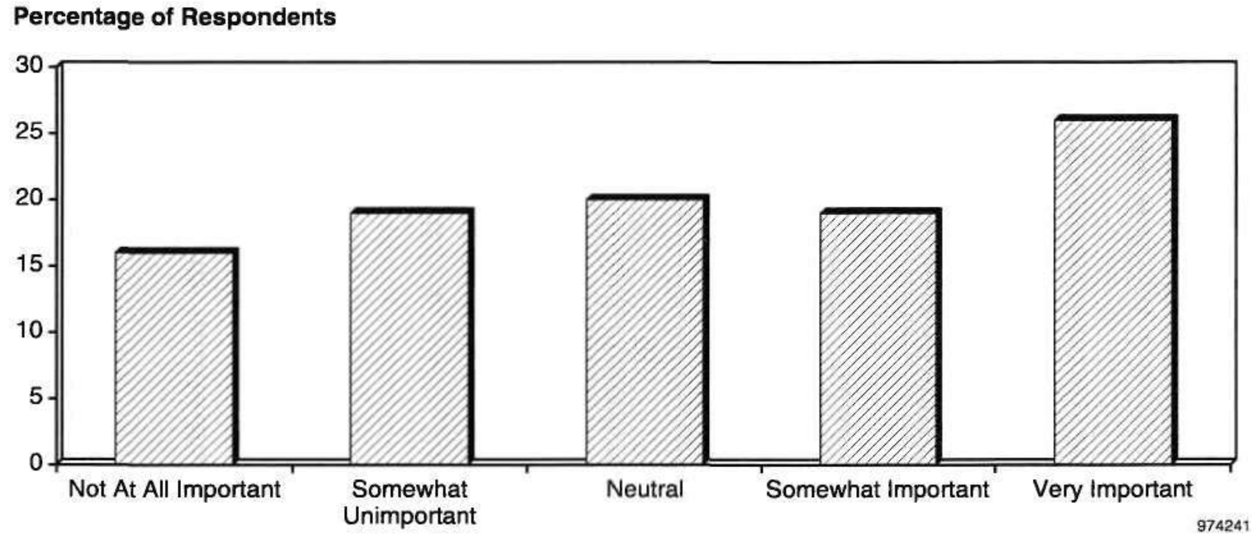
The explosion of the Internet and the World Wide Web has led many CAD/CAM/CAE vendors to implement some sort of Web-based strategy, which may be as simple as Web-enabling their software, or more complex, such as designing a "collaborative engineering" environment based on the Web. This survey shows that users, too, are interested in the Web, but there is no strong consensus as to how they actually need to use the Web.

Dataquest asked respondents if they had access to the World Wide Web at their site—78 percent of respondents said they did. However, respondents tended to be neutral about the importance of Web access for their jobs (see Figure 3-8 and Table 3-4). Those respondents in automotive and electrical and electronic machinery rated Web access the lowest among all industries, while those in the manufacturing NEC and other categories rated Web access higher than average.

When respondents asked how they were using the Web, again there was no strong consensus. Personal use made up 29 percent of responses, searching for component and part information for design work comprised 32 percent of responses, and "other reasons" made up 38 percent of responses (see Figure 3-9).

Clearly, the user community is waiting for a Web-based strategy that helps them do something; they just have not identified what that "something" is. The next year should prove interesting, as vendors bring to market more elaborate Web-based strategies and users begin to mull over the potential of the Web and reach a point where they can explicitly characterize their Web-based design and manufacturing needs.

Figure 3-8
Importance of Access to World Wide Web



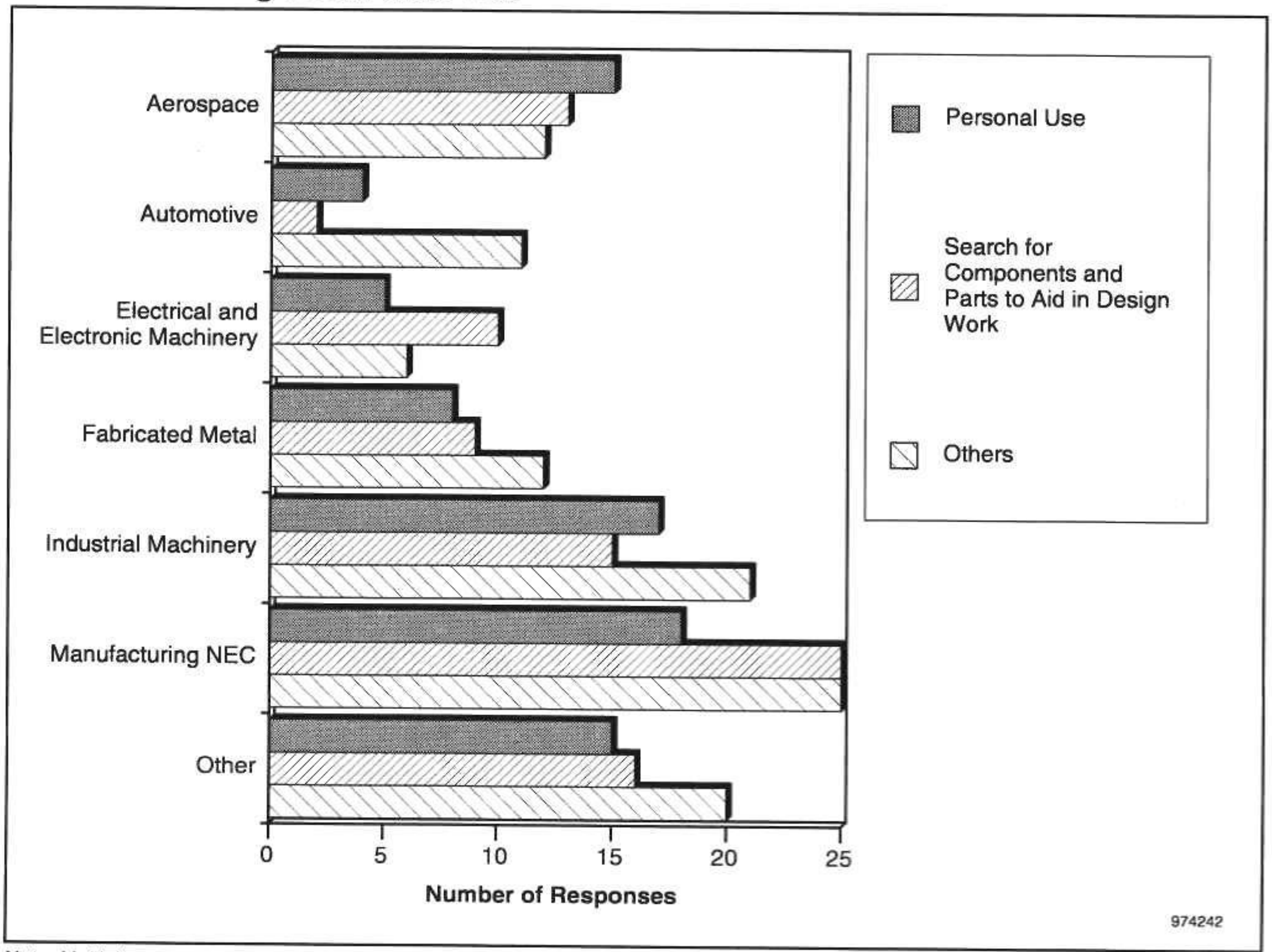
Source: Dataquest (June 1997)

Table 3-4
Importance of Access to World Wide Web by Industry

	Weighted Average of Responses
Aerospace	3.3
Automotive	2.7
Electrical and Electronic Machinery	2.9
Fabricated Metal	3.0
Industrial Machinery	3.0
Manufacturing NEC	3.6
Others	3.5
All Respondents	3.2

Note: Data shown is weighted average of responses by industry. 1 = not important, 5 = very important
Source: Dataquest (June 1997)

Figure 3-9
Reasons for Using World Wide Web



Note: Multiple responses allowed
Source: Dataquest (June 1997)

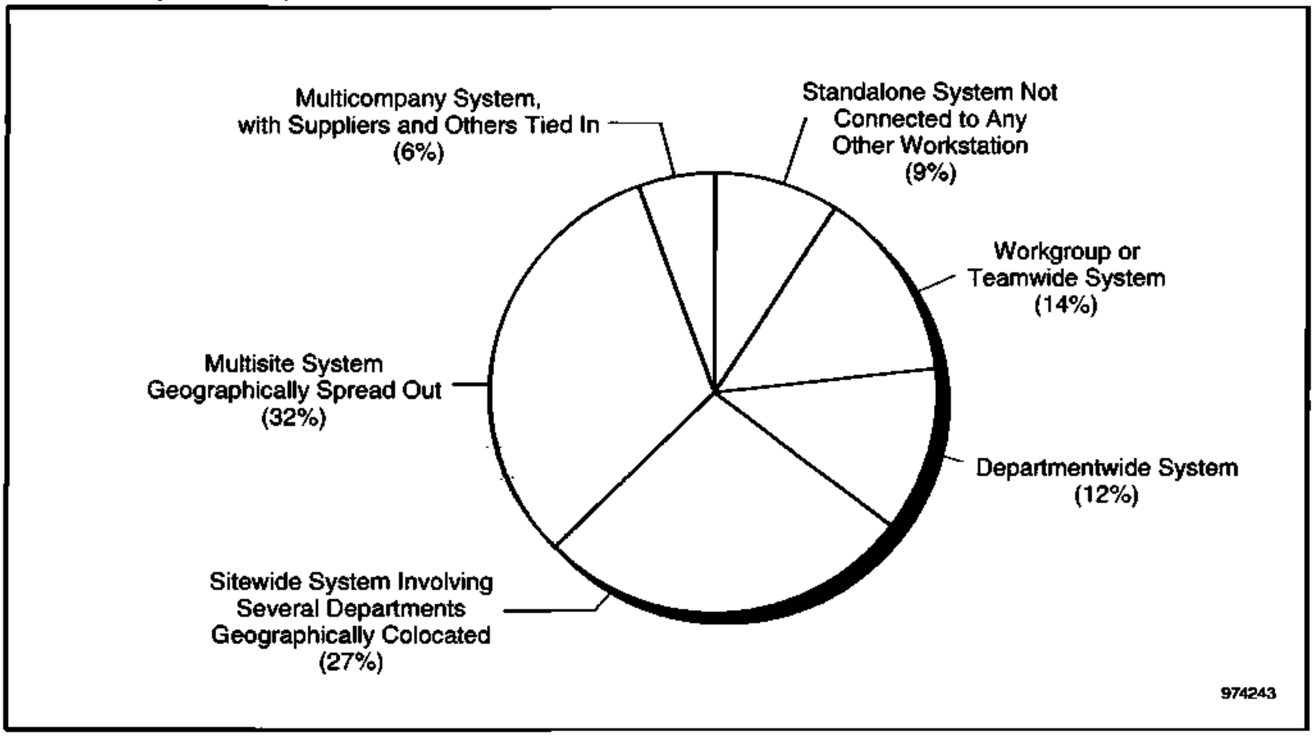
Chapter 4
The Designer's Work Environment and Future Purchasing Plans

Level of System Operation

Respondents indicated a number of levels of CAD/CAM/CAE system operation. Ninety-one percent of respondents are in some type of networked environment, as indicated in Figure 4-1. (This contrasts with previous surveys, where typically one-half of respondents work on a standalone system.) Again, this high percentage of networked environments is a result of this survey focus on UNIX-based CAD users. As in previous surveys, few respondents have reached the point where they have implemented a network with suppliers and clients tied into their system. Such an elaborate network may soon become more commonplace, given the developments being made in intranets.

Those respondents in sitewide, multisite, or multicompany system setups make up the majority of product data management (PDM) system users. PDM systems are discussed further in Chapter 6.

Figure 4-1
Level of System Operation



Source: Dataquest (June 1997)

UNIX-Based Users: Will They Migrate to Windows NT?

Nearly every person associated with the mechanical CAD/CAM/CAE market has spent hours trying to find, predict, or invent the answer to this question: When will the high end, UNIX-based mechanical designers move to NT? At last, Dataquest has some North American end-user data supporting the statement that actual movement of UNIX-based CAD users to NT-based CAD systems will occur, but not at lightning speed. Instead, it will happen in a slower, more predictable fashion.

Dataquest asked users what their main CAD operating system will be two years in 1999 and in 2001. The results are summarized in Figures 4-2 and 4-3. It is important to keep in mind that all survey respondents identified UNIX as their main CAD operating system today, so these results start from a base of 100 percent UNIX users, and that these are responses from end users and are not a Dataquest forecast of mechanical CAD operating systems.

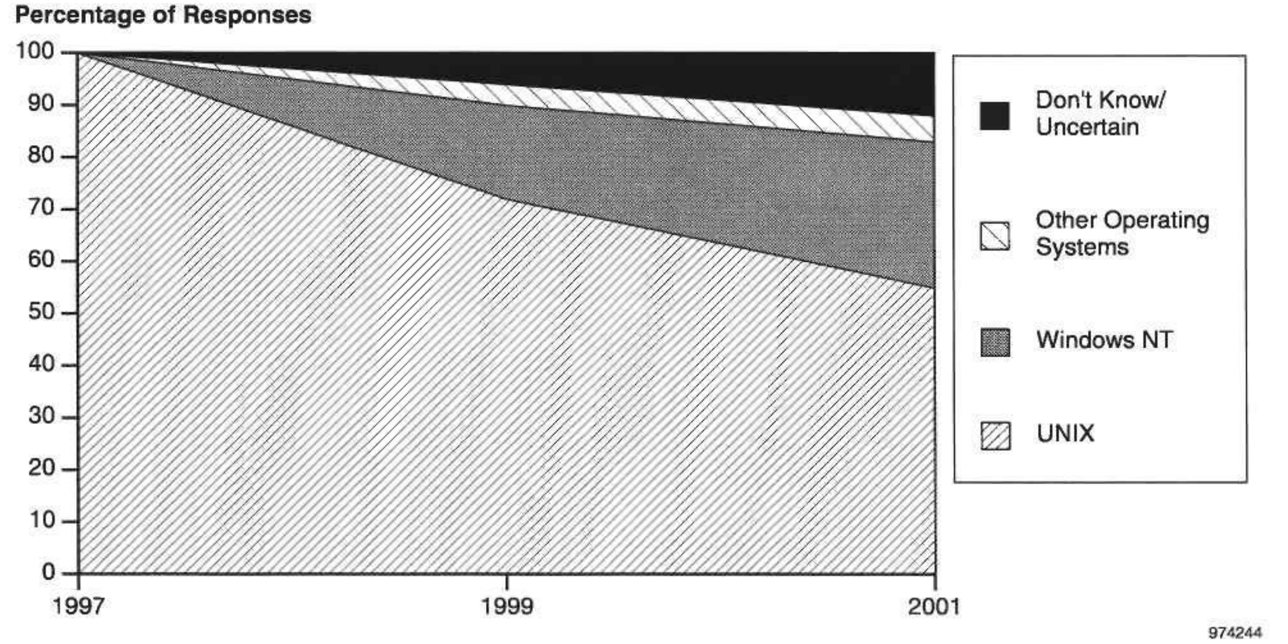
UNIX will indeed cede some ground to Windows NT in CAD. Over the next two years, 18 percent of users plan to move to the Windows NT operating system, and by the end of 2001, 28 percent expect NT to be their primary CAD operating system. Further, 6 percent of respondents are unsure what their main CAD operating system will be in 1999, with that number growing to 12 percent in 2001. Previous end-user surveys have shown that users tend to be more optimistic about change than in reality. Expect the actual movement to NT to be slower than the numbers cited above.

The overall numbers do not give the whole picture. It appears as though each industry will adopt the NT operating system at very different rates. Figure 4-3 illustrates some of these industry-level differences. If the user community has its wishes, NT will make its greatest gains in electrical and electronic machinery and aerospace, but UNIX will also lose the least amount of ground in aerospace and in the "Others" category. These results are a change from previous surveys, where aerospace respondents were expecting to see less adoption of NT than seen here. This comes as a surprise, as aerospace sites tend to be larger sites that are well entrenched in UNIX and have the expertise and resources to maintain a UNIX-based system. Also, the aerospace industry relies heavily on applications for which vendors have not yet announced a full-fledged NT solution. Automotive users appear more guarded about their transition to NT. The automotive industry also relies heavily on applications for which their "choice" vendors have not yet announced complete NT-based CAD/CAM/CAE solutions.

What Is Driving the NT Decision

Dataquest asked respondents about their reasons for and against moving to the NT operating system for their mechanical design work. The two top reasons to move to NT were NT-based CAD software functionality and the prospect of reduced hardware costs (see Figure 4-4). Indeed, NT-based CAD functionality has come a long way in the past few years. Just last year, UNIX-based users did not cite NT CAD functionality as a reason motivating their switch to NT. Also, hardware vendors should take note: A previous survey also found the prospect of reduced hardware costs to be a top reason to move to NT-based CAD among current UNIX users.

Figure 4-2
Future Operating System, User Responses



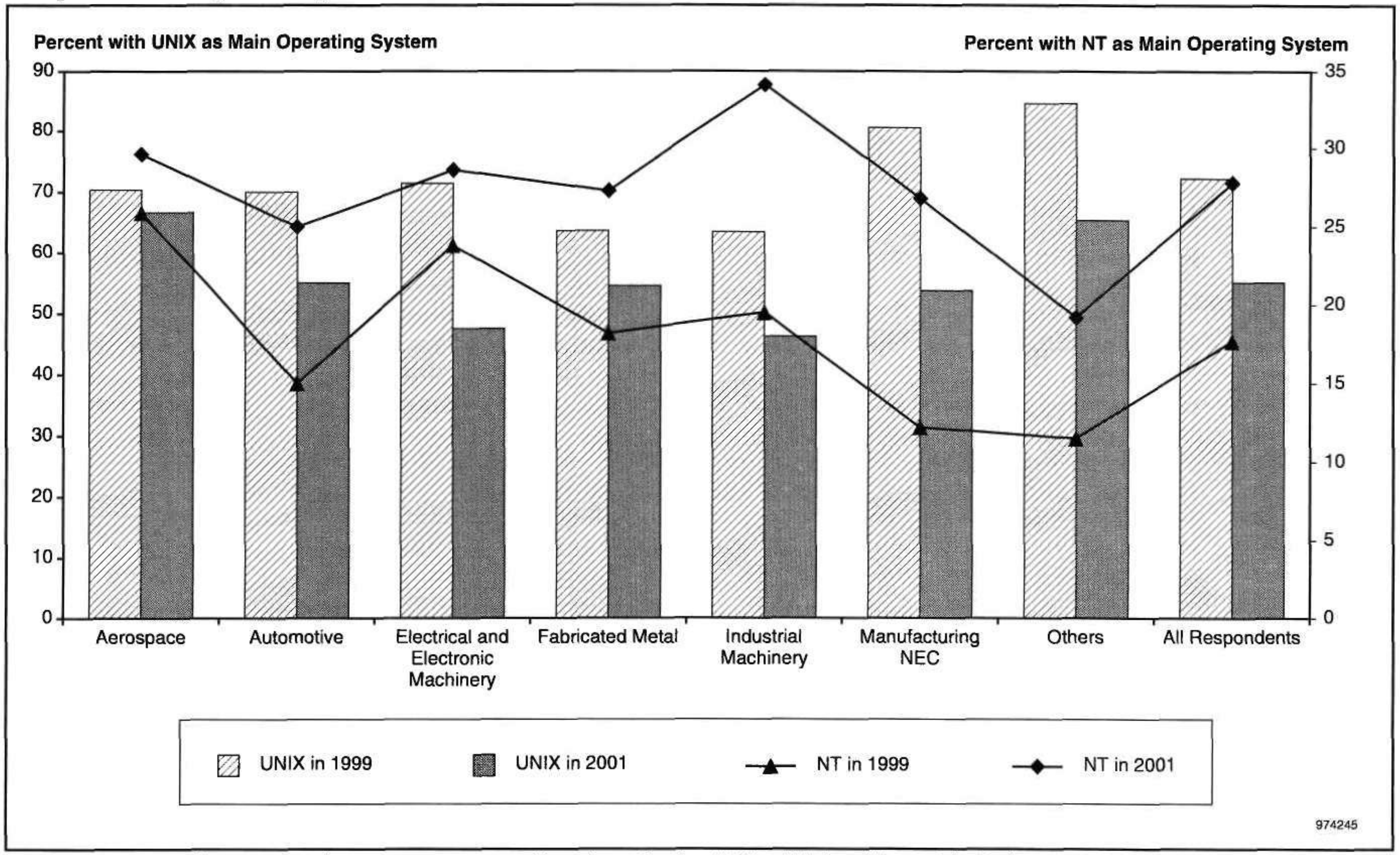
Note: "Other Operating Systems" comprises mostly Windows 95 responses.
Source: Dataquest (June 1997)

Dataquest also investigated the reasons users did *not* expect to adopt NT as their primary operating system. Here, the top reasons were satisfaction with current UNIX operating system, followed by the functionality of NT-based applications—specifically, the ability of such applications to handle large or complex designs (see Figure 4-5). The costs associated with purchasing new NT-compatible hardware or software were also top issues. Legacy data issues continue to rank low among the areas of concern against moving to NT. Mechanical CAD/CAM/CAE software vendors with a substantial installed base of UNIX licenses should look to maintaining a technological edge on NT-based CAD applications as well as keeping current users satisfied. (Satisfaction with CAD is discussed further in Chapter 5.)

CAD Purchasing Decisions

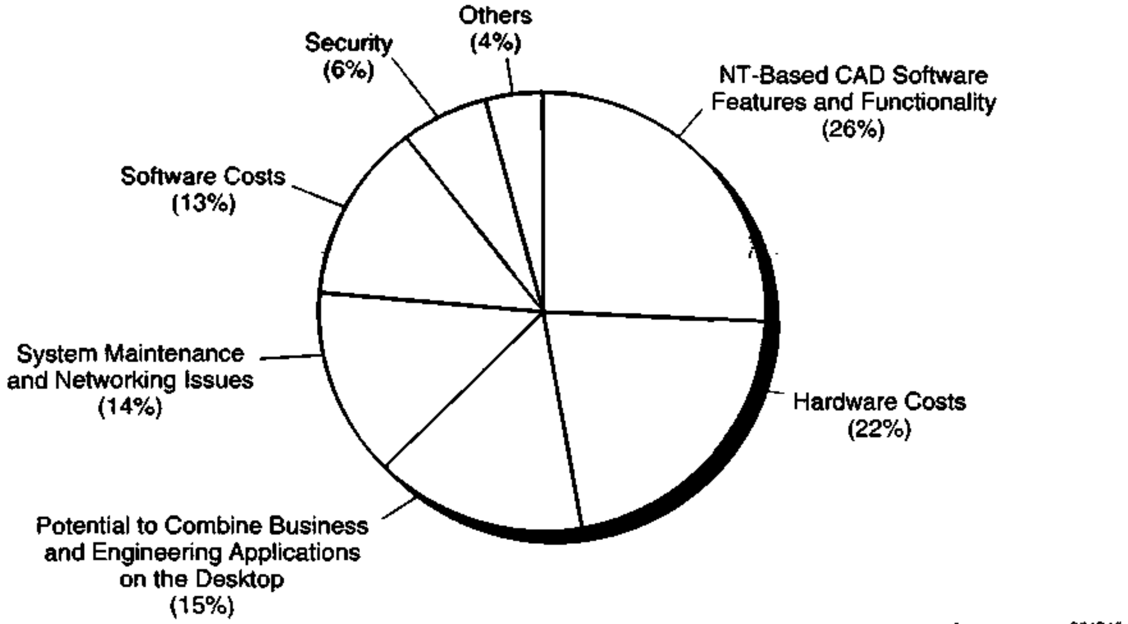
For UNIX-based mechanical designers, CAD/CAM/CAE purchase decisions tend to be centralized, with 67 percent of respondents stating that CAD purchasing decisions are made based on corporate edict or a policy to standardize on one CAD system. Twenty-seven percent of respondents said that their purchase decisions were project specific. The response rate was too small to analyze results by industry.

Figure 4-3
Adoption of NT by Industry



Note: Numbers will not add to 100 percent because responses to operating systems other than UNIX and Windows NT are not depicted.
Source: Dataquest (June 1997)

Figure 4-4
Reasons to Move to NT



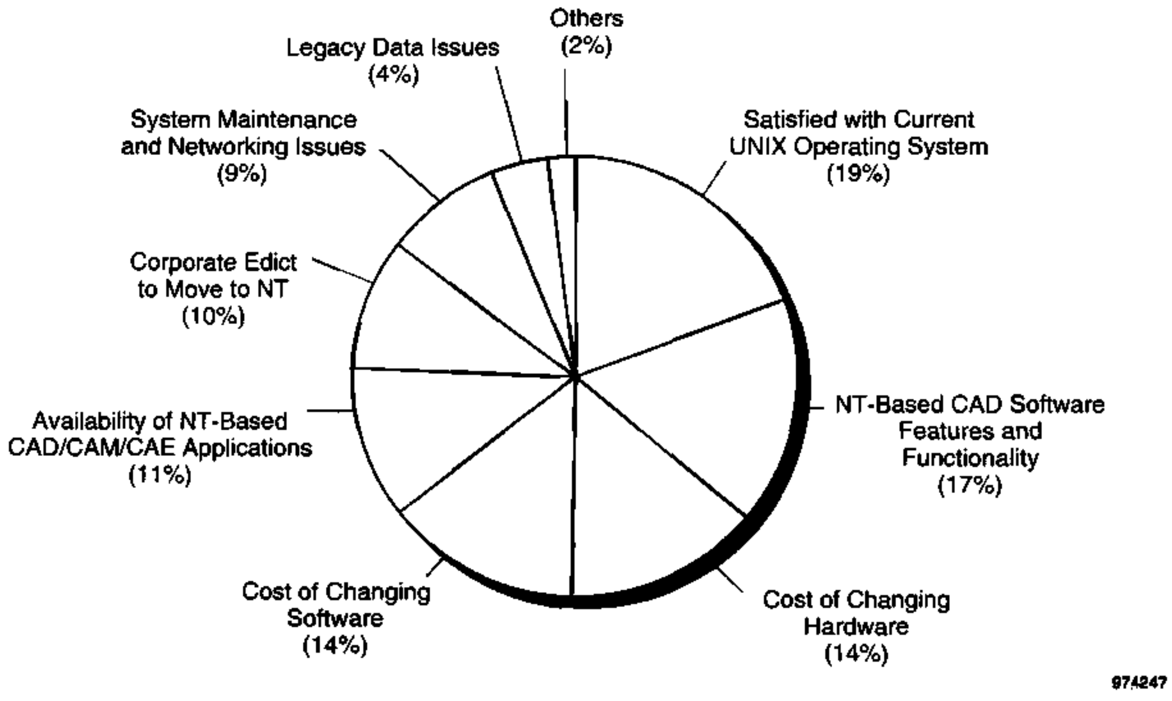
Note: Multiple responses allowed
Source: Dataquest (June 1997)

CAD/CAM/CAE Seat Counts

Users, on the whole, are expecting the total number of CAD/CAM/CAE seats at their site to increase or remain the same from 1997 to 1999, with some variation by industry, as shown in Figure 4-6. The number of respondents expecting an increased seat count is high (as much as 71 percent of industrial machinery respondents). Chapter 3 discussed the prospect of CAD reaching its saturation point within our respondent companies. Dataquest advises readers to interpret the results in Figure 4-6 in light of the data presented in Figure 3-2. Dataquest would have expected an even smaller percentage of respondents to anticipate seat count growth in light of the desire to reduce the number of professionals working on CAD in an ideal situation. However, it is not known if the desire to reduce the number of CAD professionals under ideal circumstances is because companies truly do have too many CAD workers or if they would like to achieve better efficiencies with CAD than they currently do today.

The anticipated percentage change of seat count increases from 21 percent in automotive to 34 percent in aerospace, with the average overall responses being a 29 percent increase. Responses for the amount of change in seat count decrease were too few to analyze.

Figure 4-5
Reasons to Not Move to NT



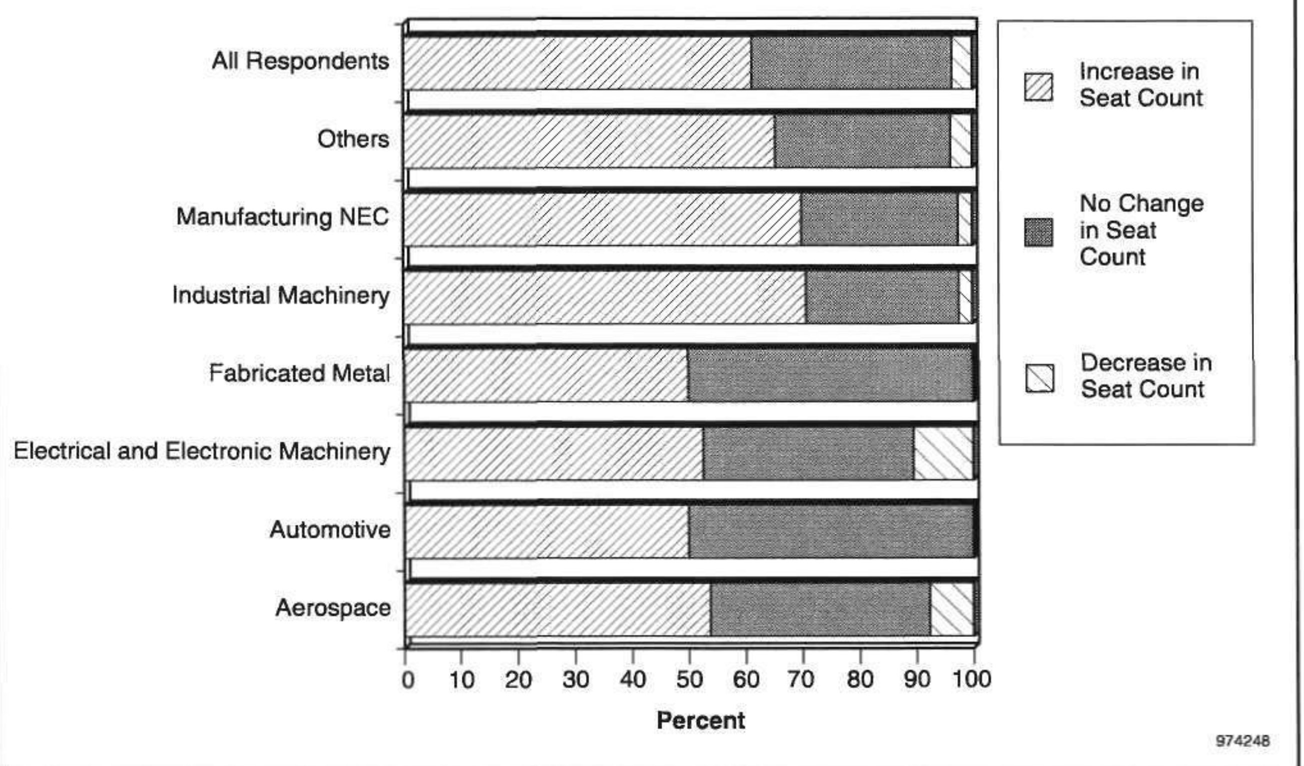
Note: Multiple responses allowed
Source: Dataquest (June 1997)

Future License Purchases by Application

Dataquest asked users to identify what CAD/CAM/CAE applications they are planning to purchase over the next two years. The results are given in Figure 4-7. Nearly one-quarter of new purchases will be drafting licenses, and one-fifth will be assembly or component design licenses. It appears as if users are planning to invest in basic CAD technology over the next two years; these high numbers for drafting and design may be a result of users expecting to move to NT. Moreover, users are not ignoring analysis—7 percent of new purchases will be linkage/mechanism analysis licenses, and 5 percent will be for other types of analysis.

For most industries, the top three areas for license purchases were drafting, assembly or component design, and conceptual design (see Table 4-1). The only exception was in fabricated metal, where the top area was product data management followed by an equal tie among drafting, numerical control, and no-license purchases.

Figure 4-6
Anticipated Seat Count Changes by Industry



Note: Multiple responses allowed
Source: Dataquest (June 1997)

CAD Software Retirements

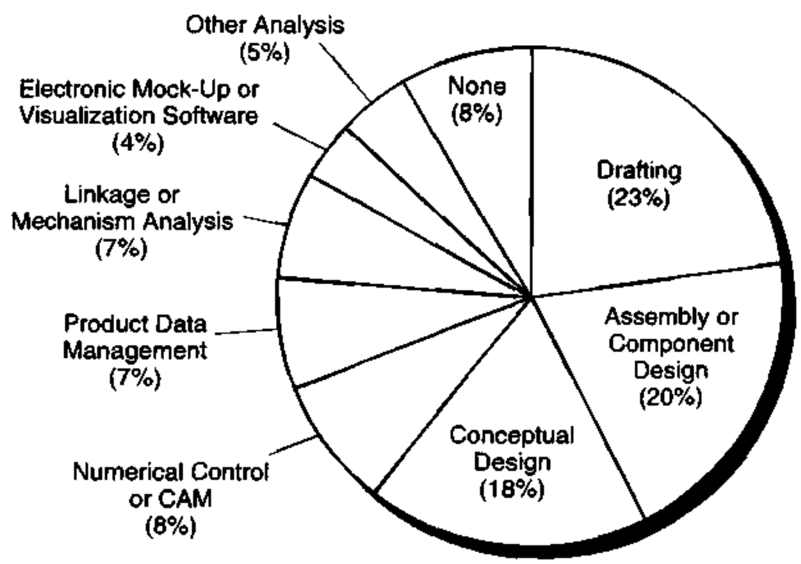
Fewer software retirements affect the capacity to absorb new modules in the future. Users were asked what percentage of their existing mechanical CAD/CAM/CAE modules they believe will be retired over the next two years. Clearly, these UNIX-based CAD users are looking for some change—overall, they are expecting to retire 20 percent of their current CAD software; in last year's survey, the average was only 10 percent. The automotive industry is expecting the fewest amount of software retirements (only 9 percent), while the fabricated metal respondents expect to retire a whopping 27 percent of their CAD software modules. Again, the results could be affected by the anticipated move to NT among respondents.

CAD Spending Plans

Dataquest asked respondents about planned increases or decreases in CAD spending for the next year. Specifically, respondents were asked if spending will increase, decrease, or remain the same for five areas:

- Mechanical CAD/CAM/CAE software
- Mechanical CAD/CAM/CAE hardware
- Service and maintenance for mechanical CAD/CAM/CAE systems
- Application development
- Consulting and systems integration

Figure 4-7
Expected License Purchases by Application



Note: A maximum of two responses was allowed.
Source: Dataquest (June 1997)

Table 4-1
Top Three Areas for Anticipated License Purchases, by Industry

	Anticipated License Purchases		
	First	Second	Third
Aerospace	Drafting	Assembly or Component Design	Conceptual Design
Automotive	Drafting	Conceptual Design	Assembly or Component Design
Electrical and Electronic Machinery	Drafting	Assembly or Component Design (tie)	Conceptual Design (tie)
Fabricated Metal	Product Data Management	Drafting (tie)	Numerical Control (tie), None (tie)
Industrial Machinery	Drafting	Assembly or Component Design	Conceptual Design
Manufacturing NEC	Assembly or Component Design	Conceptual Design	Drafting
Others	Conceptual Design	Drafting	Assembly or Component Design

Source: Dataquest (June 1997)

The results are summarized by industry in Table 4-2 and are discussed later in this report.

Table 4-2
Spending Changes

	Software			Hardware			Service/Maintenance			CAD/CAM/CAE Application Development			Consulting/Systems Integration		
	Increase	Decrease	Remain Same	Increase	Decrease	Remain Same	Increase	Decrease	Remain Same	Increase	Decrease	Remain Same	Increase	Decrease	Remain Same
Aerospace	40	8	52	44	8	48	38	8	54	43	9	48	35	13	52
Automotive	50	15	35	30	30	40	20	25	55	24	12	65	32	21	47
Electrical and Electronic Machinery	47	16	37	59	18	24	28	17	56	29	7	64	41	18	41
Fabricated Metal	68	5	27	57	10	33	50	9	41	38	0	62	24	5	71
Industrial Machinery	59	2	39	54	15	32	36	8	56	38	5	56	34	8	58
Manufacturing NEC	49	15	37	54	22	24	56	15	29	29	3	69	10	10	79
Others	46	8	46	58	8	33	40	4	56	35	4	61	38	0	63
All Respondents	52	9	39	51	16	33	42	12	46	34	5	60	29	10	61

Source: Dataquest (June 1997)

Software and Hardware

Similar to last year's end-user survey, this survey revealed that users are expecting increased mechanical CAD/CAM/CAE software and hardware spending over the next year. However, the major difference between the two surveys is this year's emphasis on UNIX-based CAD users. UNIX-based CAD users spend four times as much money on CAD software and hardware each year than users of any other CAD operating system. As Table 4-2 illustrates, slightly more than one-half of (UNIX-based) survey respondents indicate that software spending will increase from today's levels. It is surprising to see such an overwhelming response to increased CAD spending from users who work in environments where CAD purchasing decisions tend to be corporate edicts and change is typically slow. A much greater percentage of respondents in fabricated metal than in any other industry are expecting an increase in software spending over the next year. As stated earlier, some of this increased software spending is a reflection of the expected future transition toward NT-based CAD/CAM/CAE software in all of the industries.

Hardware spending plans over the next year look just as bright (see Table 4-2). Here, hardware implies computing hardware (for example, PCs and workstations) as well as related peripherals (for example, plotters, printers, and terminals).

It is unusual for users to anticipate spending increases in both software and hardware. Typically, one takes precedence over the other. Dataquest expects that, over the next few years, CAD users in North America will be seriously re-evaluating their existing CAD/CAM/CAE systems, with careful consideration given to the new operating systems available and how much value/functionality they can get out of their software for the money they spend on it.

Maintenance, Application Development, and Consulting

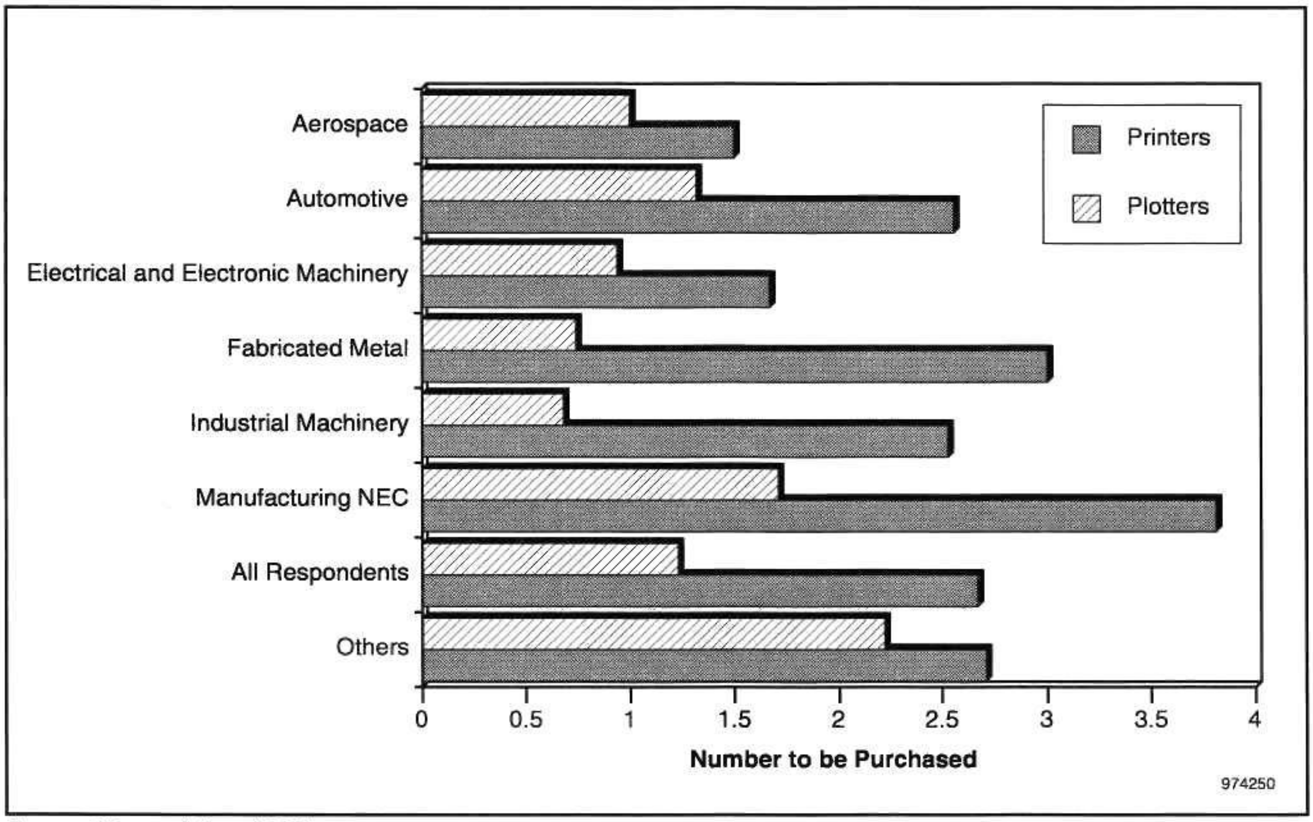
As shown earlier, more than one-half of all respondents are expecting increased hardware and software spending next year. On the other hand, spending for mechanical CAD/CAM/CAE service and maintenance, application development, and consulting is expected to remain at about the same levels for many respondents. If the results in Table 4-2 are any indication, the future looks stable (but is not growing wildly) for consultants/systems integrators and application developers. However, it looks better for those involved in CAD/CAM/CAE system maintenance.

The planned increases in spending for maintenance are reasonable. As users add more computers, networks, and software to their current CAD/CAM/CAE systems, maintenance and related service costs will undoubtedly increase. Looking to the future, as the goal of object-oriented CAD software, objects, and new architectures become market realities, Dataquest expects application development spending to rise accordingly.

Plotters and Printers

Any increase in the number of CAD/CAM/CAE seats leads to a corresponding increase of peripherals such as printers and plotters. Users in this survey plan to purchase, on average, one plotter and two printers over the next two years (see Figure 4-8 for results by industry). As a point of reference, this report includes a summary of users' current plotter technology in Table 4-3. Laser plotters were the most frequently mentioned, followed by ink jet and electrostatic.

Figure 4-8
Planned Plotter and Printer Purchases over Next Two Years



Source: Dataquest (June 1997)

Table 4-3
Plotter Technology (N = 365)

	Number of Responses
Laser	98
Ink Jet	83
Electrostatic	63
Color Ink Jet	50
Pen	38
Thermal	28
Others	5

Note: Multiple responses allowed
Source: Dataquest (June 1997)

Chapter 5
Mechanical Application Perceptions

This chapter reveals what designers think of the mechanical applications they use—what benefits they have seen, what software functionality and characteristics they seek, and what influences their purchasing decisions. In delving into these issues, Dataquest asked users a series of questions based on their agreement with certain business-related statements, their satisfaction with the mechanical applications themselves (for example, analysis and assembly design), their satisfaction with specific design-related tools and technologies (for example, photo-realistic imaging and 3-D graphics), and their "wish lists" of items (for example, application stability and ease of use). The results are explored in the following sections.

Is CAD/CAM/CAE Technology Helping to Meet Business Goals?

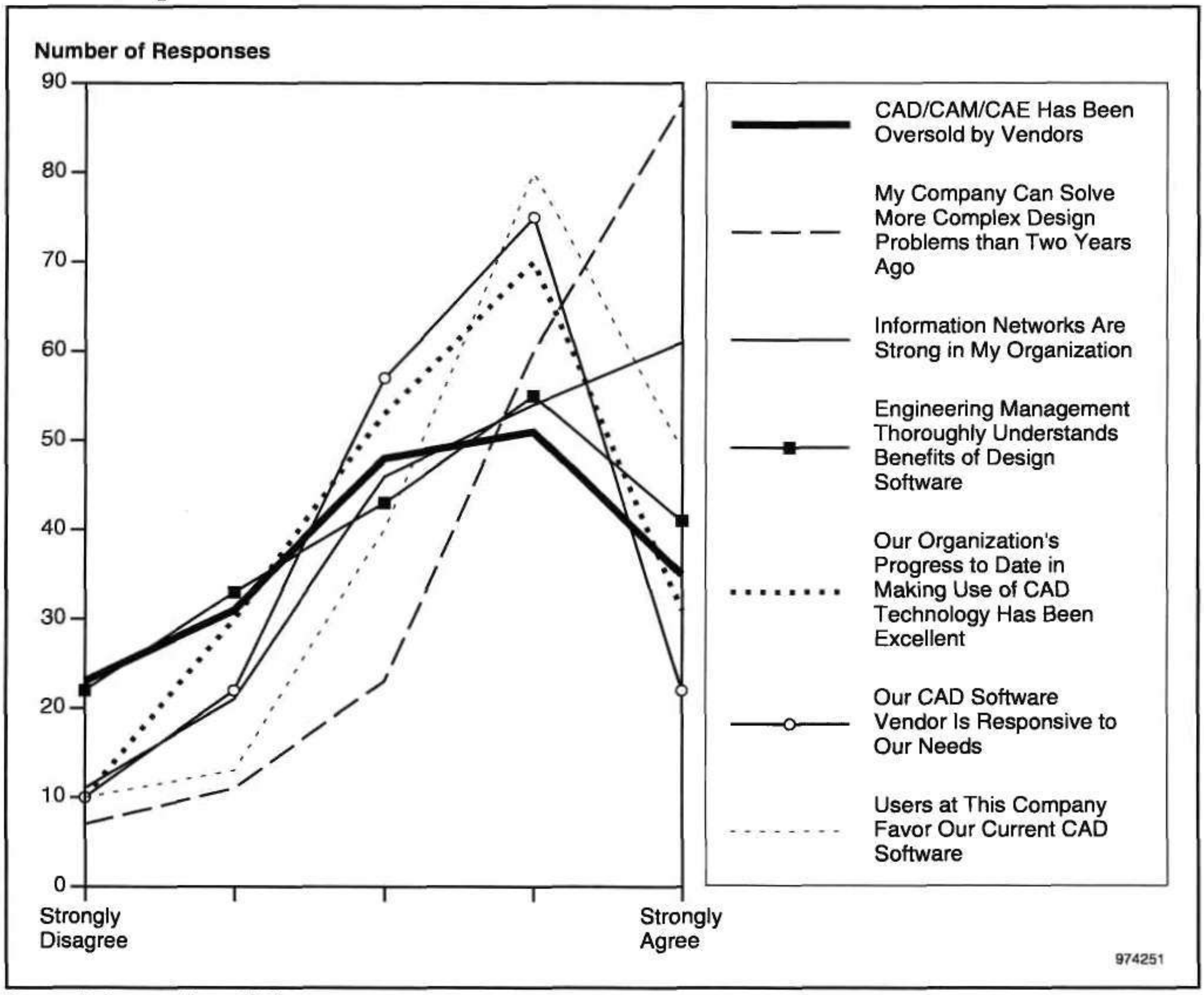
Many factors can affect whether a company or business in discrete manufacturing succeeds or fails, and CAD/CAM/CAE technology is just one of them. While CAD technology has promised many things to many people, Dataquest decided to investigate just what users think about how well CAD technology is deployed in a company. The idea is that those companies who have had more success in deploying CAD technology are better able to make the connection between CAD investment (dollars spent) and meeting business objectives (profits returned).

Dataquest asked respondents to what level they agree or disagree with a series of general statements concerning CAD/CAM/CAE, its role in the company, and its benefits—not just to engineering design, but to the company's overall business processes.

Overall, respondents in this survey are fairly happy with their CAD/CAM/CAE systems with respect to their company's business goals. The results are displayed in Figures 5-1 and 5-2. In particular, Figure 5-2 shows results from this year's UNIX-based group of respondents in comparison to last year's mixed group (UNIX- and PC-based) survey respondents—the ratings are nearly identical. The one notable difference was that UNIX-based users felt less strongly about the statement that, "Information networks are strong in my organization." Dataquest has always felt that those companies with strong information networks are better able to adopt new technologies and respond to change. The two groups of respondents pulling down this rating were in aerospace and industrial machinery.

Most respondents strongly agreed that CAD/CAM/CAE has helped their companies solve more complex design problems. The widest range of responses was seen when users responded to the statements "CAD/CAM/CAE has been oversold by vendors," and "engineering management thoroughly understands benefits of design software."

Figure 5-1
CAD Perceptions



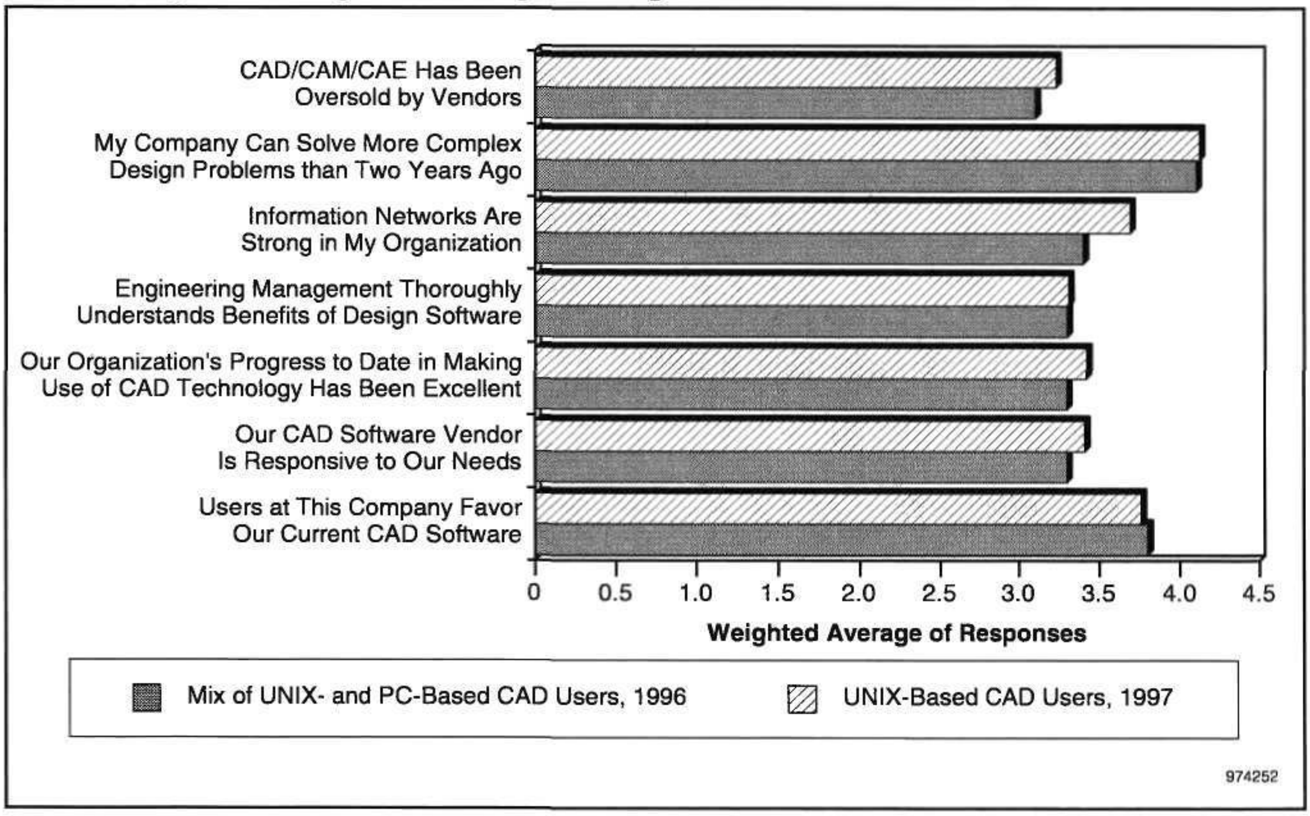
Source: Dataquest (June 1997)

Mechanical CAD/CAM/CAE Applications—What Users Think

Designers were asked to rate their mechanical CAD/CAM/CAE applications with respect to importance and satisfaction on a scale of 1 (not important or not satisfied) to 5 (very important or very satisfied). These applications were as follows:

- Detailing
- Component design
- Assembly design
- Conceptual design
- Analysis
- Manufacturing applications
- Product data management
- Data exchange and translation

Figure 5-2
CAD Perceptions, Weighted Average of Responses



Source: Dataquest (June 1997)

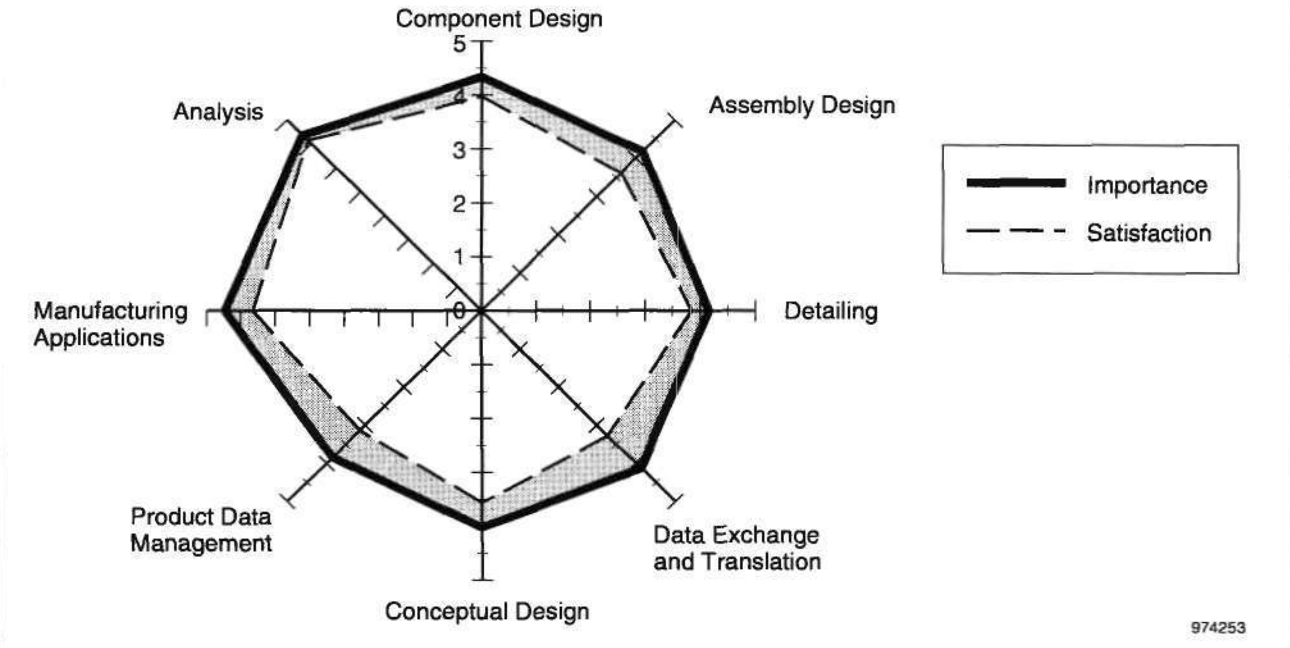
Figure 5-3 provides a visual interpretation of these user importance and satisfaction ratings. The most important characteristic according to user rankings—component design—is plotted on a 1-to-5 scale at the top of the chart, and the other applications (for example, detailing, assembly design), are plotted in a counterclockwise manner about the axes in order of decreasing importance. The satisfaction rating for each application is mapped along the same axes as its corresponding importance rating. The gap, or difference, between the importance and satisfaction ratings for each application is indicated in Figure 5-3 by gray shading, exposing the areas that need vendor attention and improvements. In an ideal situation, importance and satisfaction ratings would be equal, and no gray area would appear in Figure 5-3 because the two circles would coincide. However, when the two circles do not coincide at every point, users are not as happy as they could be.

The numerical values of the gaps are given in Table 5-1. While most of the gaps in Table 5-1 are not large, there are clearly some unmet needs out there. Once again, the importance of data translation software to designers and engineers becomes apparent. It was ranked high in importance by survey respondents, but this same group of people is very unsatisfied—a negative 0.85 gap—with the translation products they use. Data translation is one area that has always demanded attention from users, and these UNIX-based users are more unsatisfied with their translators than we typically see. The high importance ranking given to detailing underscores the importance in mechanical design of this very basic application. In comparison to other applications, the gap here, negative 0.31, is not large.

Software vendors could better spend their efforts focusing on other user-perceived problems, as we shall see later in this chapter.

Product data management did not rank high in importance among these North American survey respondents; similar results have appeared in earlier surveys of Europe and North America. It is true that PDM did not really begin taking off until 1995, and the PDM market is still taking shape, but just because PDM is not ranked high in importance does not mean that users are satisfied with what PDM solutions they have. On the contrary, the satisfaction rating for PDM was the lowest among all of the mechanical applications.

Figure 5-3
Importance/Satisfaction Gap Analysis of Mechanical Applications



Note: Ratings on a scale of 1 to 5 (1 = not important/not satisfied, 5 = very important/very satisfied)
Source: Dataquest (June 1997)

Table 5-1
Importance/Satisfaction Gap Analysis of Mechanical Applications

	Importance	Satisfaction	Gap
Component Design	4.34	3.97	-0.37
Assembly Design	4.18	3.62	-0.56
Detailing	4.16	3.85	-0.31
Data Exchange and Translation	4.13	3.28	-0.85
Conceptual Design	4.02	3.56	-0.46
Product Data Management	3.85	3.14	-0.71
Manufacturing Applications	3.73	3.32	-0.41
Analysis	3.68	3.57	-0.11

Note: Ratings on a scale of 1 to 5 (1 = not important/not satisfied, 5 = very important/very satisfied)
Source: Dataquest (June 1997)

Design-Related Tools and Technologies—What Users Want

Getting a product to market is not just about CAD software and design, but it is also about how CAD and related technologies are used together. A host of tools and technologies are on the market today—such as photo-realistic imaging and 3-D graphics cards—that are targeted at making the lives of designers easier.

Dataquest asked users to rate the following CAD-related tools and technologies with respect to importance and satisfaction on a scale of 1 (not important/not satisfied) to 5 (very important/very satisfied):

- High-performance 3-D graphics
- Design optimization capabilities
- Photo-realistic imaging
- Sharing of design files via Internet or intranet
- CAD to CAM integration
- CAD to CAE integration

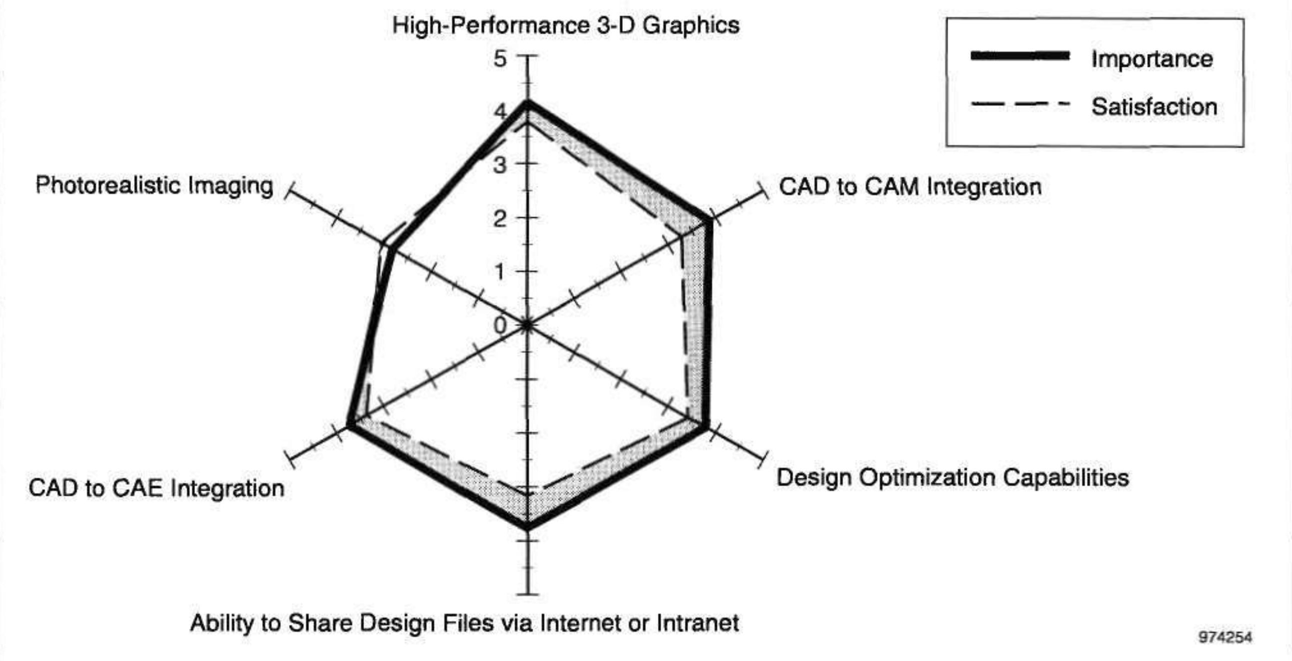
Figure 5-4 and Table 5-2 outline user ratings for the items listed above. Clearly, these UNIX-based designers and engineers want a lot of performance from their CAD solutions—tight integration among modules, good graphics, and design optimization capabilities.

Better 3-D graphics is one area that UNIX-based workstation vendors tout over their PC-based and NT-based competitors. And, as our survey shows, graphics is ranked high in importance to these UNIX-based designers and engineers. (Surprisingly, however, photo-realistic imaging is of less importance, and users are satisfied with their imaging solutions.) As companies take on more complex design problems and become more entrenched in 3-D design, it is natural that graphics become more of an important factor influencing purchasing decisions. The same is true for design optimization capabilities—as users begin to use more analysis and CAE tools in conjunction with CAD tools, the importance of optimization will rise.

To no one's surprise, integration of CAD with both CAM and CAE ranked high in importance and also showed large importance-satisfaction gaps. The user-perceived dissatisfaction with CAD to CAM and CAD to CAE integration is consistent with earlier data concerning exchange and translation.

As explored earlier, mechanical designers are beginning to use the World Wide Web and Internet for design-related activities. Here, survey respondents are interested in sharing design files via the Internet or intranet, but their satisfaction with their abilities to do so today is less than satisfactory.

Figure 5-4
Importance/Satisfaction Gap Analysis of CAD-Related Technologies



Note: Ratings on a scale of 1 to 5 (1 = not important/not satisfied, 5 = very important/very satisfied)
Source: Dataquest (June 1997)

Table 5-2
Importance/Satisfaction Gap Analysis of CAD-Related Technologies

	Importance	Satisfaction	Gap
High-Performance 3-D Graphics	4.14	3.78	-0.36
CAD to CAM Integration	3.87	3.29	-0.58
Design Optimization Capabilities	3.80	3.43	-0.37
Ability to Share Design Files via Internet or Intranet	3.76	3.16	-0.6
CAD to CAE Integration	3.73	3.36	-0.37
Photo-Realistic Imaging	2.82	3.06	0.24

Note: Ratings on a scale of 1 to 5 (1 = not important/not satisfied, 5 = very important/very satisfied)
Source: Dataquest (June 1997)

Characterizing the Ideal Software Solution and CAD Vendor

When it comes to CAD/CAM/CAE solutions, one can look at user-rated importance and satisfaction from one of two angles. The first one is concerned with specific mechanical applications and CAD-related technologies. Dataquest explored these areas earlier in this chapter. The other angle is concerned with overall satisfaction with CAD/CAM/CAE solutions—such as software stability and vendor service.

Dataquest created a "wish list" of items and asked users to rate the importance and satisfaction of the following 10 characteristics relevant to any mechanical application:

- Software is bug free and stable.
- Software has advanced features and functionality.
- Software is easy to learn and use.
- Software is compatible with current CAD environment.
- Software performs complex or compute-intensive tasks well.
- Software has a low cost per seat.
- Vendor service and support.
- Software is easy to customize.
- Vendor is flexible in its licensing policies.
- Applications and modules are tightly integrated.

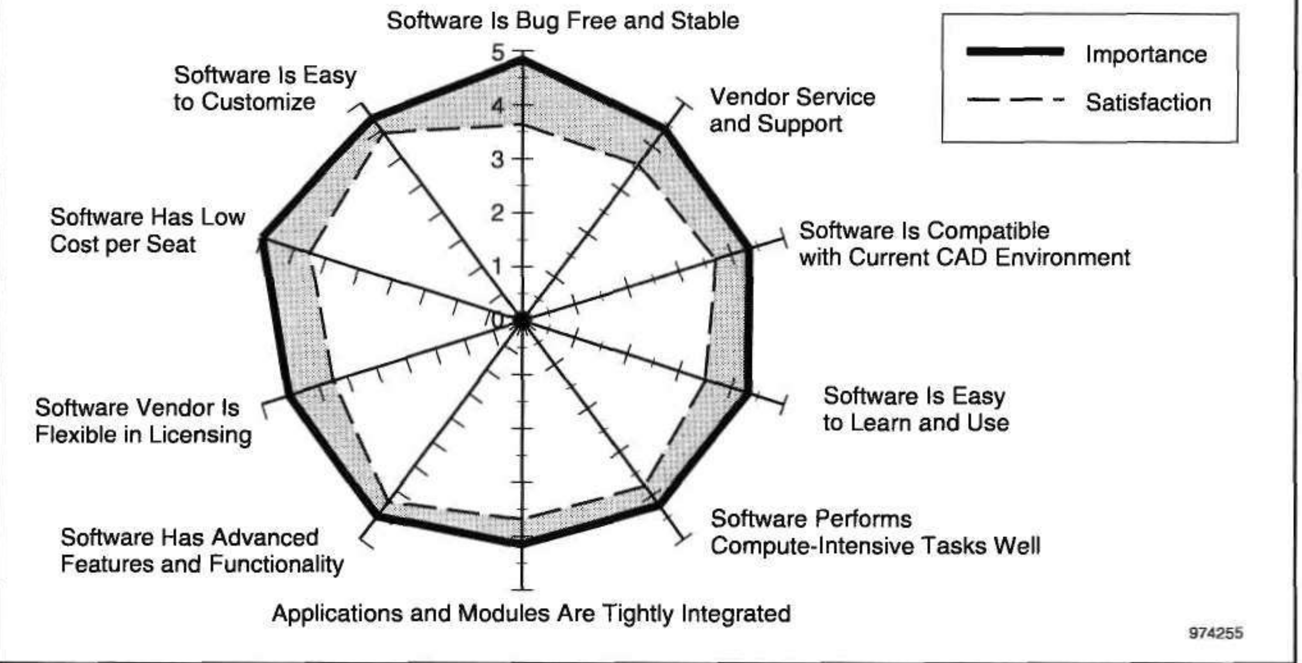
It is with this wish list that the real dissatisfaction with CAD/CAM/CAE solutions among end users becomes apparent. Nearly every item on the list was ranked with an importance rating of 4.0 or higher (see Figure 5-5 and Table 5-3). All of the issues on the wish list factor into a company's decision to purchase mechanical CAD/CAM/CAE tools, and vendors could choose to address any one of these issues, as all of the gaps are large. This report discusses only some of these issues in the following paragraphs.

Topping the list in importance was the request for software that is bug free and stable. The gap here is quite large—negative 1.20—and the importance rating is one of the highest we have seen in recent years of surveying CAD users. Software stability has always been an issue with the mechanical design community and can sometimes be an impediment to the adoption of new technologies and methodologies. It also comes as no surprise that the importance-satisfaction gap for vendor service and support is similarly large.

Software that is easy to learn and use is also important to the design community. Engineers are always facing time-to-market pressures, and they have little time to spend learning new tools or applications or going to training. Only recently have UNIX-based CAD vendors begun to concentrate on ease-of-use issues in earnest. These vendors should take their cues from some of the newer, midrange packages arriving on the market today with intuitive interfaces and robust learning tools.

Of all the items on the wish list, the ones with the smallest gaps are ease of customization and advanced features and functionality. While these technology-driven issues are important, there are clearly other areas in which a vendor can excel to become a commanding player in the mechanical design market.

Figure 5-5
Importance/Satisfaction Gap Analysis of an Ideal CAD Solution



Note: Ratings on a scale of 1 to 5 (1 = not important/not satisfied, 5 = very important/very satisfied)
Source: Dataquest (June 1997)

Table 5-3
Importance/Satisfaction Gap Analysis of an Ideal CAD Solution

	Importance	Satisfaction	Gap
Software Is Bug Free and Stable	4.84	3.64	-1.20
Vendor Service and Support	4.40	3.58	-0.82
Software Is Compatible with Current CAD Environment	4.34	3.71	-0.63
Software Is Easy to Learn and Use	4.32	3.51	-0.81
Software Performs Compute-Intensive Tasks Well	4.23	3.79	-0.44
Applications and Modules Are Tightly Integrated	4.15	3.68	-0.47
Software Has Advanced Features and Functionality	4.03	3.73	-0.30
Software Vendor Is Flexible in Licensing	4.02	3.24	-0.78
Software Has Low Cost per Seat	4.00	3.25	-0.75
Software Is Easy to Customize	3.72	3.45	-0.27

Note: Ratings on a scale of 1 to 5 (1 = not important/not satisfied, 5 = very important/very satisfied)
Source: Dataquest (June 1997)

Chapter 6
PDM Interests

No one associated with mechanical design and discrete manufacturing has been able to ignore the issue of PDM. But, despite all of the discussion, the market has yet to explode. Vendors have been trying to understand just how to position PDM to users, to whom to sell the solution, and what functionality users really need. Each vendor's approach to PDM is starkly different.

Dataquest asked a series of questions to better gauge the prospects for PDM among UNIX-based mechanical designers. About one-third of the sample, or 66 respondents, said that they have a PDM system already in place, and 21 percent plan to introduce PDM within the next two years (see Figure 6-1). Awareness or knowledge of PDM is high in North America—on average, only 4 percent of respondents did not know what PDM is.

Those survey respondents having a PDM system were further asked a series of questions about their respective systems. All industries were represented in this sample size of 66, with manufacturing NEC being the largest group The following statements characterize all 66 respondents' PDM sites:

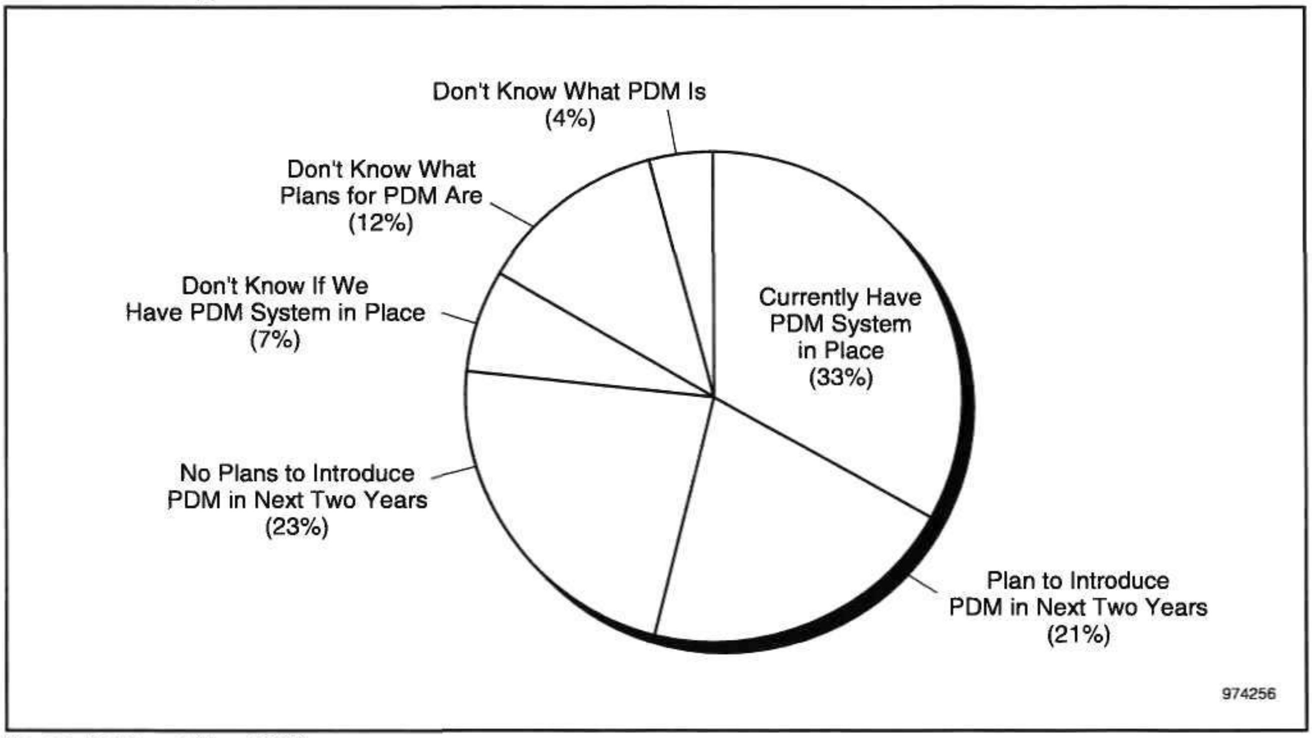
- PDM solutions have been around for many years, and not all systems being used today are commercial systems. Seventy-three percent of users said that their PDM systems are commercial systems, while 27 percent said they were still using in-house developed systems.
- Of all respondents, 37 percent of users were in the pilot stages of implementation at the time of our survey, and 63 percent were in the production phase with PDM.
- One of the major problems PDM vendors face is trying to figure out what organization within a company is the PDM decision-making body. Determining who to approach isn't easy—the purchase decision makers for PDM tends to be all over the place. Thirty-one percent of respondents said that engineering makes PDM purchase decisions, 24 percent said the central computing group (such as the corporate information officer or information systems group) makes the decision, and the remaining 45 percent said that it is a joint decision between engineering and information systems.
- The time it took to have the PDM system up and running ranged from one to 36 months. 7.5 months was the average for pilot users, and 10.6 months was the average for production users. These figures are actually a few months less than the results of last year's survey. The shorter time could be a reflection of users implementing portions of PDM systems, such as vault-only capabilities, or are taking implementation in stages. Median time for both pilot and production users was six months.
- One-half of respondents report the money spent on acquiring and setting up their PDM system has been at budget (see Figure 6-2). These results are consistent with previous survey results; PDM vendors and systems integrators seem to be doing a good job of setting budget expectations correctly.

- Vendors need to know which group within an organization is most likely to buy PDM, and these results show that PDM systems still have their roots in engineering. Engineering was cited most often as the group using the PDM system on a regular basis (48 percent of responses), followed by manufacturing (see Figure 6-3). PDM and manufacturing resource planning (MRP) vendors have been striving to integrate their systems for the past two years. It appears as if PDM use, while still concentrated within engineering, is spreading slowly to the manufacturing arena.

Figure 6-4 illustrates what PDM users think some of the benefits of their systems are. Here, the data is split to show pilot users, production users, and all users. For those in the pilot phase, users say that it is too early to tell what the benefits of PDM are. Putting that aside, these users are seeing two closely related benefits—shorter time to market, and shorter development cycles as the major gains. Production users overwhelmingly said that PDM systems help organize business processes. While vendors continually tout messages that PDM systems will help reduce product development times, lower costs, and help companies bring products to market faster, the industry rarely hears the message that PDM systems will help to organize a company's business processes. But from a user's perspective, this is exactly one of the benefits they are seeing.

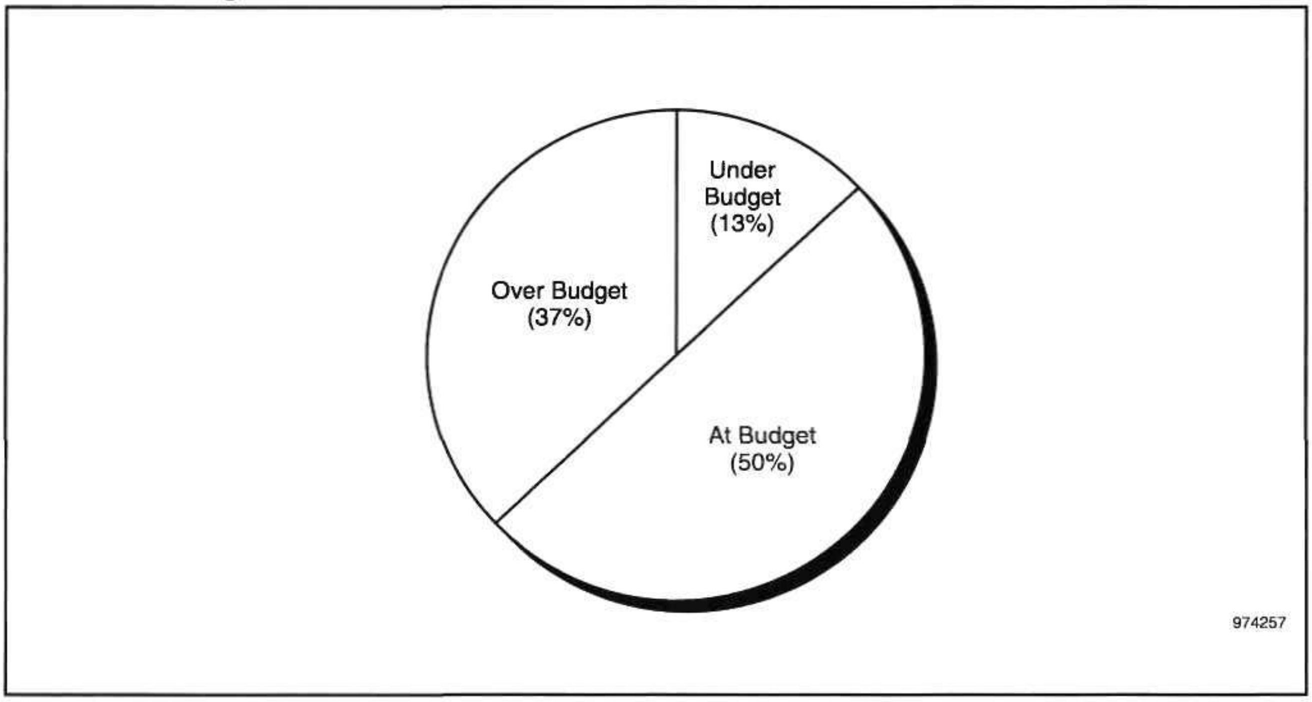
Finally, Dataquest asked users what two improvements could be made to their PDM systems. The results are shown in Figure 6-5. Here, Dataquest included "do not know" as an option. While previous surveys have shown "do not know" as the top choice for improvement, now respondents report they are better able to comment on what needs to be improved. Overall, users are looking for their PDM system to be more tightly integrated with other systems within the company, including CAD. Respondents still cite "better understanding of what PDM system does" as one of the improvements that can be made to their system, highlighting the fact that PDM is still fighting some basic uphill battles within an organization.

Figure 6-1
Planned Adoption of PDM in North America



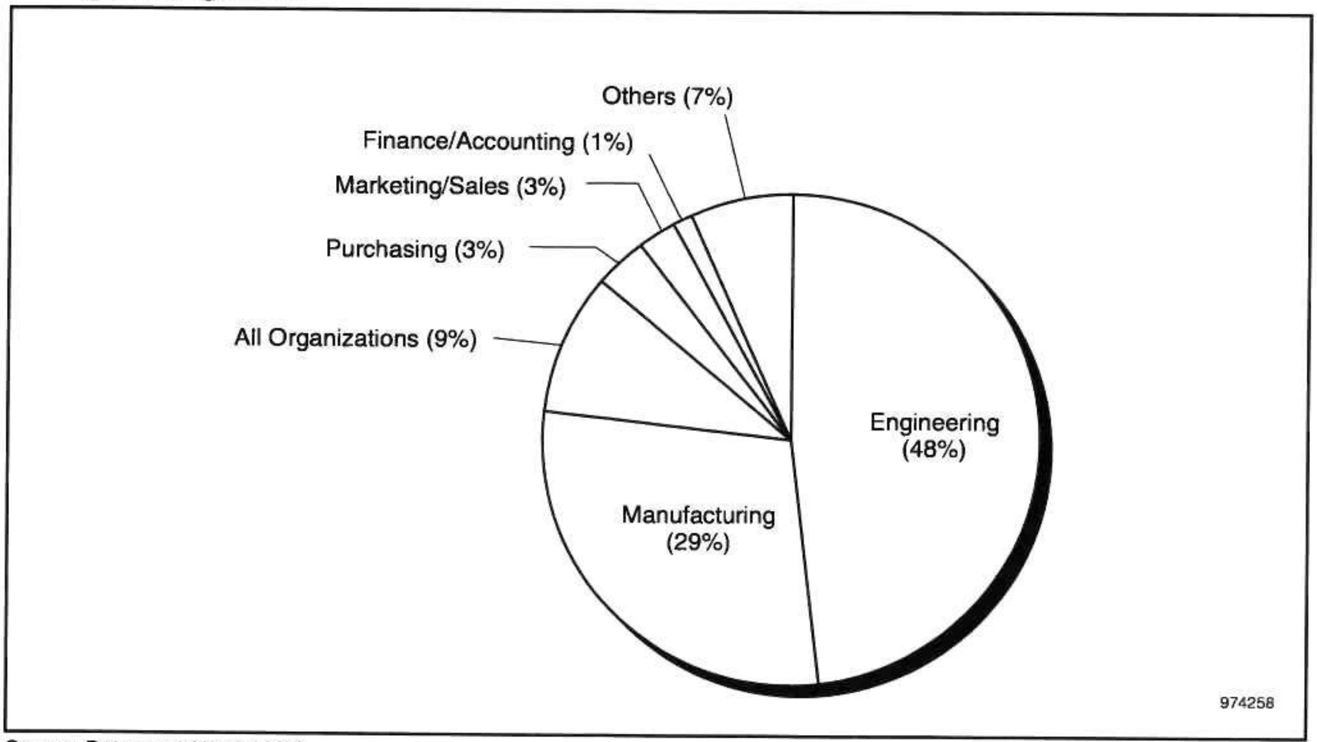
Source: Dataquest (June 1997)

Figure 6-2
The PDM Budget



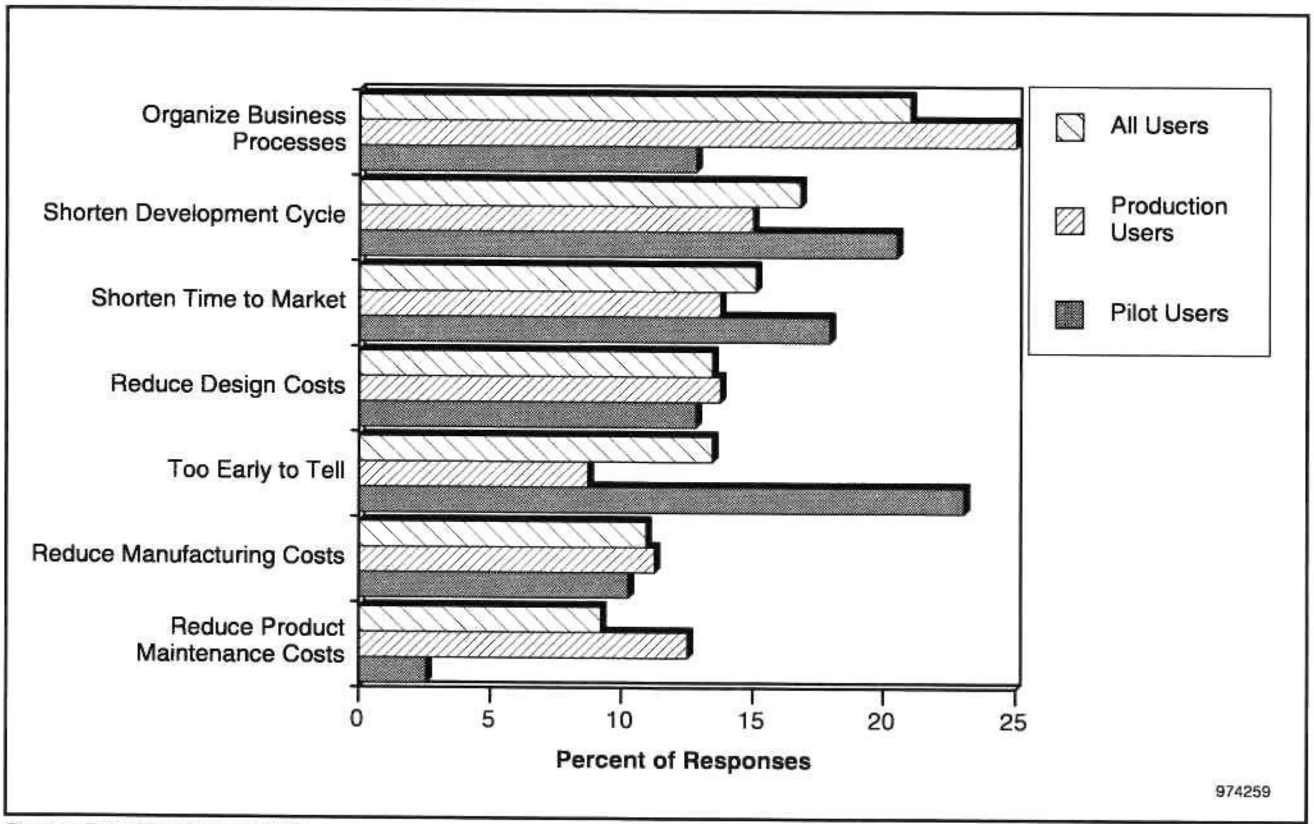
Source: Dataquest (June 1997)

Figure 6-3
Groups Using PDM



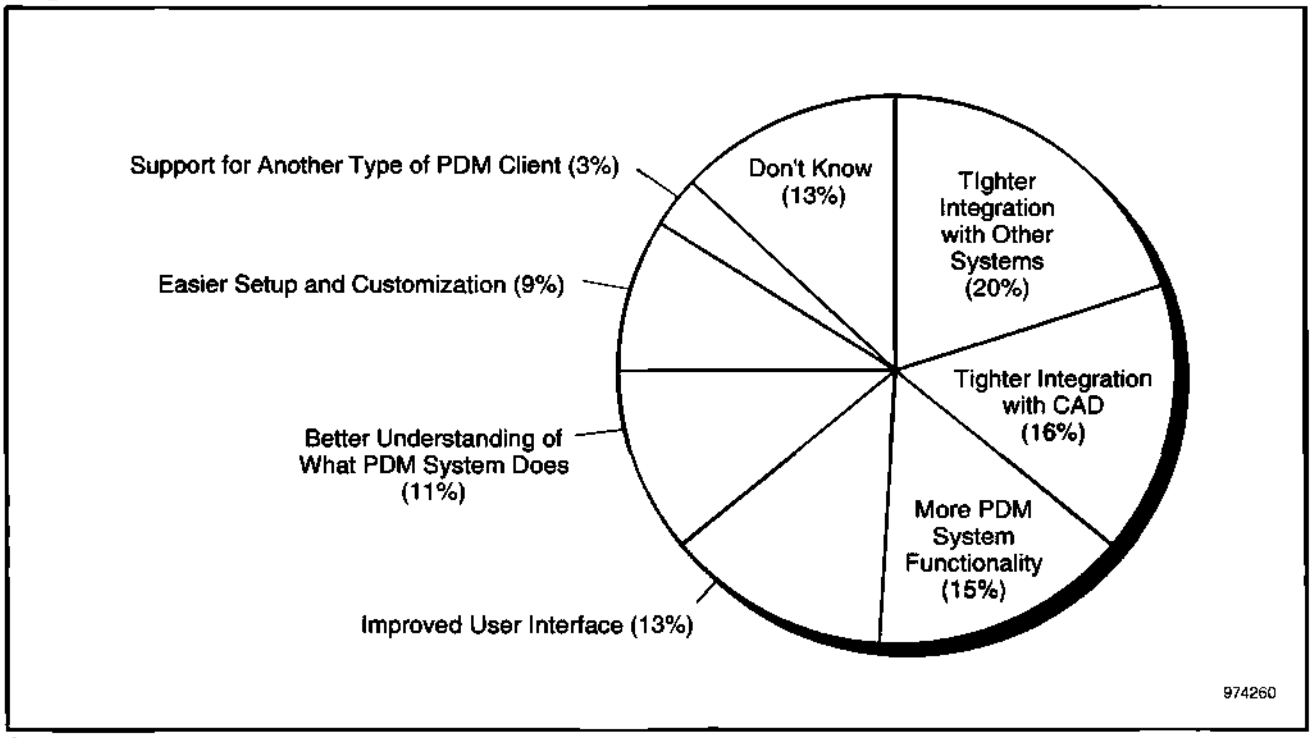
Source: Dataquest (June 1997)

Figure 6-4
User-Perceived Benefits of PDM



Source: Dataquest (June 1997)

Figure 6-5
Improvements to PDM



Source: Dataquest (June 1997)

Chapter 7
Conclusions

While mechanical CAD/CAM/CAE technology has been around for a number of years, the technology is still evolving, and end users' experiences are still not flawless. Satisfaction ratings are less than importance ratings for basic CAD/CAM/CAE software functionality, and users are not completely satisfied with their CAD vendors' service. Furthermore, while design automation has become indispensable to many mechanical designers and engineers, users are looking beyond CAD to integration issues, process issues, and related technologies. The prospects for UNIX-based mechanical design packages still looks healthy, as many UNIX-based survey respondents have no plans to change operating systems anytime soon. Indeed, mechanical designers and engineers will keep vendors on their toes for many years to come, and opportunities exist for those vendors willing to address issues outside of purely design.

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