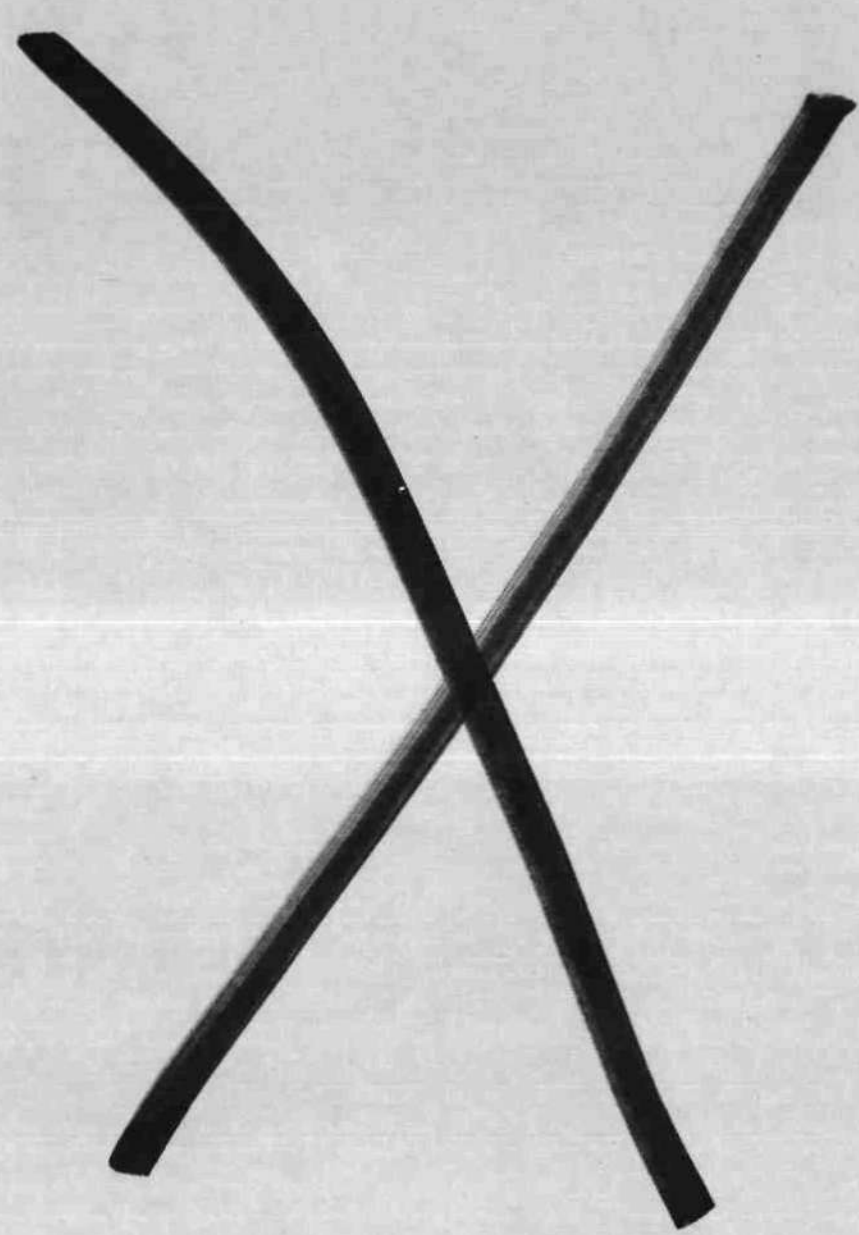


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MECHANICAL CAD/CAM/CAE WORLDWIDE



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Perspective

Mechanical CAD/CAM/CAE Worldwide

Market Analysis

Analysis Software: Moving to the Mainstream

Abstract: *Despite high hopes for its growth, the analysis market has not really taken off in the past few years. Vendors are now exploring avenues for increasing their penetration of the installed base of designers by trying to move into the mainstream. This Perspective looks at where the analysis market is today and how well the vendors are succeeding in their efforts. Dataquest's market analysis reveals that the market did not grow from 1996 to 1997, but it is predicted to grow at a compound annual growth rate of 9 percent over the next five years.*
By Daya Nadamuni

Introduction

Creating virtual products with all the associated parts and subassemblies before committing the design to manufacturing is an attractive proposition that seeks to reduce design to manufacturing cycles and cut costs of rework and redesign before the physical prototype stage. The task of analysis software is to take a design and simulate different conditions (such as stresses and strains, temperature variations, or vibrations) that the final product will be subject to in reality and give the engineers a glimpse of how the product will behave under real-world conditions. The software helps engineers and analysts to come up with an optimal solution for the given specifications of the operating environment in which the product will function.

Subjecting a design to this kind of rigorous analysis gives the designer an opportunity to flag errors and rework the design before it goes into manufacturing. As a methodology, the process of conducting the analysis before the physical prototype is manufactured represents a shift from the historical design and manufacturing process, in which a physical prototype is analyzed for conformance to the design specifications.

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The Process

Several kinds of analysis can be conducted on a component or an assembly of parts to determine stresses and strains on the product. Finite element analysis (FEA), for example, can be used to determine material deformation. Computational fluid dynamics (CFD) can be used to assess the heat dissipation or fluid flow. This Perspective will focus on FEA.

Once the geometry for the design has been created, the model has to be prepared for analysis. Traditionally, this has been a difficult process because the analysis system is not necessarily tied closely to the CAD system. In the course of the preprocessing stage, healing algorithms are used to clean up the model, if necessary. When using finite element analysis, this stage of the process also includes creating the finite element mesh and adding boundary conditions and loads.

The premise of FEA is based on the fact that component geometry is broken down into smaller elements that can then be analyzed more rigorously and thoroughly. Over the past few years, there has been much debate over the use of p-elements versus the more traditional h-elements in breaking down the part model. The debate over which element to choose has focused on the perceived trade-offs among speed, accuracy, and types of problems that these elements are able to solve. The status today is that most of the analysis software available offers both choices to the analyst because the analyst has the knowledge of when to use the appropriate method. Once preprocessing has been completed, the loads and boundary conditions are specified, and solvers can be used to determine whether the design meets the operating conditions satisfactorily or if the design needs to be reworked. At this stage of the process, CAD and CAE vendors are also adding optimization modules that can find the best solution given the maximum and minimum specifications for the design.

The common link among the solvers that can be used for specific analytical applications is that the analysis is performed on the geometry brought in from a CAD system or recreated from scratch in the analysis software.

Displaying the results of the analysis is equally important. Postprocessing software that displays the results in both text and graphical formats is an integral part of the analysis package today and helps in making decisions on whether a design needs to be reworked or not. For example, stress and material deformation on a specific component can be displayed on a solid model of the part by shading it in various colors to indicate areas of maximum and minimum stress.

All the analysis functions are mathematically intensive. The basis of competition in the analysis software market has been the rigor and mathematical purity of the solution for various problems. However, the market is moving away from competition based on specific solution methods (p- versus h-elements) to other arenas of competition.

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The Market

Despite high hopes for its growth, the analysis market has not really taken off. In previous years, revenue growth for this market hovered around the average mechanical CAD/CAM/CAE market growth rate. However, in 1997, the computer-aided engineering (CAE) market posted essentially no growth. Software revenue for the CAE market was U.S.$515 million in 1997.

Table 1 shows market share for the CAE vendors. MacNeal-Schwendler is the leader in this market, with revenue of U.S.$104 million, followed by Structural Dynamics Research Corporation. One interesting feature of the analysis market is that it is quite fragmented, with CAD vendors providing some analysis tools and with specialty analysis vendors—and even within the analysis vendors, enclaves of niche players with best-in-class solutions for certain analysis problems.

Table 1
Software Revenue for the CAE Market, 1997 (Millions of Dollars)

	1996	1997	Growth (%) 1996-1997	1997 Market Share (%)
MacNeal-Schwendler	106.3	104.0	-2.2	20.2
Structural Dynamics Research	64.1	73.2	14.2	14.2
Parametric Technology	56.3	61.8	9.8	12.0
IBM*	42.0	49.3	17.5	9.5
ANSYS	37.0	35.1	-5.2	6.8
MARC	19.5	21.7	11.4	4.2
Mechanical Dynamics	11.6	15.3	32.0	2.9
Altair Computing	12.0	13.0	8.6	2.5
Adina R&D	10.3	11.1	7.0	2.1
Algor Interactive Systems	10.5	10.9	3.5	2.1
All Companies	**512.1**	**515.7**	**0.7**	**100.0**

*IBM is the exclusive reseller for Dassault Systemes.
Source: Dataquest (December 1998)

Forecast

Given that the analysis market grew less than 1 percent from 1996 to 1997 in terms of software revenue, Dataquest's forecast for software revenue growth in this market between 1998 and 2002 is for a compound annual growth rate (CAGR) of slightly under 9 percent. We believe the market will return to higher growth rates, based on the following assumptions:

- There will be an uptake of analysis tools aimed at the midrange designer and specialist.
- We will see closer integration of the CAD system with the analysis software.
- Analysis solutions will become more vertical for use in specific industries outside the traditional automotive and aerospace industries.

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- Slow growth among the major CAE vendors has caused the market to stagnate, masking the fairly good growth shown in specialty analysis markets.

In the light of these factors, it is important to focus on certain technical and nontechnical market trends in the CAE market today.

Emerging Trends in the Analysis Market

Analysis has long been the stronghold of specialized analysis software companies, which have prided themselves on the mathematical accuracy and rigor of their solutions. But what has been a niche market is starting to become mainstream in response to user wants and needs for more streamlined tools, tighter integration between software packages, increasing CAD vendor participation in this market, and more partnerships forged between the CAE and CAD vendors.

Tighter CAD and CAE Integration

As mentioned earlier, the move to system-level integration means that analysis needs to be done as early as the conceptual stage of the design. Because the analysis is based primarily on the geometry created in the CAD model, the analysis software needs to be tied as closely as possible to the CAD software used for the design so that the preprocessing stage is as painless as possible.

Embedding the Solid Modeling Kernel in CAE Software

Tight integration speeds up the modeling and geometry creation, which already consumes much of the analysis process. As a response to the need for greater integration between the model geometry from the CAD system and the analysis software, analysis providers, including ANSYS, MacNeal-Schwendler and Structural Research and Analysis Corporation, to name a few, are embedding solid modeling kernels such as ACIS from Spatial Technologies and Parasolid from Unigraphics Solutions in their software packages in an attempt to make bidirectional transfer of data between CAD and CAE smoother and more accurate.

CAE Tool Now an Icon

Some analysis programs now run inside the CAD system itself so that the user does not leave the CAD environment to perform the analysis. Loads and boundary conditions can be applied directly to the CAD model itself. Often the analysis software appears as an icon on the menu bar of the CAD program. For example, MSC/InCheck from MacNeal-Schwendler and DesignSpace from ANSYS are available as icons within Mechanical Desktop from Autodesk. COSMOS/WORKS from Structural Research and Analysis Corporation is similarly available as an icon within SolidWorks.

Historically, CAD vendors have had links with CAE vendors at different levels of integration to be able to provide a way for analysts to plug in the solvers of their choice—CAD vendors offer the basic solvers, but the more specialized solvers tend to come from the CAE companies.

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Moving beyond the Specialist

For years, CAE companies have focused on the specialist analyst community with the training and the background to handle the analysis software and interpret the results. Automotive and aerospace companies have been at the forefront of analysis tools users, and CAE vendors have faced several marketing challenges in trying to expand beyond this traditional domain. Their solutions to these challenges are multifaceted: They are making the tools easier to use, providing intelligent templates to automate the analysis, and creating packages that can be used by nonspecialists.

Ease of Use

Ease of use has become a very important part of the technology and market strategy for both CAD and CAE vendors. CAE vendors, in particular, are concentrating on efforts to make analysis less esoteric and more mainstream by creating a product that lets the designers do some preliminary analysis before the design is passed to the analysis specialist. The idea is to make a product that is easy to use and does not require the kind of specialized training demanded by a traditional, high-end analysis package. Ease of use includes tighter interfaces to CAD packages and a trend toward less mesh-centric analysis, where FEA models are built directly from the CAD model. The mesh is still generated but is displayed only when the user wants to see it.

Software for Nonspecialists

The desire to make an analysis product that works for designers and design engineers is driven partly by the recognition that there is a much larger installed base of designers than of analysts and that to take analysis into industries where traditionally little or no analysis is done as part of the design and manufacturing process requires a product that is easy to use. The growth of midrange CAD packages means that analysis vendors want to target designers who may have very little familiarity with CAE.

All the major analysis companies have to come to this realization, as a look at the kind of products they have begun offering over the past few years indicates.

Two examples of these kinds of products have been mentioned earlier in this Perspective, DesignSpace from ANSYS and MSC/InCheck from MacNeal-Schwendler.

Both MSC/InCheck and DesignSpace are aimed at the design engineer and give the engineer access to a subset of the functionality that is contained in the companies' flagship products. The engineer can evaluate what-if scenarios and do some fundamental analysis based on the preliminary design. Once the initial analysis is complete, the design can be sent to the specialists for further analysis.

In addition, analysis vendors have been responding to designers' needs by developing better user interfaces, error-checking codes, and automatic mesh generators and healers. A note of caution is that the technology still is not foolproof. There are plenty of potential problems, such as setting boundary

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conditions or meshed model cleanup, that might escape the designer. Others want more feedback from their tools that will help them correctly set loading conditions and understand the results.

Intelligent Templates

Different companies are achieving this sort of standardization of the analysis effort in different ways, but one common idea seems to be to use a set of standard templates that allows the designer to do a first-pass analysis. Major analysis vendors are all coming out with add-on modules that give the analyst a continuing role in the process but also give the designer some fundamental rules under which to evaluate the results of the analysis.

One example is a product from ANSYS called Advanced Controls, a module in the DesignSpace product line. This product configuration, DesignSpace Expert, provides the ability to execute intelligent templates created by analysts for use by the design engineers. Specialists within a company set up a series of templates for either a product or a process that can be used by novice engineers and designers. The company then has a way to capture the knowledge that these senior analysts possess and allow it to be used by nonspecialists.

Other companies, such as Structural Research and Analysis Corporation with its new COSMOS/DesignStar, are evolving similar modules for their CAE product lines.

However, although the product captures the knowledge of the engineer and can be used to evaluate alternative scenarios, the intent is not to replace the specialist but to automate the initial design process and turn over the more serious, show-stopping problems to the specialist for high-end analysis.

CAD Vendors and Analysis

There are several analysis packages from CAE-only vendors, but CAD vendors also offer analysis packages. Major CAD software packages have some basic analysis capabilities that are usually modular and are sold as add-on modules. Some companies, such as Dassault Systemes, have their own solvers and have additional partnering relationships with analysis vendors so that those solvers can be plugged into the CAE environment provided by the CAD vendor.

Table 2 is a partial list of CAE offerings from CAD and CAE vendors. Most of the analysis companies offer a variety of solvers, preprocess and postprocess software. This table is not an exhaustive list of either companies or products. We have attempted only to give a flavor of what is available in the market.

Table 2
Sample List of CAE Offerings from CAD and CAE Vendors

Vendor	Offering
Structural Dynamics Research Corporation	I-DEAS Simulation Advisor
Dassault Systemes	CATIA Analysis and Simulation Solutions, GPS, ELFINI
Unigraphics Solutions	UG/Scenario, GFEM
Matra Datavision	Euclid Analyst
Parametric Technology Corporation	Pro/Mechanica
ANSYS	ANSYS, DesignSpace
MacNeal-Schwendler	MSC/Nastran, MSC/Patran
Structural Research and Analysis Corporation	COSMOS
Enterprise Software Products	FEMAP
Algor	Algor FEA
CADSI	PolyFEM
Hibbitt, Karlsson & Sorensen (HKS)	ABAQUS

Source: Dataquest (December 1998)

With every new release of CAD software, a trend toward the CAD vendor folding the analysis into the design tool becomes more visible. The presumption is that whoever owns the geometry owns the process. Many CAD vendors see themselves as controlling the preprocess and the results visualization—the postprocess—stage. CAD vendors even provide basic solvers in many cases. The CAD vendor's view is that the CAE vendor becomes involved only at the stage of providing the more advanced analysis functions. The CAD vendors present themselves as more than qualified to take on the basic analysis function because they control the geometry with which the model has been created. Therefore, they believe, their analysis solutions are likely to be more robust in terms of associativity between the CAD model and the CAE model. CAD vendor Parametric Technology Corporation has actually acquired CAE vendor Rasna. Others, such as Unigraphics Solutions, prefer to create an environment where the CAD vendor provides some pre- and postprocessing capabilities, but where the CAE solution is embedded within the CAD tool and does most of the analysis and optimization work.

A Common Vision

CAD and CAE vendors would like to move toward even more intelligent and knowledge-based systems that do not stop with capturing the expert knowledge of the analyst, perhaps in templates, but that go even beyond that to allowing the software to suggest design changes that not only optimize the solution for the given specifications but actually suggest changes necessary to optimize the final product. Vendors are talking about analysis tools providing design guidance and going beyond performing verification functions.

Leading vendors in both the CAD and CAE markets such as Dassault Systemes, SDRC, and MacNeal-Schwendler have strategic visions for a set of

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products that can capture all the knowledge generated within a company in terms of products, process, personnel, and even outside factors that would affect the product or process. This sort of CAE software, imbued with intelligence that goes beyond wizards or intelligent templates that prompt an engineer based on captured knowledge, is still in the future.

Dataquest Perspective

For many companies, with little beyond the most preliminary analysis, designers tend to overdesign in order to get products out the door in time to meet the market window. A large proportion of the analysis seats sold tend to be in the automotive and aerospace industries. Even within this user base, deployment of analysis seats tends be at a ratio of one or two CAE seats for every 10 CAD seats. Analysis vendors have been trying hard to get to the large installed base of designers who currently use minimal or no CAE tools. Their strategies to bring analysis to the enterprise and expand their user base have been changing over the last few years. In the past, analysis companies tended to focus on creating specific solutions for nonanalyst designers. Their current product focus is to create a line of products that takes the designer through a series of steps toward higher-end analysis. Problems that are beyond the expertise of the design engineer can be handed over to a specialist.

CAE vendors, despite their good partnering relationships with CAD vendors, find themselves hemmed in on several fronts by CAD vendors seeking to expand their influence in the analysis areas as well. CAD vendors, driven in part by a move by their users to the virtual prototyping paradigm for design, are trying to provide a solution set rather than point tools to their users so they can generate the CAD, CAM, and CAE information from the same set of tools. Companies such as Dassault Systemes and SDRC, to name just two, are visualizing a more streamlined design process that facilitates knowledge capture, knowledge transfer, and best practices within the organization and that makes the tools easy to use, even for the designer. As owners of the geometry creation process, they believe they are the most qualified to take on the basic functions of the CAE side of the creative process.

Interestingly, given that users are talking about wanting tools to transfer designs more seamlessly from CAD to CAE and wanting the benefits of tighter integration with CAD packages, some analysis vendors are starting to question this strategy, citing the issues that arise from supporting multiple CAD packages. For the majority of the vendors, however, the golden mean seems to be for CAE to exist within the body of the CAD package, embedded as an icon or available as an analysis window within the same environment.

As a result of these technological and market forces, Dataquest expects to see more consolidation among the analysis vendors in the next five years. One recent example is the merger of CADSI and LMS, two specialty analysis vendors. CADSI is active in the kinematics marketplace with its motion analysis products and also has a FEA package called PolyFEM. It would also not be very surprising to see CAD vendors buying out specialty analysis vendors. Particularly in the case of analysis technology, many of the specific

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solvers are advanced enough that it would require a large R&D investment from CAD vendors to duplicate them. The good news is that as we move toward the virtual prototyping paradigm for system-level design, analysis will become an integral part of the process. Companies that do not currently engage in analysis as part of the design-to-manufacturing process will find themselves having to acquire the capabilities and the tools. Also, there are still untapped areas within this market to pursue, such as nonlinear analysis, and nontraditional industries to target, such as electronic packaging (which we can no longer consider "untapped").

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Perspective



Mechanical CAD/CAM/CAE Worldwide

Market Analysis

European Mechanical CAD/CAM/CAE Market Update

Abstract: *This document provides an analysis of the European mechanical CAD/CAM/CAE software market by region, component, and platform. 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.*
By Petra Gartzen

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

The following characterized the European CAD/CAM/CAE/GIS market in 1997:

- The European CAD/CAM/CAE/GIS market remained static at $6.1 billion in total factory revenue in 1997. Calculated in European currency units (ECU), the market grew 11.1 percent.
- CAD/CAM/CAE/GIS software revenue increased 4.4 percent to $2.3 billion. Based on ECU, software revenue grew 16.1 percent.
- The largest application segment in Europe is mechanical, with 48.3 percent of the total European CAD/CAM/CAE/GIS software market. It increased 13.5 percent in 1997 based on ECU.
- Europe-based vendors generated only 25.4 percent of the mechanical CAD/CAM/CAE software revenue, compared with 74.6 percent generated by U.S. -based vendors.
- UNIX-based software still dominated the market, accounting for nearly 66 percent of mechanical CAD/CAM/CAE software sales in Europe in 1997. By 2002, this share will decrease to 46 percent as NT-based applications gain more ground.

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- The largest regional market for mechanical CAD/CAM/CAE software in 1997 was Germany, with U.S.$414 million in software revenue, representing 37.4 percent of the European market.

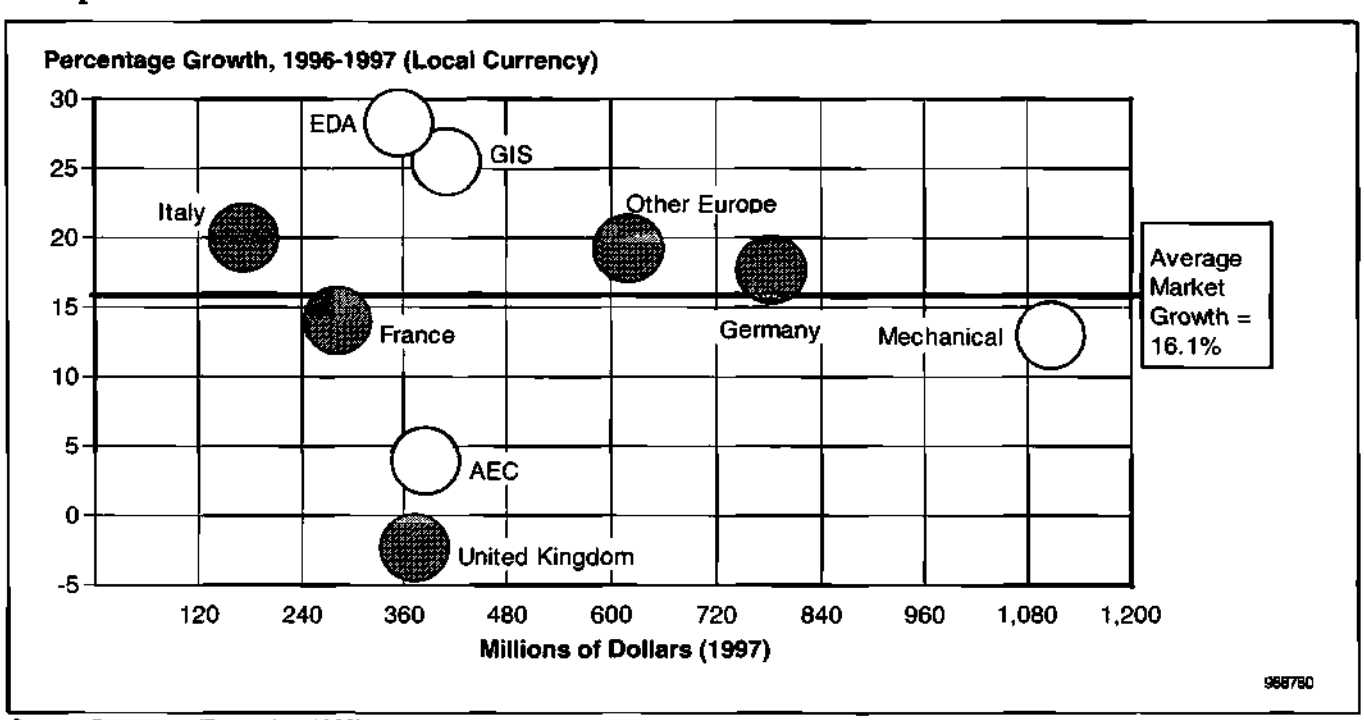
The top five vendors accounted for 62 percent of mechanical CAD/CAM/CAE software revenue in 1997, compared with 53 percent in 1996. Their combined revenue increased by 19.9 percent.

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.

The Continuing Impact of Currency Shift

Fluctuating exchange rates once again masked the true performance of the 1997 CAD/CAM/CAE/GIS market. European CAD/CAM/CAE/GIS software grew 4.4 percent from 1996 to 1997 when measured in U.S. dollars. The dollar appreciated 11.2 percent against the ECU, so European CAD/CAM/CAE/GIS software revenue grew 16.1 percent from 1996 to 1997 when measured in ECU. Table 1 shows the U.S. dollar's performance over the past three years against the individual European currencies. Table 2 highlights the effect that the fluctuations in the dollar exchange rate had on the performance of the European CAD/CAM/CAE/GIS market.

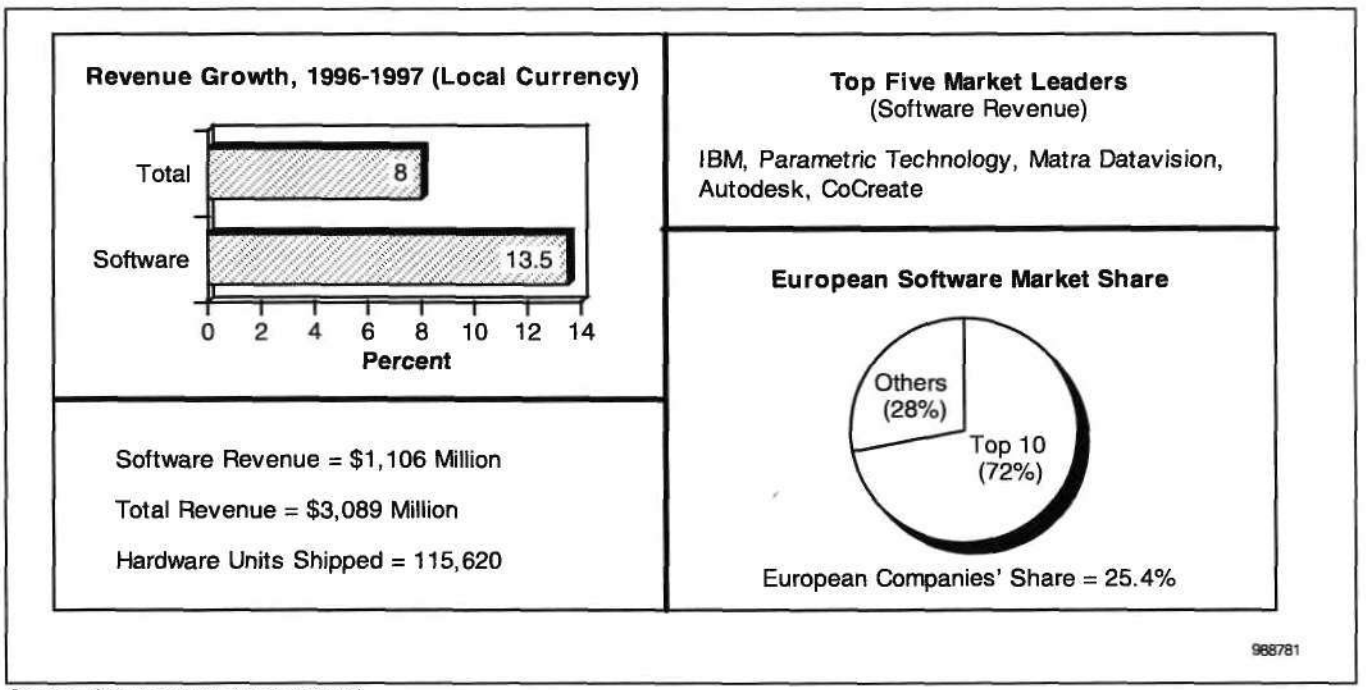
Figure 1
European CAD/CAM/CAE/GIS Software Market Portfolio



Source: Dataquest (December 1998)

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Figure 2
European Mechanical CAD/CAM/CAE Market Snapshot



Source: Dataquest (December 1998)

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

Country	Currency	1995	1996	1997	Preliminary Average, 1998[1]	Projected Rate, 1999[2]	U.S. Dollar Appreciation (%) 1995-1996	1996-1997	1997-1998	1998-1999
Austria	Schilling	10.06	10.59	12.20	12.44	11.96	5.2	15.2	2.0	-3.9
Belgium	Franc	29.42	30.96	35.79	36.48	35.05	5.2	15.6	1.9	-3.9
Denmark	Krone	5.59	5.81	6.61	6.74	6.47	3.9	13.7	2.0	-3.9
Finland	Markka	4.37	4.59	5.19	5.37	5.17	5.1	13.0	3.5	-3.7
France	Franc	4.97	5.12	5.84	5.93	5.70	2.9	14.1	1.6	-3.9
Germany	Deutsche mark	1.43	1.50	1.73	1.77	1.70	5.2	15.2	2.0	-3.9
Italy	Lira	1,628.21	1,542.72	1,703.02	1,744.55	1,678.92	-5.3	10.4	2.4	-3.8
Netherlands	Guilder	1.60	1.69	1.95	1.99	1.92	5.2	15.7	2.2	-3.8
Norway	Krone	6.33	6.46	7.08	7.56	7.56	2.1	9.6	6.8	-0.1
Spain	Peseta	124.40	126.68	146.45	150.09	144.33	1.8	15.6	2.5	-3.8
Sweden	Krona	7.14	6.71	7.64	7.93	7.88	-6.0	13.9	3.8	-0.6
Switzerland	Franc	1.18	1.24	1.45	1.46	1.40	4.8	17.3	0.6	-4.1
United Kingdom	Pound	0.63	0.64	0.61	0.60	0.59	1.3	-4.7	-1.3	-1.4
Europe	ECU	0.77	0.80	0.89	0.90	0.86	2.9	11.2	1.2	-3.6

[1]Preliminary average for 1998
[2]Projected rates for 1999
Source: Dataquest (September 1998)

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Table 2
Software Revenue History and Forecast, All Operating Systems (U.S. Dollars and ECU)

	1995	1996	1997	1998	1999	2000	2001	2002	Growth Rate (%) 1996-1997	Growth Rate (%) 1997-1998	CAGR (%) 1997-2002
European Revenue (U.S. $M)											
Mechanical	987	1,084	1,106	1,188	1,295	1,391	1,515	1,686	2	7	8.8
AEC	411	421	392	408	450	500	542	587	-7	4	8.4
GIS/Mapping	317	362	413	466	528	592	671	748	14	13	12.6
EDA	284	324	377	440	515	591	674	759	16	17	15.0
All Applications	**2,000**	**2,192**	**2,289**	**2,501**	**2,787**	**3,074**	**3,402**	**3,780**	**4**	**9**	**10.6**
Exchange Rate (ECU/U.S.$)	0.77	0.80	0.89	0.90	0.86	0.86	0.86	0.86	-	-	-
European Revenue (ECU M)											
Mechanical	764	863	979	1,065	1,119	1,202	1,309	1,457	13	9	8.3
AEC	318	335	347	366	389	432	468	507	4	5	7.9
GIS/Mapping	245	289	366	417	456	511	580	646	27	14	12.1
EDA	220	258	334	394	445	511	583	656	29	18	14.4
All Applications	**1,547**	**1,745**	**2,026**	**2,242**	**2,408**	**2,656**	**2,939**	**3,266**	**16**	**11**	**10.0**

Source: Dataquest (October 1998)

Looking ahead, currency fluctuations will continue to be felt in all global markets. The dollar started to depreciate during the latter months of 1997, so, assuming a stable currency for the remainder of this year, 1998 will end with the dollar appreciating only about 1 percent against the ECU.

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 purposes of this forecast, Dataquest assumes that the September exchange rate will remain stable in the future.

Mechanical CAD/CAM/CAE Market in Europe

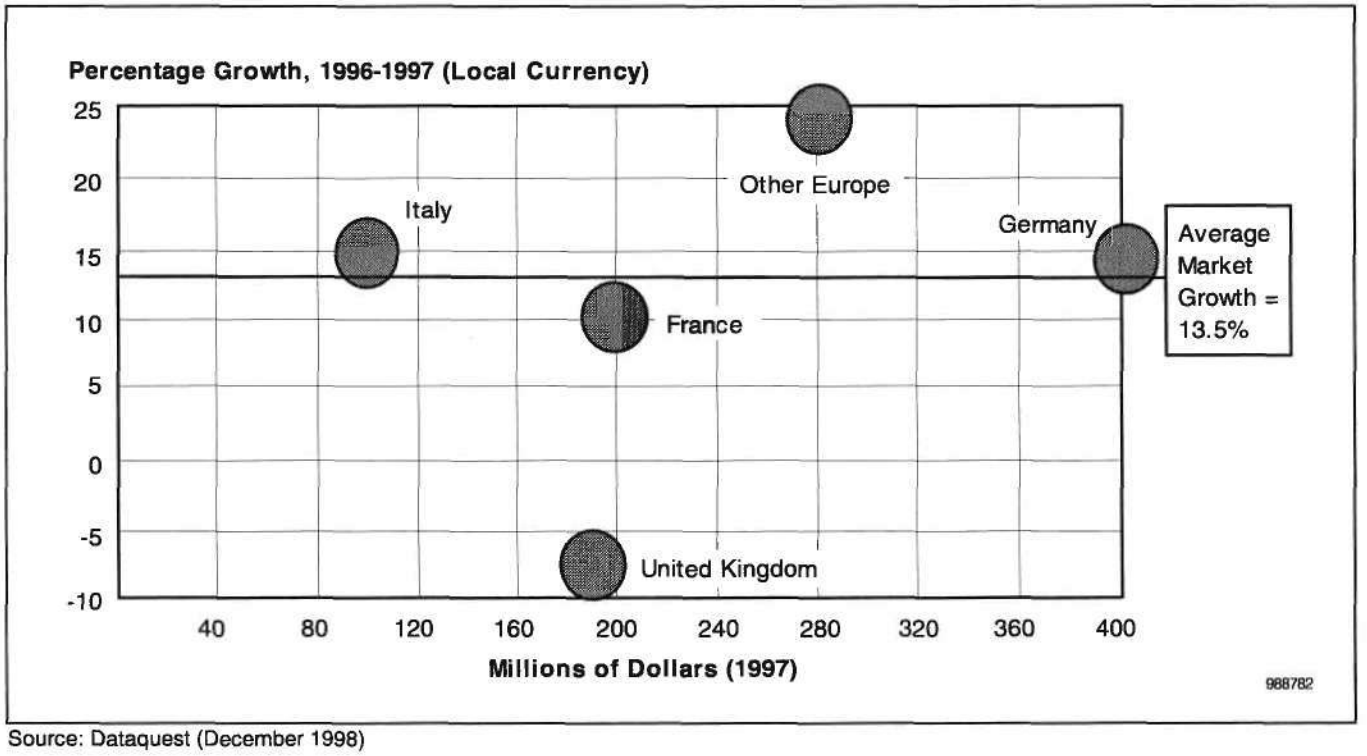
Mechanical applications, which totaled $1.1 billion, held a 48 percent share of the total European CAD/CAM/CAE/GIS software market in 1997, compared with 50 percent in 1996, and increased by 13.5 percent in software revenue in 1997. The top 10 vendors grew 13.4 percent and controlled 72 percent of this market, compared with 76 percent in 1996. The market is expected to increase by another 9 percent to $1.2 billion in 1998 (all growth rates are based on ECU).

Dataquest expects the market for mechanical CAD/CAM/CAE software to grow at a compound annual growth rate (CAGR) of 8.8 percent until 2002.

Figures 3 and 4 give a snapshot of the mechanical CAD/CAM/CAE software market in 1997 and Dataquest's predictions for the market by major European country.

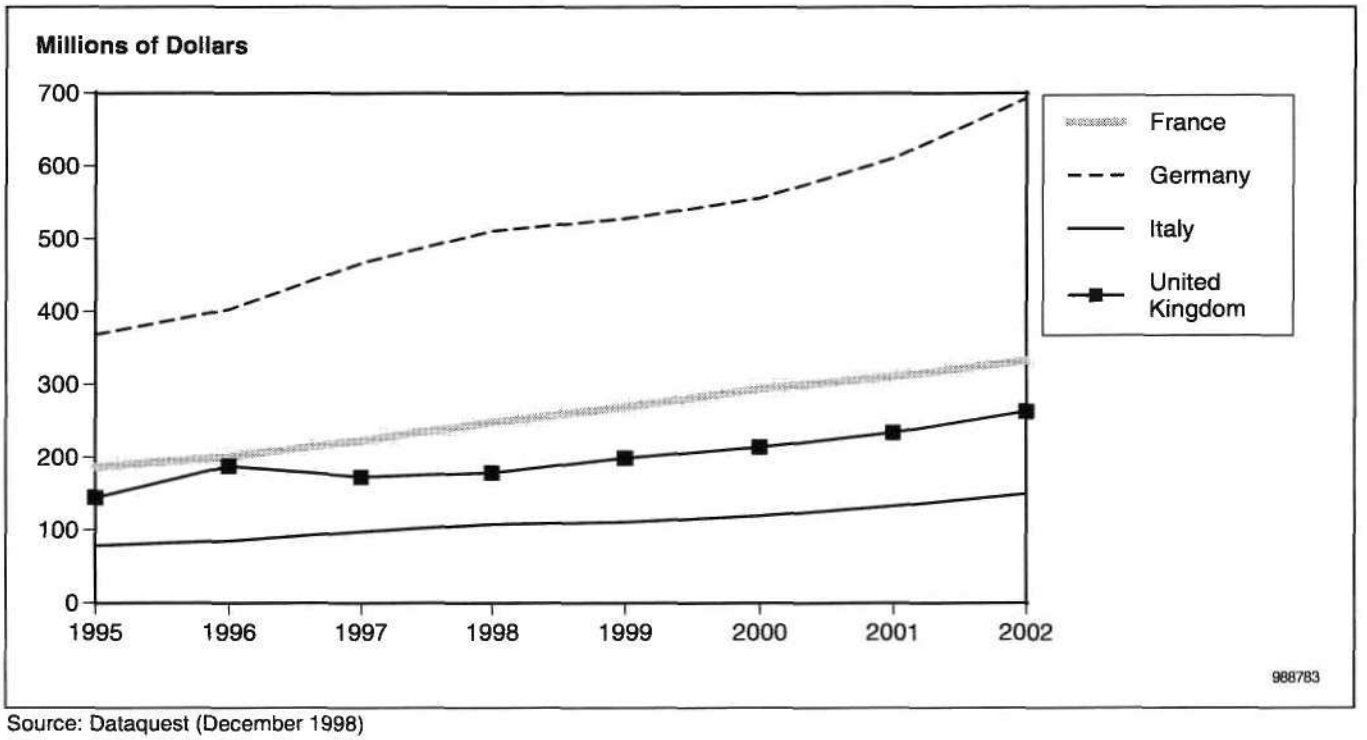
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Figure 3
European Mechanical CAD/CAM/CAE Software Market Portfolio



Source: Dataquest (December 1998)

Figure 4
European Mechanical CAD/CAM/CAE Software Revenue Forecast by Country



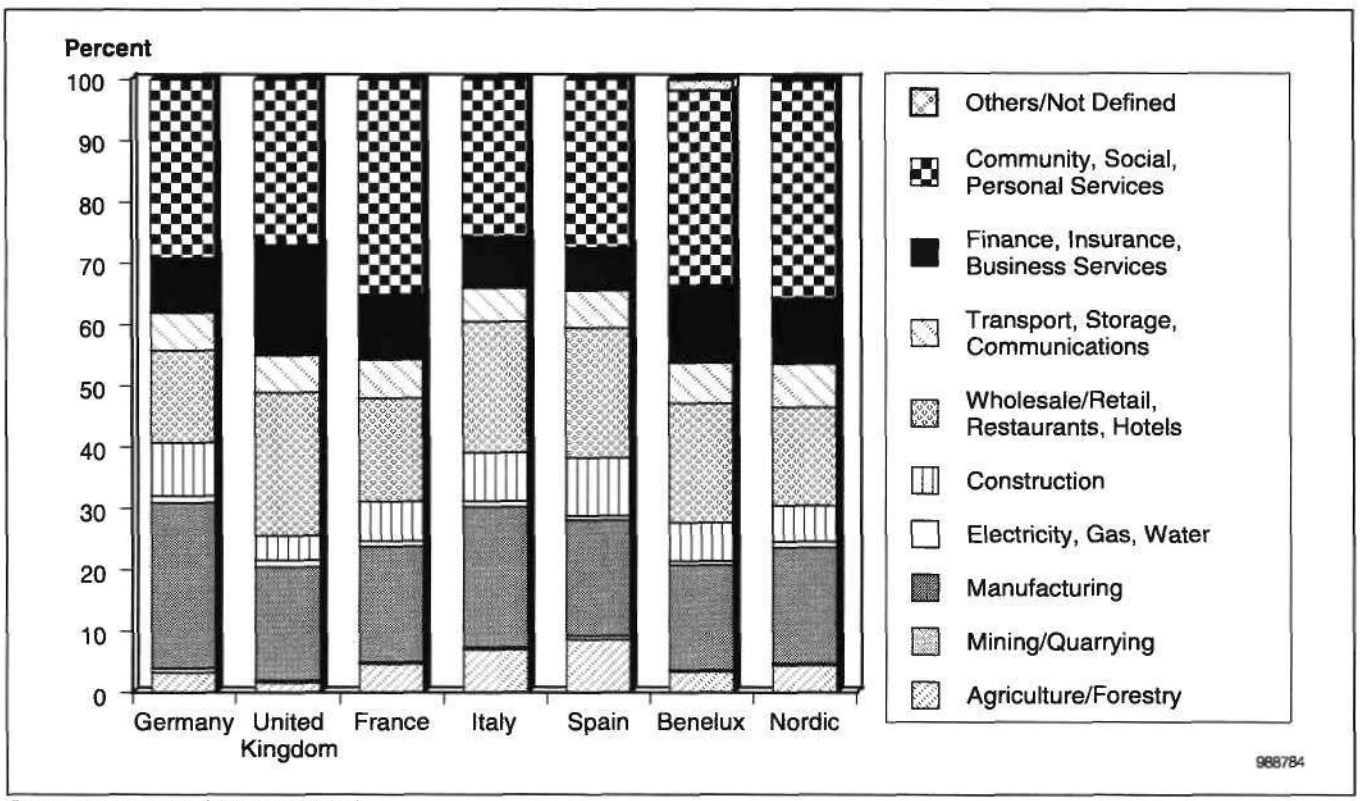
Source: Dataquest (December 1998)

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Over the past three years (1995 through to 1997), investment has been heavy 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 begin to slow during 1998. In 1998 and 1999, Dataquest expects the machinery industry to pick up growth, investing mainly in NT-based solutions. However, because 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 8 percent between 1998 and 2001.

The economic statistics make it 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 5 and 6). This is also reflected in Germany's 37 percent share of 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 6 percent in 1998, slowing to 3.3 percent in 1999. The machinery industry in particular will increase 8.2 percent in 1998 and 4.5 percent in 1999. This will drive CAD investment in the machinery sector in Germany, and this in turn will ensure that growth rates for Europe as a whole will remain relatively high.

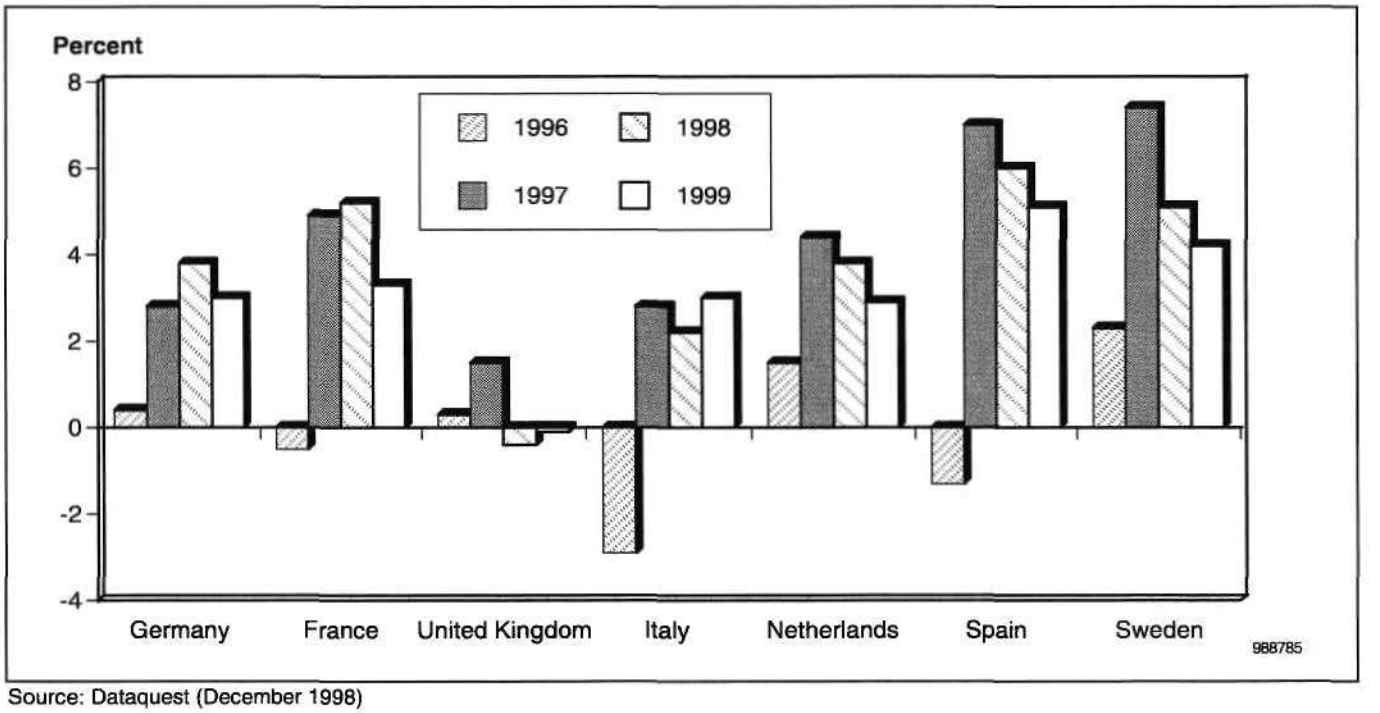
Figure 5
European Manufacturing Industry—Percentage of Workforce by Industry



Source: Dataquest (December 1998)

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Figure 6
European Industrial Production Growth Forecast



Source: Dataquest (December 1998)

European Mechanical CAD/CAM/CAE Market by Component

The software share of the total revenue for mechanical CAD/CAM/CAE applications has increased at the expense of hardware revenue. This trend is expected to continue as hardware prices continue to fall at a faster rate than software prices (see Figure 7).

Mechanical CAD/CAM/CAE Market by Platform

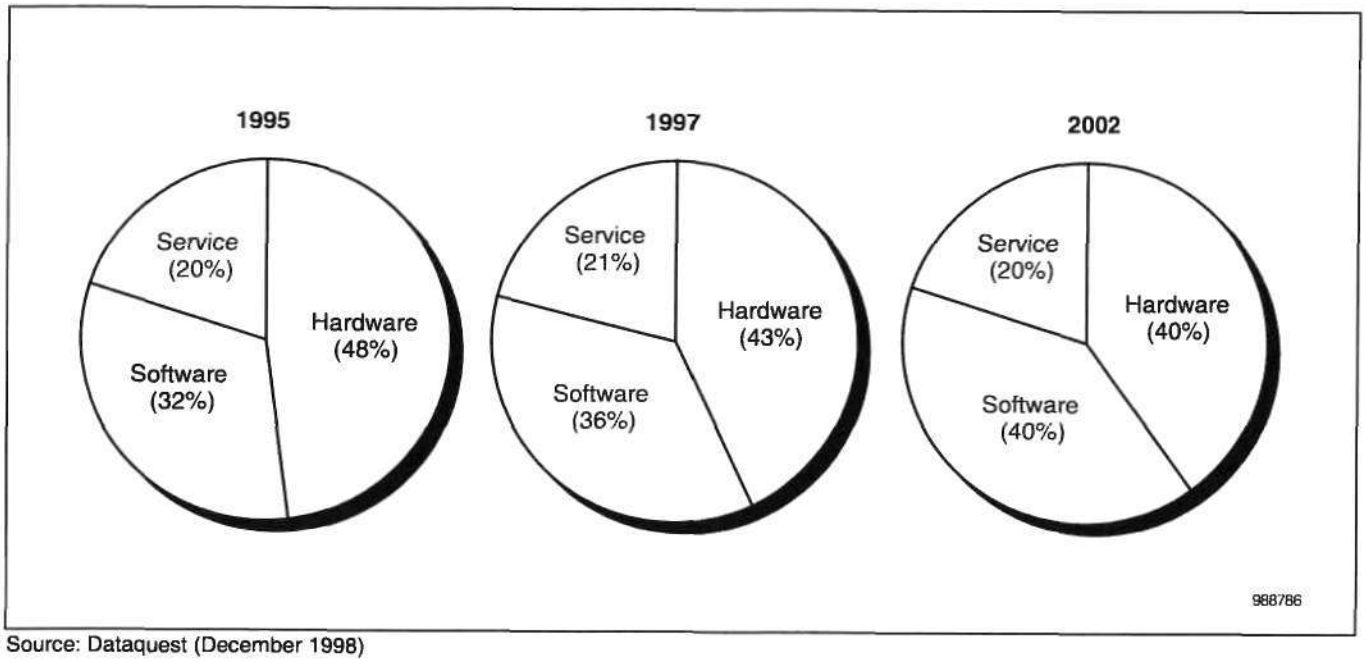
The mechanical CAD/CAM/CAE market segment, in terms of software revenue, is still dominated by UNIX-based solutions, which accounted for 66 percent of European mechanical CAD/CAM/CAE software revenue. UNIX-based seats made up 43 percent and PC-based seats 46 percent of the mechanical CAD/CAM/CAE installed base in 1997 (see Figures 8 and 9). With growth of 126 percent in 1997, 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 is primarily driven by large UNIX-based orders from the automotive and aerospace industries.

In Europe, 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-size companies.

In major industries such as automotive and aerospace, adoption of NT-based solutions will take longer because most of the large companies have just

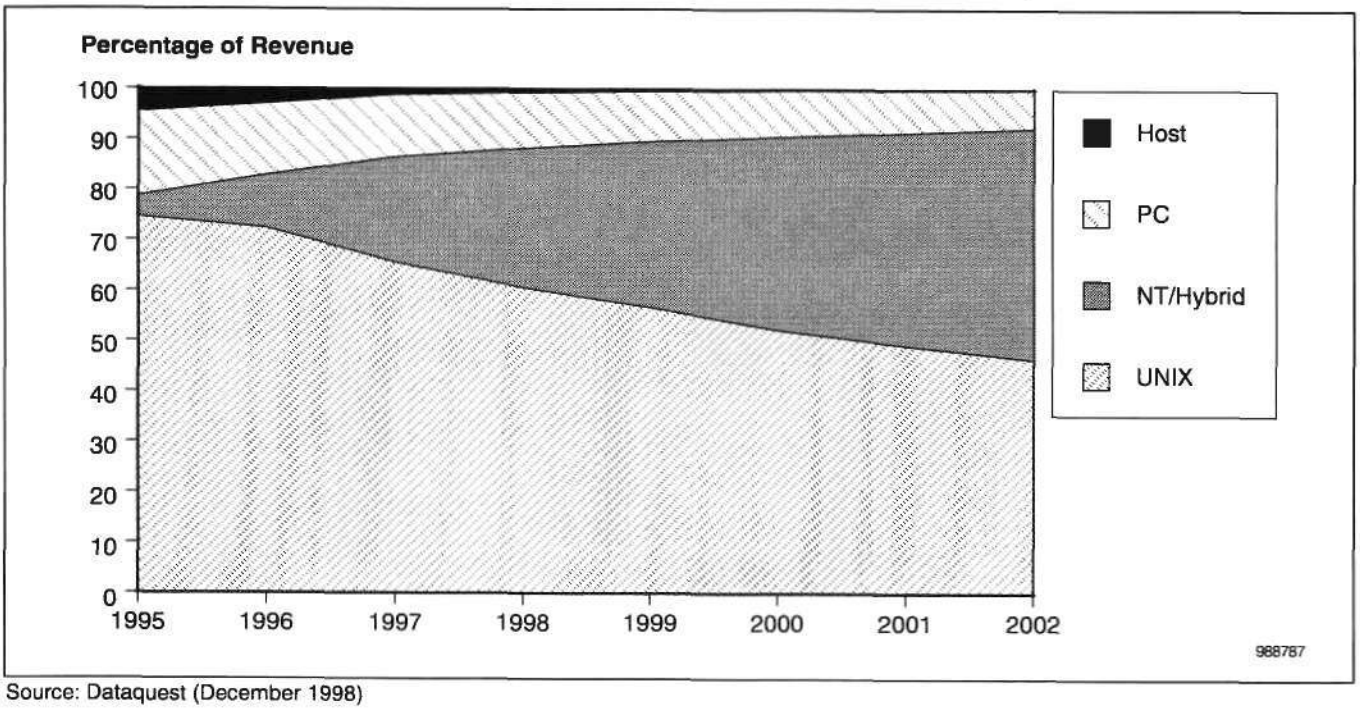
invested in UNIX-based systems. Given the long IT investment cycles in these industries, it will take a number of years until these new installations will be replaced.

Figure 7
European Mechanical CAD/CAM/CAE Revenue by Component, 1995, 1997, and 2002



Source: Dataquest (December 1998)

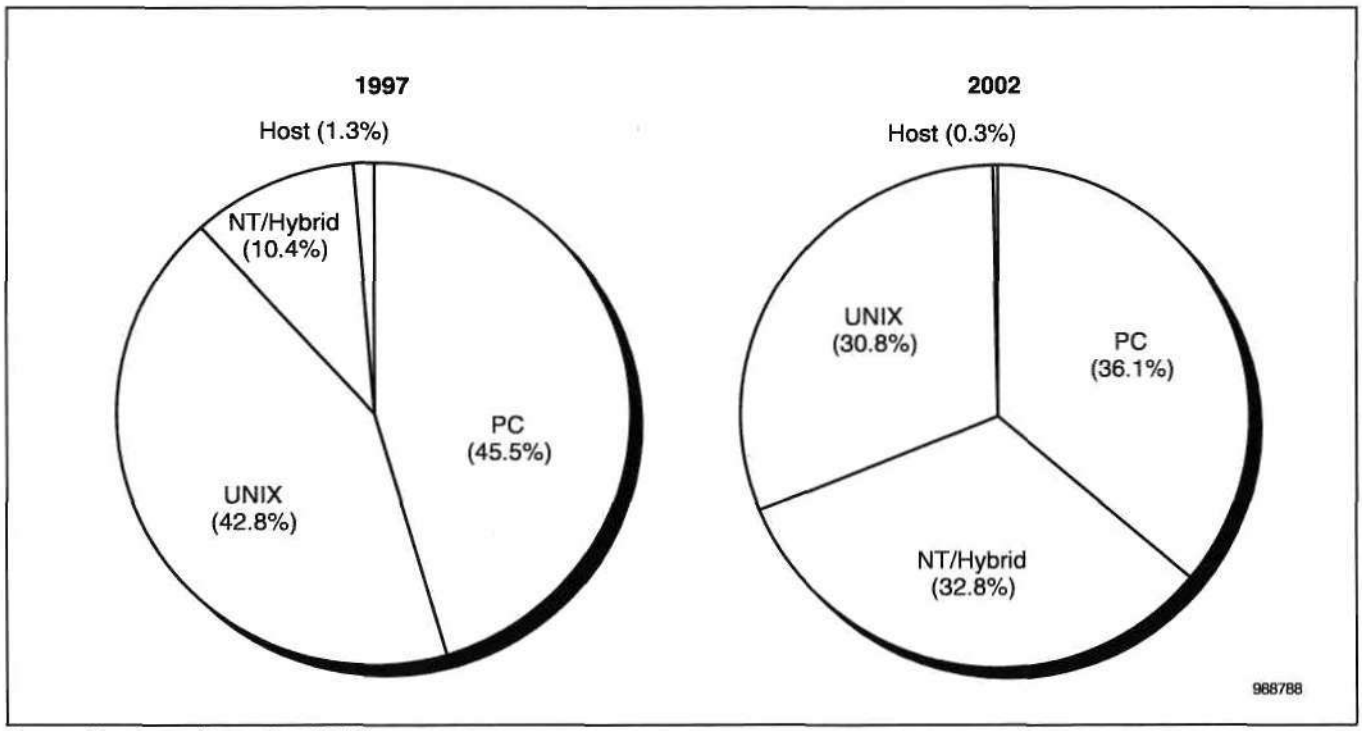
Figure 8
European Mechanical CAD/CAM/CAE Software Revenue Forecast by Platform



Source: Dataquest (December 1998)

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Figure 9
European Mechanical CAD/CAM/CAE Hardware Seat Installed Base by Platform



Source: Dataquest (December 1998)

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 continuing IT investment.

CAD investment in Europe is part of global corporate strategy. This means that when orders are placed in Europe, generally they are much larger than in the United States, as shown by the various large orders that came in from Europe over the past three years. But this trend 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 most of the large companies in the automotive and aerospace industries have now made their CAD renewal investments, Dataquest does not expect the mechanical CAD/CAM/CAE software market to continue to grow at its 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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A Gartner Group Company



Perspective

Mechanical CAD/CAM/CAE Worldwide

End-User Analysis

CAD/CAM/CAE Technology: Management Perspectives, Part Two

Abstract: *What are some of the factors that affect the decision to purchase a mechanical CAD system? How do managers view the technology? In this Perspective, we examine the results of a recent CAD/CAM/CAE management end user survey. This is the second of two Perspectives summarizing the joint* Computer-Aided ENGINEERING/*Dataquest survey.*
By Daya Nadamuni and Sharon Tan

Introduction

Computer-Aided ENGINEERING (CAE) magazine and Dataquest recently completed a joint end-user survey of mechanical CAD/CAM/CAE managers in North America. The purpose of the survey was to better understand current usage, benefits, and management of CAD/CAM/CAE technology in a number of industries.

Dataquest is summarizing the results of the survey in two Perspectives. The first Perspective, published in September ("CAD/CAM/CAE Technology-Management Perspectives," dated September 1998, CMEC-WW-DP-9809), focused on management viewpoints on CAD technology, including benefits, justifications, and upgrade/budget schedules. This second Perspective looks at Internet/intranet/Web plans and management's satisfaction with current CAD solutions. The results of the survey will also be published in the November issue of *Computer-Aided ENGINEERING* (please see http://www.penton.com/cae/ for information on subscribing to *Computer-Aided ENGINEERING* magazine).

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(For Cross-Technology, file in the Client/Server Software and Technical Applications binder)

Survey Methodology and Respondent Demographics

CAE magazine and Dataquest developed a four-page survey questionnaire. Survey candidates were randomly pulled from Penton Publications' database of CAE magazine subscribers with management titles. CAE magazine published and mailed the surveys, and the completed surveys were sent to Dataquest for analysis. There were 159 surveys completed. While our intent was to survey North American CAD/CAM/CAE managers, 24 respondents (15 percent of all respondents) identified themselves as nonmanagers. Overall, the survey respondents had a significant amount of managerial experience, with 64 percent of respondents reporting 10 or more years of experience in management.

Company size varied from fewer than 10 employees at a given location to 9,999 employees. For the purposes of this survey, 57 percent of respondents were from small companies (fewer than 200 employees), 31 percent from medium-size companies (200 to 999 employees), and 12 percent from large companies (1,000 employees or more).

On the whole, we can characterize the majority of survey respondents as managers coming from small to medium-size companies with less than $100 million in fiscal revenue. More detailed demographic information is available in the first Perspective in this series.

2-D Design and 3-D Design

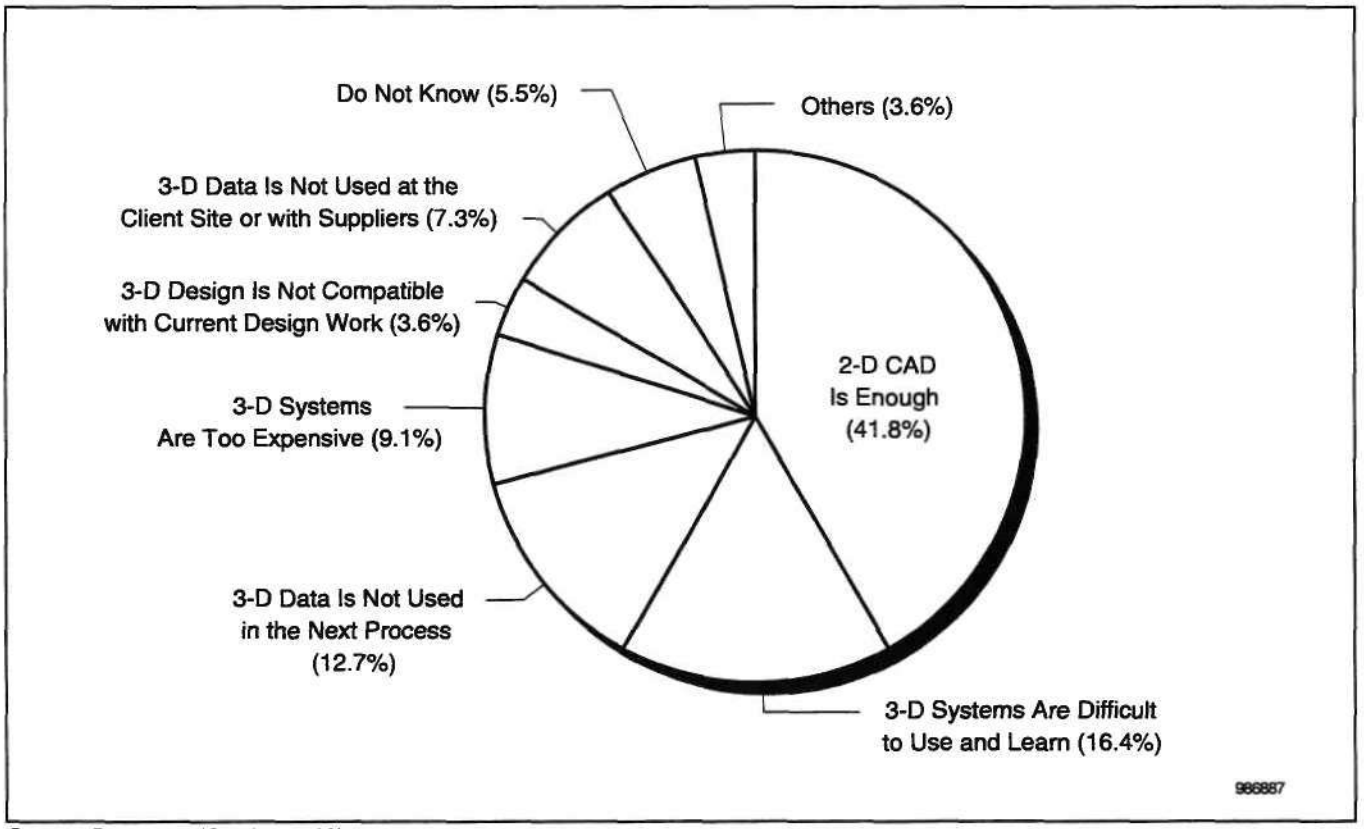
A great majority of the vendors in the mechanical CAD/CAM/CAE market today are selling products that are geared toward or facilitate 3-D design and analysis. With this in mind, we asked the respondents if they considered 3-D design to be the main form of design today. The results were somewhat surprising; only 51 percent of the respondents answered in the affirmative. However, when we asked if 3-D design would be the main form of design in 2000, 73 percent of the respondents gave affirmative responses. While we have traditionally found user responses to be more optimistic than realistic, we also realize that the respondents for this survey tended to be CAD/engineering managers who perhaps exert greater influence on CAD purchases than other respondents that we typically survey.

We then asked the respondents who indicated that they used mainly 2-D design today to state their most important reason for not moving to 3-D design. Figure 1 lists the reasons given by users for not using 3-D design at present.

The most popular response given by 42 percent of respondents was that they believed 2-D CAD was sufficient for their purposes. A further 16 percent of the respondents also claimed that 3-D CAD was difficult to learn and use. Four percent of the respondents cited nontechnical reasons for staying with 2-D design packages. For many companies it appears that there is no compelling reason to move to 3-D design. 3-D design is not used downstream or upstream by clients or suppliers, or in the next step of the design/manufacturing process.

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Figure 1
Why Is 3-D CAD Not the Main Form of Design Today or in 2000?



Source: Dataquest (October 1998)

The responses to the 2-D design versus 3-D design question showed some variation by industry. The results of the survey in this case were not very surprising. The automotive and aerospace industries have traditionally had a much greater focus on 3-D design than, for example, the fabricated metal industry. There were 61 percent of the respondents in the automotive and aerospace industries that use 3-D design today and 88 percent expect to do so in 2000. However, only 22 percent of respondents in the fabricated metal industries use 3-D design now, and only 33 percent expect to do so in 2000. Figures for CAD usage are listed by industry in Table 1.

Table 1
3-D CAD Usage by Industry, 1998

Industry	Percent
Automotive/Aerospace	20
Fabricated Metal	12
Industrial/Commercial Machinery	22
Electrical Equipment, Industrial Controls, Toys	15
Services	17
Government, Education, Process Industries, Recreation	14
Total	**100**

Source: Dataquest (October 1998)

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Given the nature of the respondents' design environment, our next goal was to survey their satisfaction or dissatisfaction with current design-related tools and technologies.

Design-Related Tools and Technologies—What Users Think and What They Want

Respondents to our survey were asked to rate the following tools and technologies with respect to importance and satisfaction on a scale of 1 (not important) to 5 (very important/very satisfied).

- Part modeling
- Assembly modeling
- Drafting/detailing
- Overall performance
- Ability to share design files via the Internet/Web
- Design optimization capabilities
- Photorealistic imaging
- CAD to CAM integration
- CAD to CAE integration

Table 2 presents the numerical results of the gap analysis (the difference between importance ratings and satisfaction ratings). Figure 2 provides a visual interpretation of these user importance and satisfaction ratings. The importance of each characteristic is mapped on a 1 to 5 scale and the satisfaction rating for each application is mapped along the same axes as its corresponding importance rating.

In an ideal situation the importance and satisfaction ratings would be equal, and no area would appear between the circles because the circles would coincide. However, when the circles do not coincide at every point users are not as happy as they could be, and this certainly appears to be the case for the respondents in this survey. The areas of divergence represent the gaps between importance and satisfaction ratings by the respondents. We would consider any gap greater than 0.5 to be an area that vendors might consider concentrating future efforts.

Drafting/detailing and overall performance of the applications used for this work ranked highest in importance with a weighted average response of 4.3 and 4.2, respectively. But these categories also showed some of the biggest importance/satisfaction gaps at 0.7 for drafting and 0.6 for overall performance. Both part modeling and assembly modeling were also very important to users, but showed smaller importance/satisfaction gaps.

There is a large importance/satisfaction gap (0.7) in design optimization capabilities of mechanical CAD software applications. Many vendors, particularly those in CAE and visualization, have attempted to address this design optimization gap either with CAE applications aimed at designers or

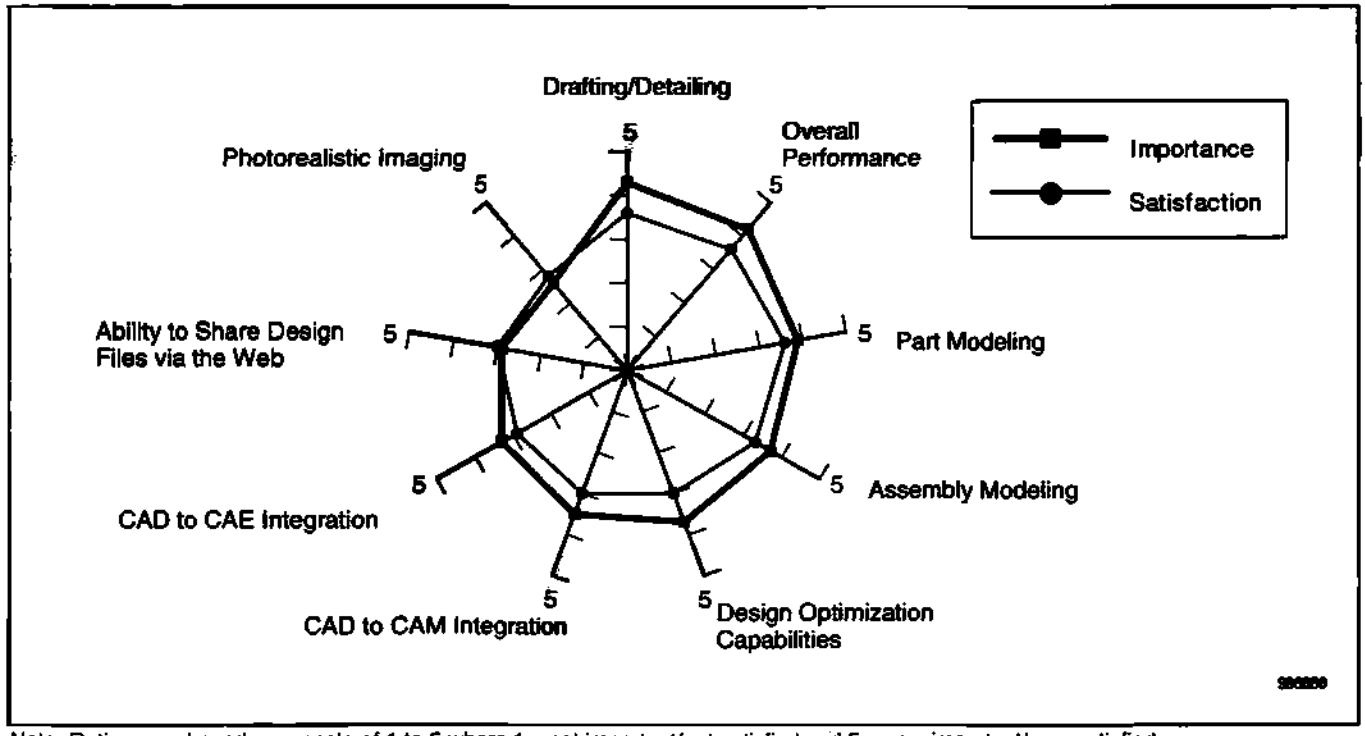
with "virtual prototyping" applications that allow designers to view and interact with assembly models in a virtual environment.

Table 2
Gap Analysis of Importance/Satisfaction Ratings for Mechanical Applications

	Importance	Satisfaction	Gap
Drafting/Detailing	4.3	3.6	0.7
Overall Performance	4.2	3.6	0.6
Part Modeling	3.9	3.6	0.3
Assembly Modeling	3.7	3.3	0.4
Design Optimization Capabilities	3.7	3.0	0.7
CAD to CAM Integration	3.5	3.0	0.5
CAD to CAE Integration	3.3	2.9	0.4
Ability to Share Design Files via the Web	2.9	3.0	-0.1
Photorealistic Imaging	2.6	2.8	-0.2

Source: Dataquest (October 1998)

Figure 2
Gap Analysis for Importance/Satisfaction Ratings



Note: Ratings are based on a scale of 1 to 5 where 1 = not important/not satisfied and 5 = very important/very satisfied.
Source: Dataquest (October1998)

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. With this in mind, we asked the respondents about the importance of CAD to CAM and CAD to CAE integration. CAD to CAM and CAD to CAE integration are

perceived as important and users did display a lack of satisfaction with the applications. This is consistent with previous user surveys conducted by Dataquest that showed users were dissatisfied with data exchange and translation software.

With the increasing penetration of the Web and the Internet into the workplace and the design process, the ability to share design files via the Web is perceived as important, though not as important as drafting/detailing or design optimization. Respondents expressed minimal dissatisfaction with the ability to share design files over the Web. The same can be said of photorealistic imaging, which has been consistently ranked lower in surveys both in importance and in dissatisfaction over the past three years.

One interesting trend that we noticed was that satisfaction ratings were generally higher for respondents who felt that their companies had fairly strong information networks and that the overall progress in using CAD technology had been good.

Design and the Internet

Collaborative engineering, project Web sites, and the use of component models downloaded from the Web have all been concepts of great interest and much discussion for the past few years in engineering circles. The last two years have seen a great deal of activity on the part of CAD vendors implementing Web browsing capabilities within their design applications, Web-enabling product data management (PDM) solutions, developing Web-based project management solutions, and in a few cases providing links with component information system (CIS) vendors. To get some idea of how the users view the Internet as a tool for engineering and product development, we asked respondents about their access to the Internet, the Internet services they use, and their security concerns about using the Internet.

Accessing the Internet

There were 82 percent of the respondents surveyed that indicated their companies gave employees access to the Internet. However, of these respondents, 70 percent gave most or all of their employees access to the Internet while 30 percent limited access to a small number of employees.

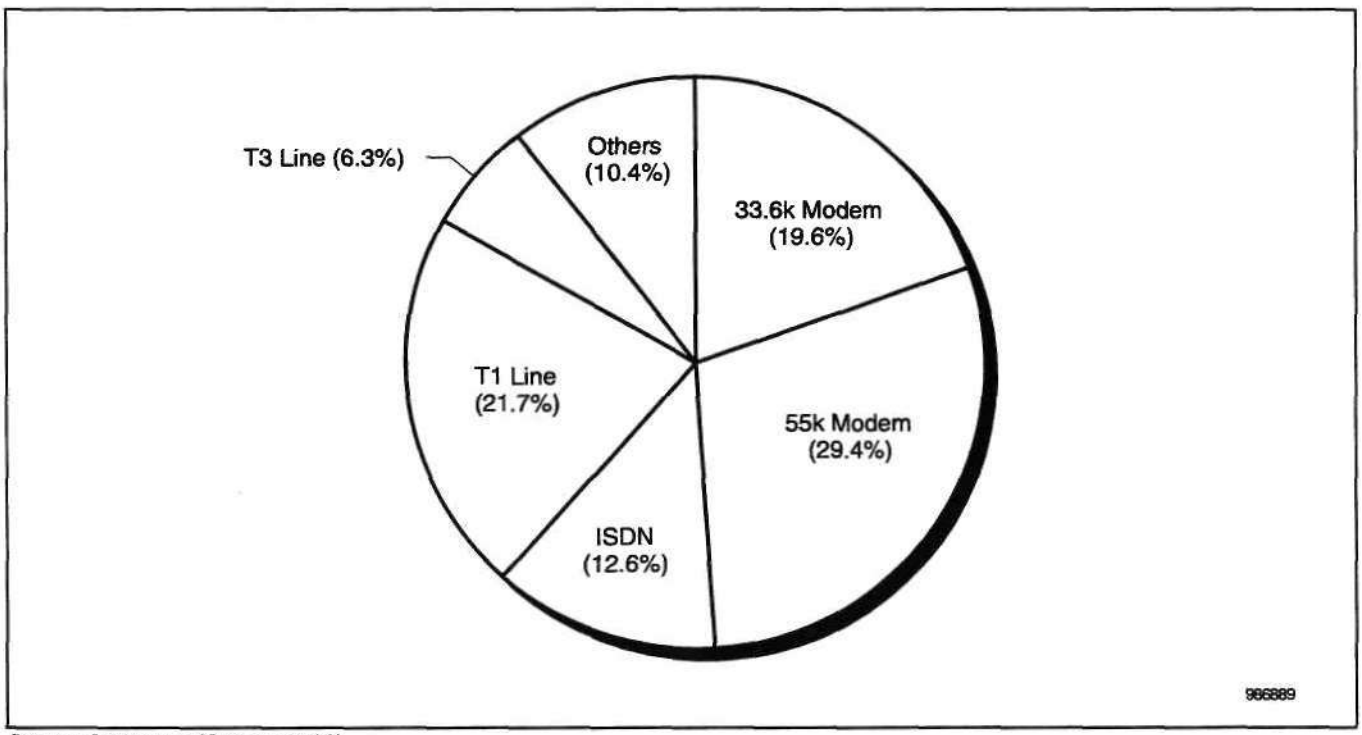
The methods used to access the Internet also varied though the 55.6k modem was the most popular, followed by the T1 line. Figure 3 shows the different types of access methods used by respondents.

Internet-Related Services

We asked respondents what Internet-related services the company uses. Here, multiple responses were allowed. E-mail was chosen by 34 percent of the respondents as the most popular service, followed by the use of the general company intranet. There were 29 percent of the respondents that used e-mail services and also accessed the general company intranet, but only 9 percent used all four of the most popular services. Surprisingly, only 2 percent of the respondents indicated that they used CAD conferencing services via model viewing, which leads us to believe that vendors may have

to do some serious evangelizing to get users to use the Internet as a tool for concurrent engineering. Table 3 shows the Internet/Web services that companies use to assist in engineering and product development. Figure 4 shows the four most popular Internet-related services used today by respondents in different industries.

Figure 3
Internet Access Method



Source: Dataquest (October 1998)

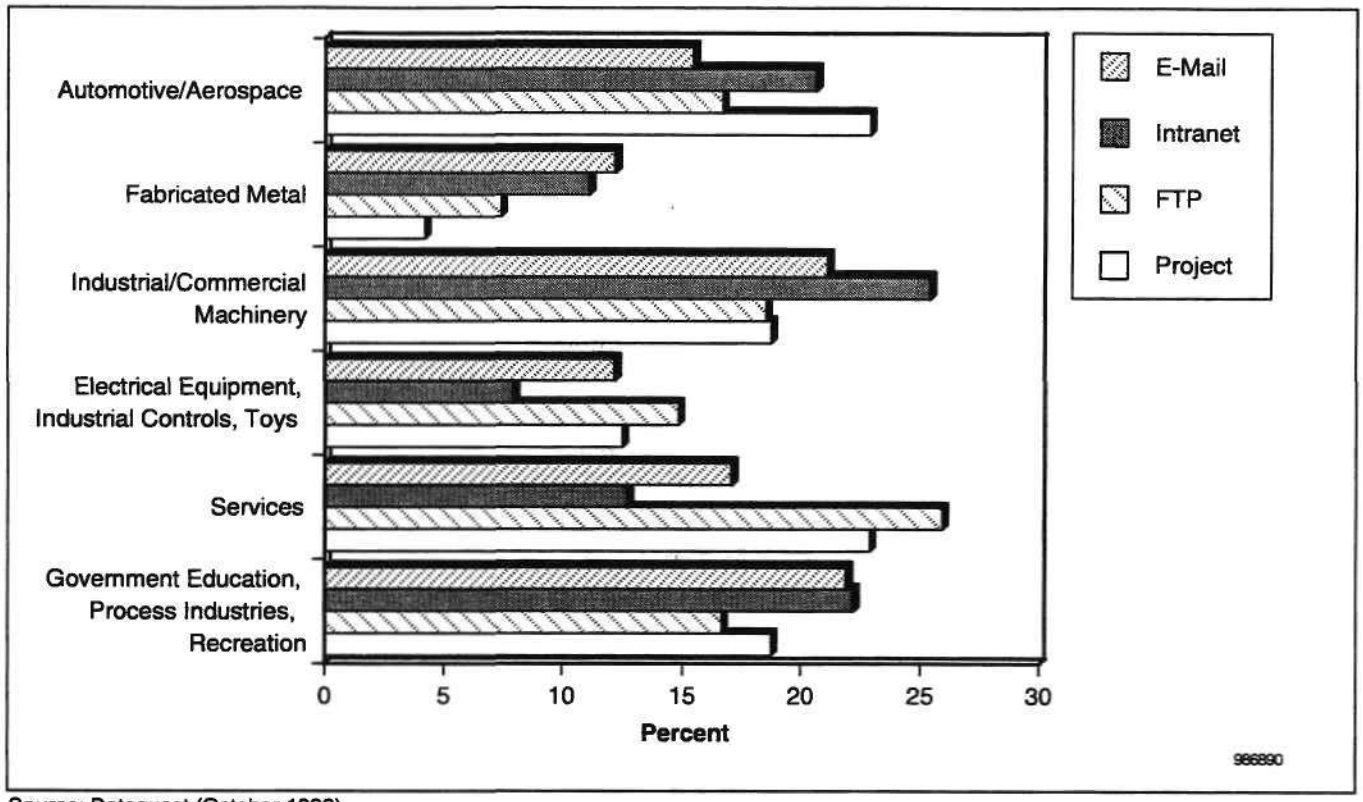
Table 3
Internet/Web Services Used Today to Assist in Engineering/Product Development

	Respondents Who Use These Services (%)
E-Mail	34
General Company Intranet	17
FTP	15
Project Web Site/Pages	13
CAD Viewer Plug-Ins	7
Videoconferencing	5
Don't Know	3
Extranet	3
CAD Conferencing(via Model Viewing)	2
Others	1
Total	**100**

Source: Dataquest (October 1998)

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Figure 4
Top Four Internet-Related Services Used by Industry (Percent)



Source: Dataquest (October 1998)

The Internet and Security Concerns

It is apparent that not every company uses or plans to use the Internet. What is holding them back? We asked respondents about their primary concerns regarding the use of the Internet as an everyday tool for engineering. The survey asked respondents to identify one of the following as their primary concern:

- Security (corporate espionage, hackers)
- Security (corrupting files, viruses)
- Bandwidth
- Reliability
- Others
- Don't know

Overall, 65 percent of the respondents were worried about the security issues of file corruption (39 percent) and corporate espionage (26 percent). Concerns were also expressed about the reliability of the Internet (11 percent) and bandwidth (9 percent). Ten percent of the respondents were unable to identify their primary concerns, and 5 percent of the respondents had other concerns such as employees wasting time playing games or using the Internet for non-work-related activities.

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Of the total number of respondents to the survey, respondents with less than $50 million in annual revenue (51 percent) were most troubled about using the Internet. The primary concerns for 63 percent of these respondents were security issues, especially Internet security with regard to file corruption and viruses. Keeping in mind that this survey was aimed at CAD/CAM/CAE managers, we looked at correlations between concerns about using the Internet and the respondents' positions within their companies. In the survey, 58 percent of the respondents identified themselves as being in engineering and design management, and of this number 64 percent identified security as being their primary concern about using the Internet. Sixteen percent of the respondents identified themselves as being in company or corporate management, and 65 percent of these respondents were again most concerned about the security issues related to use of the Internet. The respondents who identified themselves as being in research and development management were also primarily worried about Internet security issues, although they did express concerns about bandwidth and the reliability of the Internet.

Looking at the correlations between seat count and concerns about using the Internet, 40 percent of the users were concerned about file corruption and 26 percent about espionage. Those with 20 or fewer seats seemed more concerned about security than those with large CAD installations. Given that 46 percent of the respondents identified themselves as being at sites with 10 seats or less and 19 percent at sites with 10 to 19 seats, it appears that the smaller the size of the seat installation and the smaller the CAD budget, the greater the concern about using the Internet.

Dataquest Perspective

For the second part of our two-part series on management Perspectives in CAD/CAM/CAE, we have looked at certain aspects of design management and trends in the industry with regard to the design environment, and at the collaborative environment with respect to the use of the Internet in concurrent engineering.

Even though vendors are promoting products heavily oriented to 3-D design, a minority of the users still see 2-D design as their main form of design today, although a high percentage of these users have indicated that they expect to move into 3-D design by 2000. However, vendors need not lose hope because the main reason given for not using 3-D design today was lack of need for 3-D design rather than trouble using the packages or dissatisfaction with the pricing of the software or the hardware. Of course the results are heavily skewed by industry but are generally in keeping with other user surveys that Dataquest has conducted in the past.

Users are still dissatisfied with the quality and overall performance of tools for drafting/detailing as is shown by the large gaps between the importance and satisfaction ratings for these two areas. Similarly, there were gaps in the importance/satisfaction ratings for CAD to CAM and CAD to CAE integration packages, as well as part modeling and assembly modeling

capabilities. This dissatisfaction has also been a recurring theme in previous surveys.

On the whole, users are quite satisfied with the current state of affairs. Major innovations in collaborative computing and concurrent engineering are not yet seen as very important by the users if we are to judge by the responses to the questions about use of the Internet. What stood out was the fact that the use of the Internet as a mechanism for collaborative engineering or even as an integral part of the design process is still limited. Half of the users surveyed did not have access to the Internet, and those who did have access used it mainly for e-mail rather than for model viewing or setting up project Web sites.

While the value of CAD/CAM/CAE technology has been proved to discrete manufacturing companies, it appears that the Internet has yet to prove its value.

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Dataquest
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Perspective



Mechanical CAD/CAM/CAE Worldwide

End-User Analysis

CAD/CAM/CAE Technology: Management Perspectives

Abstract: *What are some of the decision factors that affect mechanical CAD system purchases? How do managers view the technology? In this Perspective, we examine the results of a recent CAD/CAM/CAE management end user survey. This is the first of two Perspectives summarizing this joint* Computer-Aided ENGINEERING/*Dataquest survey.*
By Sharon Tan and Daya Nadamuni

Introduction

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Computer-Aided ENGINEERING magazine and Dataquest recently completed a joint end-user survey of mechanical CAD/CAM/CAE managers in North America. The purpose of the survey was to better understand current usage, benefits, and management of CAD/CAM/CAE technology across a number of industries.

Dataquest is summarizing the results of the survey in two Perspectives. This first Perspective focuses on management viewpoints on CAD technology, including benefits, justifications, and upgrade/budget schedules. The second Perspective will look at Internet/intranet/Web plans and management's satisfaction with current CAD solutions. The results of the survey will also be published in the November issue of *Computer-Aided ENGINEERING* (see http://www.penton.com/cae/ for more details on subscribing to *Computer-Aided ENGINEERING* magazine).

Survey Methodology and Respondent Demographics

The four-page survey questionnaire was developed by both *Computer-Aided ENGINEERING* (CAE magazine) and Dataquest. Survey candidates were randomly pulled from Penton Publication's database of CAE magazine

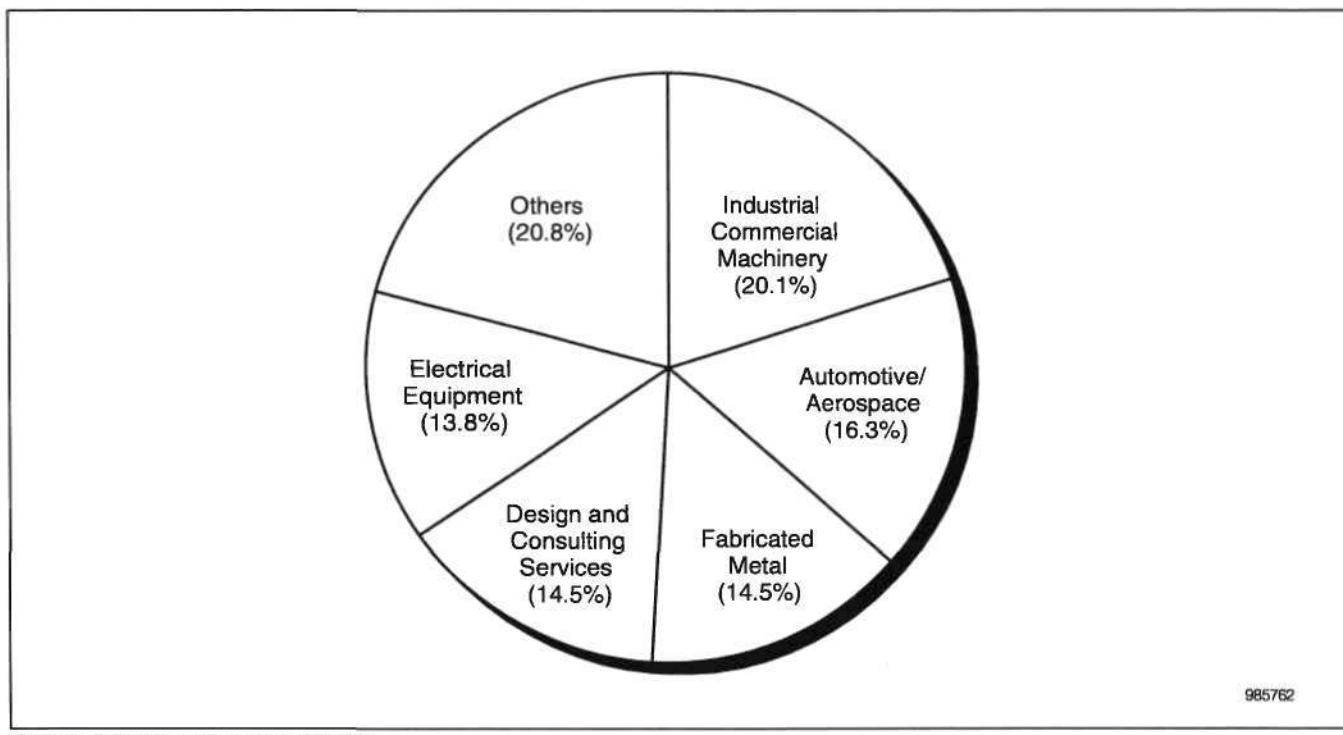
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subscribers with management titles. CAE magazine published and mailed the surveys; completed surveys were sent to Dataquest for analysis. In total, 159 surveys were completed. While our intention was to survey North American CAD/CAM/CAE managers, 24 respondents (or 15 percent of respondents) identified themselves as nonmanagers. Sixty percent of respondents were in engineering and design management, 16 percent in corporate management, 6 percent in manufacturing management, and 5 percent in research and development management. Overall, the survey respondents had a significant amount of managerial experience, with 64 percent of respondents having 10 or more years of experience in management.

A variety of industries were represented in the survey. A breakdown of respondents by industry is given in Figure 1. The "other" category consists mainly of respondents from government (17 responses), communications (6 responses), and process manufacturing (5 responses).

Company size varied from fewer than 10 employees at a given location to 9,999 employees. For the purposes of this survey, 57 percent of respondents were from small companies (fewer than 200 employees), 31 percent from medium-size companies (200 to 999 employees), and 12 percent from large companies (1,000 employees or more).

Figure 1
Respondent Breakdown by Industry



Source: Dataquest (September 1998)

Company revenue also varied greatly, with 30 percent of respondents' companies posting revenue less than $10 million. About 23 percent posted revenue between $10 to $50 million, and 14 percent were respondents from

companies with over $1 billion in annual fiscal revenue. On the whole, we can characterize the majority of survey respondents as managers coming from small to medium-size companies with less than $100 million in fiscal revenue.

Seat Counts and CAD Budgets

Large CAD/CAM/CAE seat installations are still somewhat of a rarity in the CAD world. Of our respondents, 46 percent are at sites with fewer than 10 seats, and 19 percent are at sites with 10 to 19 seats. No respondent had 3,000 or more seats at a site.

Similarly, large budgets for hardware, software, implementation, and training are also rare in the CAD market. We asked respondents how much their company spends annually on CAD/CAM/CAE technology. A total of 21 percent of respondents spent less than $10,000 annually; only 4 percent of respondents spent more than $1 million. Of course, given the small installation size of our sample population, we would expect smaller CAD budgets.

In Figure 2, we have shown the percentage of responses for CAD spending for our three major seat count categories (fewer than 10 CAD seats, 10 to 19 seats, and more than 19 seats). Little difference in spending can be seen between those companies with fewer than 10 CAD seats and those with 10 to 19 CAD seats. These companies tend to spend less than $50,000 annually for CAD technology, which puts the highest possible spending at $50,000 per seat and the lowest possible spending at $2,632 per seat for everything (hardware, software, training, and implementation services annually). For those companies with more than 19 seats, about half spend under $250,000 annually, and half spend over that amount.

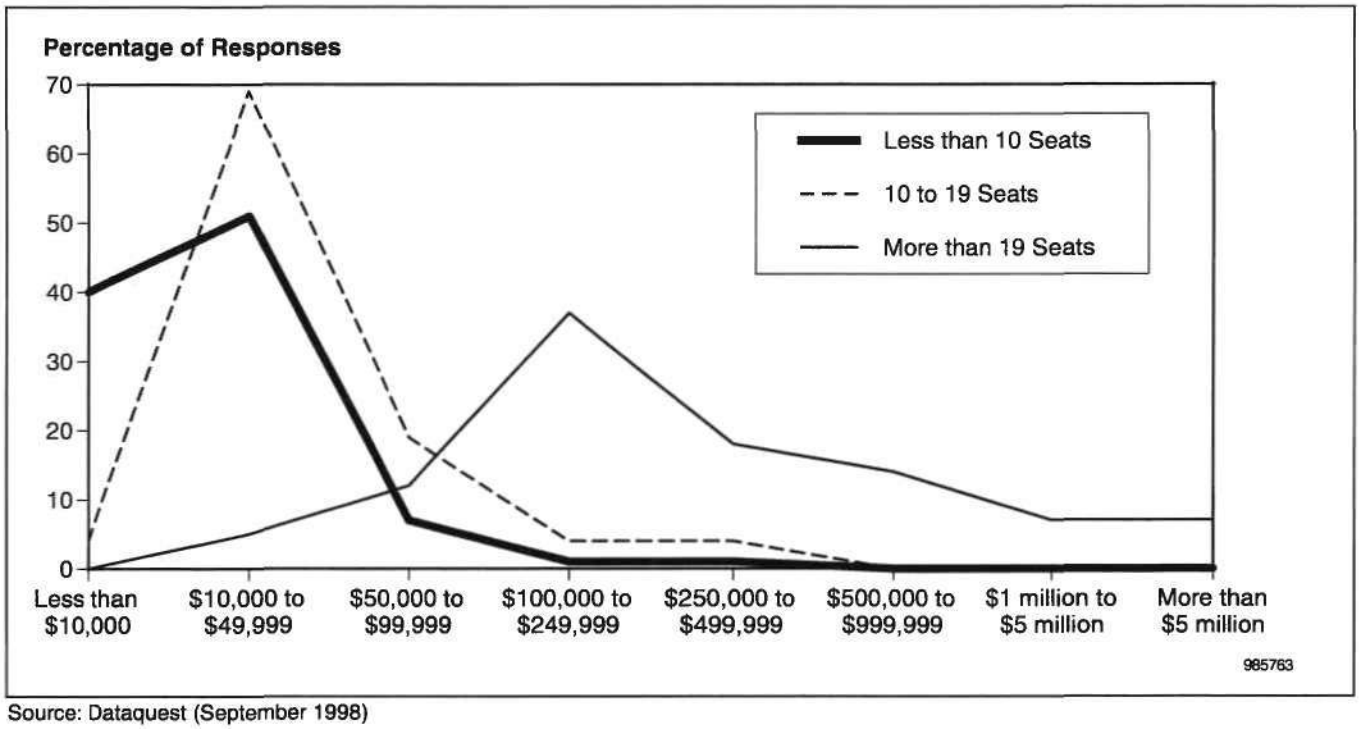
Looking closer at these companies that spend less than $50,000 annually on CAD (where 61 percent of our respondents fell): given the average software seat price for UNIX-based CAD software of about $20,000 and midrange CAD systems of under $10,000, it appears as if these companies could only purchase somewhere in the neighborhood of five new CAD software licenses each year—and that's on the optimistic side. Indeed, the CAD market is reaching maturity to the point where we expect growth in new software licenses to slow considerably from the high double-digit growth the market has shown in previous years.

Frequency of Hardware Upgrades

Respondents in our survey are on a fast-paced hardware upgrade schedule, with nearly 90 percent of all respondents stating that they upgrade their CAD/CAM/CAE workstations and PCs every three years or sooner. Full results by operating system are shown in Figure 3.

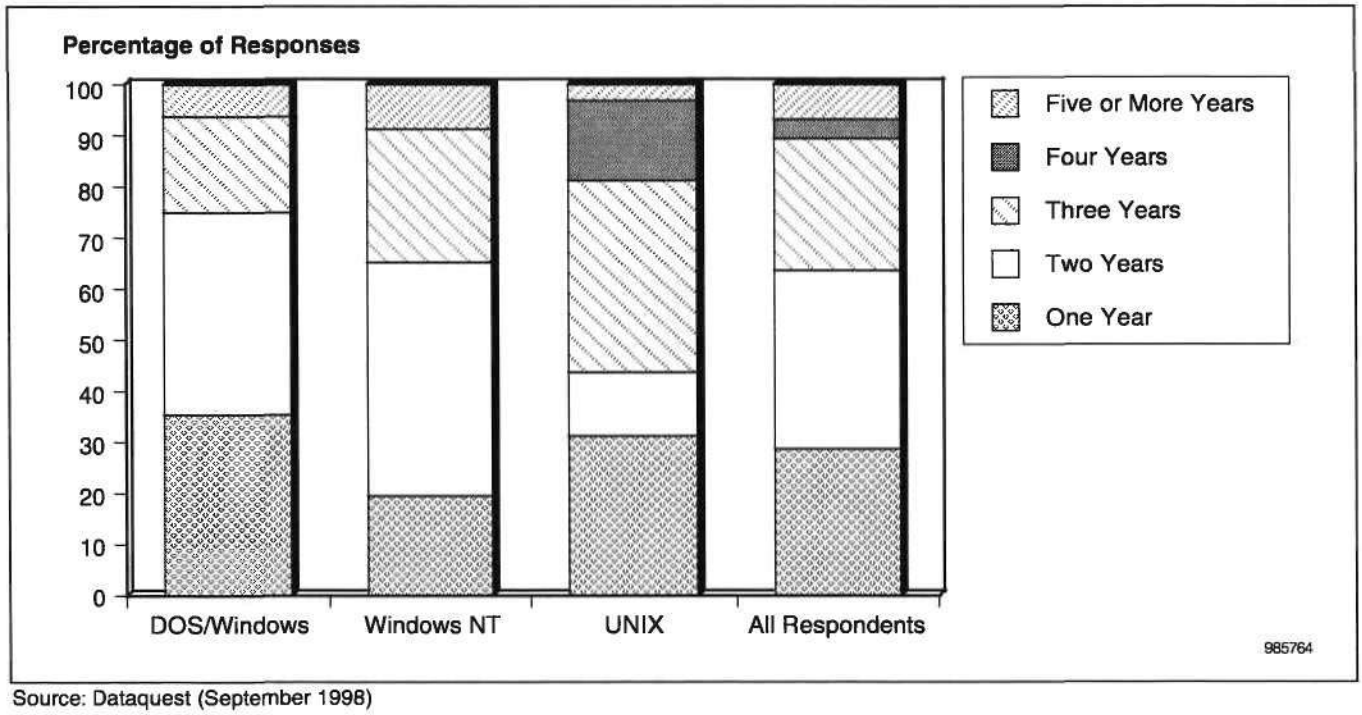
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Figure 2
Annual CAD/CAM/CAE Spending by CAD Installation Size



Source: Dataquest (September 1998)

Figure 3
Hardware Upgrade Schedule



Source: Dataquest (September 1998)

As we would expect, upgrade schedules for UNIX-based systems are the longest, Windows/DOS-based PCs the shortest, and Windows NT-based

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PCs/workstations fall somewhere between the two. We venture that there is a tight correlation between upgrade schedules and typical system costs, with the higher-priced systems being upgraded less frequently than lower-priced hardware.

We would have expected respondents in the UNIX camp to upgrade their systems even less frequently than they revealed in our survey. With an average workstation turnover of 2.5 years, there is a significant sales opportunity here for workstation, PC, and software vendors.

Operating System Changes in Store

Table 1 outlines what our survey sites currently have as their primary CAD operating system and what they expect to have in 2000. Similar to what we have seen in earlier surveys, users are fully embracing the Windows NT operating system for their CAD needs. According to our survey respondents, all operating systems will indeed cede some ground to Windows NT in mechanical CAD/CAM/CAE over the next two years. Readers should note that previous end-user surveys have consistently shown that users tend to be more optimistic about change than in reality. We expect actual movement to Windows NT to be somewhat slower than the numbers cited in Table 1.

When asked for the primary reason for choosing the company's CAD operating system in use today, the top reason was the availability of applications for that operating system (26 percent of respondents), closely followed by corporate support for that operating system (23 percent), and hardware performance (22 percent). Interestingly, price of both hardware and applications fell to the bottom of the list (7 percent each). In Table 2 we have broken down the top two reasons cited by industry.

Clearly, one of the more revealing splits of the operating system shifts that will occur in the future is by industry (see Table 3), where it is clear that among automotive and aerospace respondents, these traditional buyers of CAD/CAM/CAE systems will keep their installed UNIX bases, and movement to Windows NT will come from the Windows/DOS camp. We would expect the UNIX camp to remain stable among this group of users, as both of these industries rely heavily on applications for which their "choice" vendors may not have announced complete Windows NT-based CAD/CAM/CAE solutions that have equivalent functionality of their time-tested UNIX counterparts. This group of users has already stated in Table 2 that availability of applications is a top reason for their current operating system choice.

In the fabricated metal industry, there is not a large installed base of UNIX CAD systems, and movement to Windows NT will come at the expense of the other Windows-based/DOS systems, according to these end users. Industrial/commercial machinery and electrical equipment, however, are another story. Here is where midrange-based systems have their largest near-term opportunity, according to our survey respondents, who are expecting to abandon their UNIX-based CAD systems in favor of Windows NT-based ones.

Table 1
Primary CAD Operating System

	Primary CAD Operating System in 1998 (%)	Primary CAD Operating System in 2000 (%)
Windows 3.x/DOS	9	5
Windows 95/Windows 98	27	18
Windows NT	33	56
UNIX	26	19
Others	5	2
Total	**100**	**100**

Source: Dataquest (September 1998)

Table 2
Reasons behind Operating System Choice

Industry	Top Reason	Second Reason
Automotive/Aerospace	Availability of applications	Hardware performance/corporate support for current system
Fabricated Metal	Corporate support for current system	Hardware performance
Industrial/Commercial Machinery	Availability of applications	Hardware performance/corporate support for current system
Electrical Equipment	Availability of applications	Hardware performance
Design and Consulting Services	Availability of applications	Cost of ownership of hardware
Others	Corporate support for current system	Availability of applications

Source: Dataquest (September 1998)

Table 3
Operating System Plans by Industry (Percent)

	Windows NT in 1998	Windows NT in 2000	UNIX in 1998	UNIX in 2000	Other Windows/ DOS Operating Systems in 1998	Other Windows/ DOS Operating Systems in 2000	Other Operating Systems in 1998	Other Operating Systems in 2000
Automotive/ Aerospace	19	33	39	38	38	25	4	4
Fabricated Metal	44	68	17	18	39	14	0	0
Industrial/Commercial Machinery	31	62	35	17	28	17	6	4
Electrical Equipment	14	48	36	14	50	38	0	0
Design and Consulting Services	35	57	17	14	35	24	13	5
Others	49	67	15	13	30	20	6	0

Source: Dataquest (September 1998)

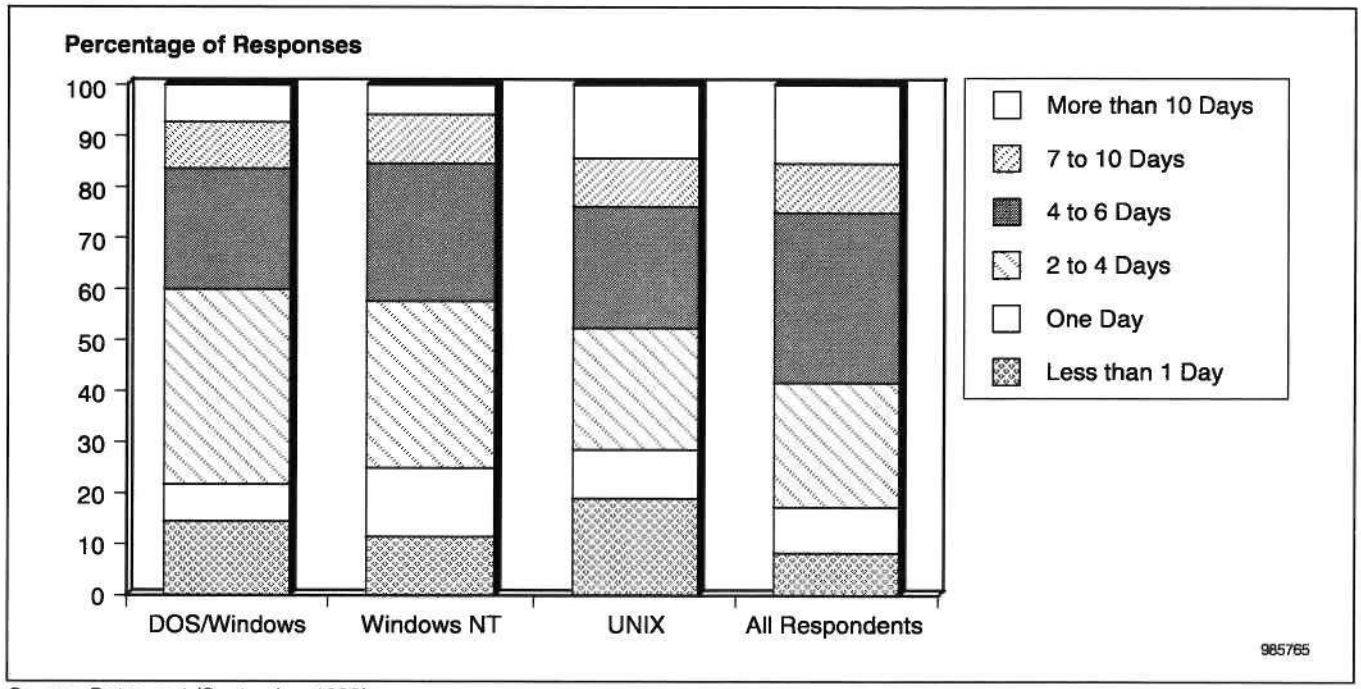
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User Training: Not Enough or Too Much?

Figure 4 shows the number of training days the average CAD/CAM/CAE user gets in the course of one year at a given respondent's company. While the median response for all users is two to four days of training, the data does indeed differ by operating system—many Windows 3.x/Windows 95/DOS-based users receive two to six days of training each year, while UNIX-based users are more spread out—with some receiving less than one day and others receiving more than 10 days of training annually. Another way to look at the data is to observe that 22 percent of Windows 3.x/Windows 95/DOS respondents receive more than six days of training each year, while 29 percent of UNIX-based users do so. These are not significant differences, but when it comes to the costs and downtime associated with an engineer in training for a day, the effect can add up quickly.

What is interesting is that the influx of Windows NT-based CAD systems has not significantly reduced the training time for engineers and designers. While the CAD software vendors may tout reduced training time as one of their system benefits, the respondents of this survey have yet to see a significant reduction in training time at their sites.

Figure 4
Number of CAD/CAM/CAE Training Days



Source: Dataquest (September 1998)

Justification for CAD

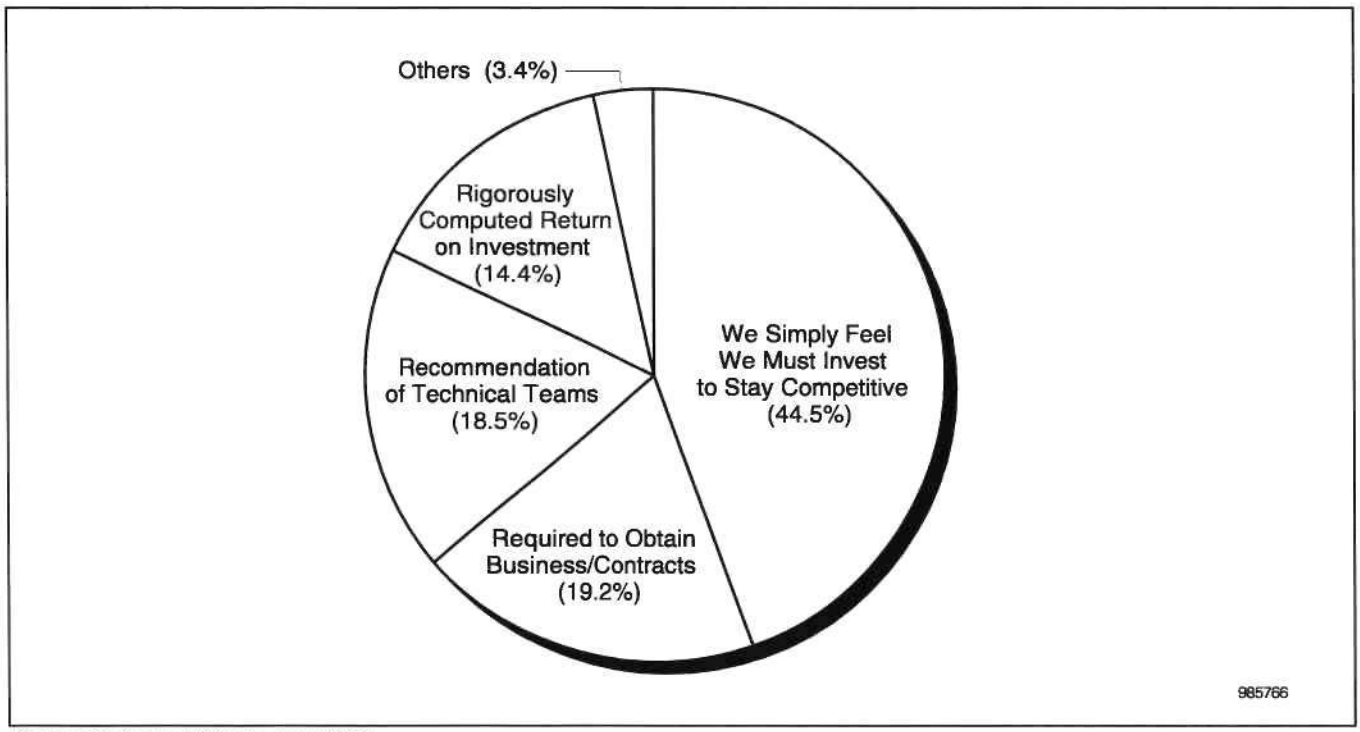
Like many software applications, CAD technology seems to go through an elaborate justification process at many end users' sites. Knowing just what

that justification process is key to a vendor's success in selling into an organization.

We asked our survey respondents how they justify their CAD/CAM/CAE investments. The results are shown in Figure 5. Clearly, managers feel that CAD/CAM/CAE technology is one way to differentiate their company from the competition—45 percent of our respondents stated that they invest in CAD technology in order to stay competitive. Overall, only 14 percent cited fiscal reasons (return on investment or ROI calculations) as the motivator for CAD investments.

However, when we look at the data based on annual CAD spending, the drivers for CAD investments are clearly different among the respondents. For those companies with smaller CAD budgets (say, under $10,000 annually in this example), investment in the technology is clearly driven by the fact that these organizations feel they must invest to stay one step ahead of their competition. Recommendations of technical teams and ROI criteria barely made it to the list of reasons to invest in CAD. At the other end of the spectrum, those companies whose CAD budgets are greater than $100,000 annually not only cited maintaining a competitive edge as a top reason, but also that ROI criteria and customer/business contract requirements are key decision drivers for CAD/CAM/CAE investments. It is helpful to remember that most of the respondents in this survey held managerial titles; this same group of people are more likely to be key influencers in the CAD justification process than engineers or designers.

Figure 5
CAD Justification

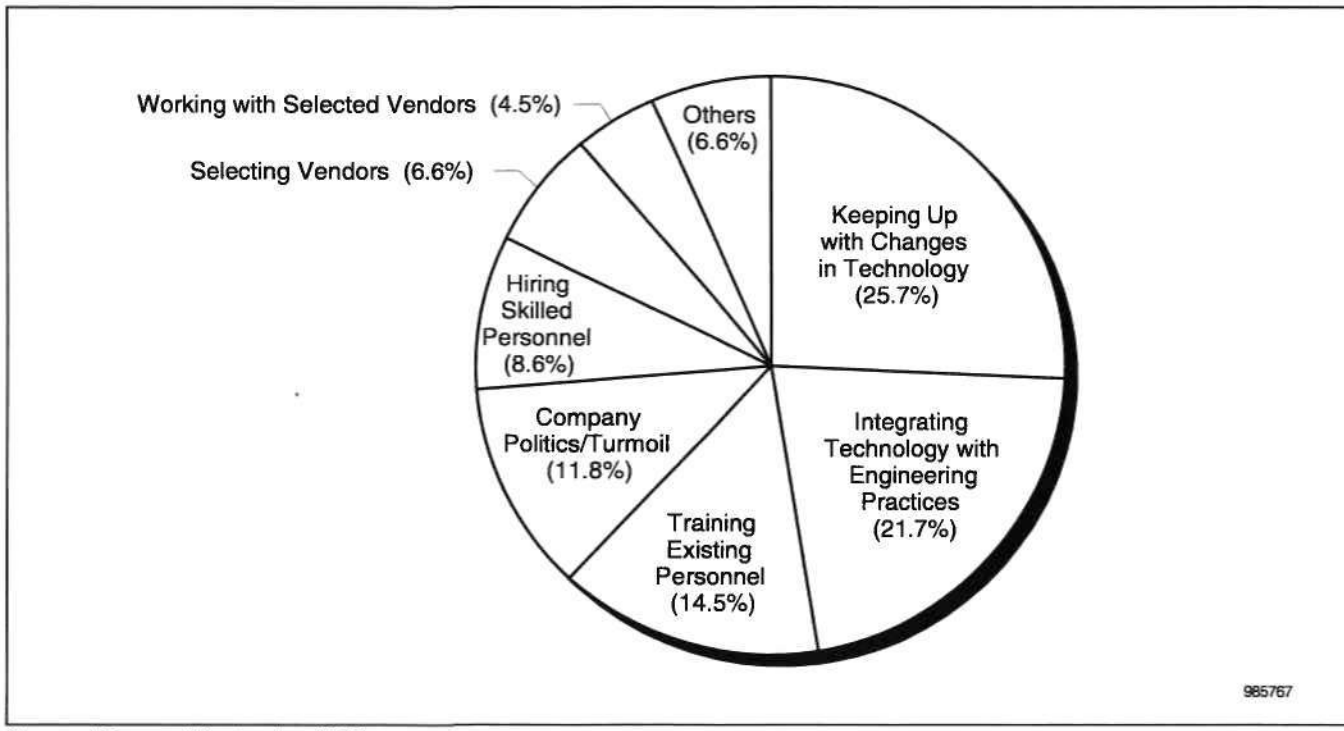


Source: Dataquest (September 1998)

Once Justified, Now Implement

Once the justification for CAD technology or renewed investment in CAD is made, just how easy is it to get things up and running smoothly? We asked our respondents what is/was the biggest problem in implementing CAD/CAM/CAE technology at their site. Interestingly, 48 percent of the respondents cited answers related to keeping up with technological changes and processes. When presented with the list of reasons shown in Figure 6, selecting and working with a chosen CAD vendor was not the big hurdle in implementing CAD. Nor was hiring skilled personnel or company politics. In fact, Figure 6 seems to indicate that the real hurdle doesn't lie with implementing the CAD system itself. Instead, it lies with the fact that new technology is just around the corner, or that integration of the CAD system with a company's engineering practices still needs some work.

Figure 6
Problems Implementing CAD/CAM/CAE Technology



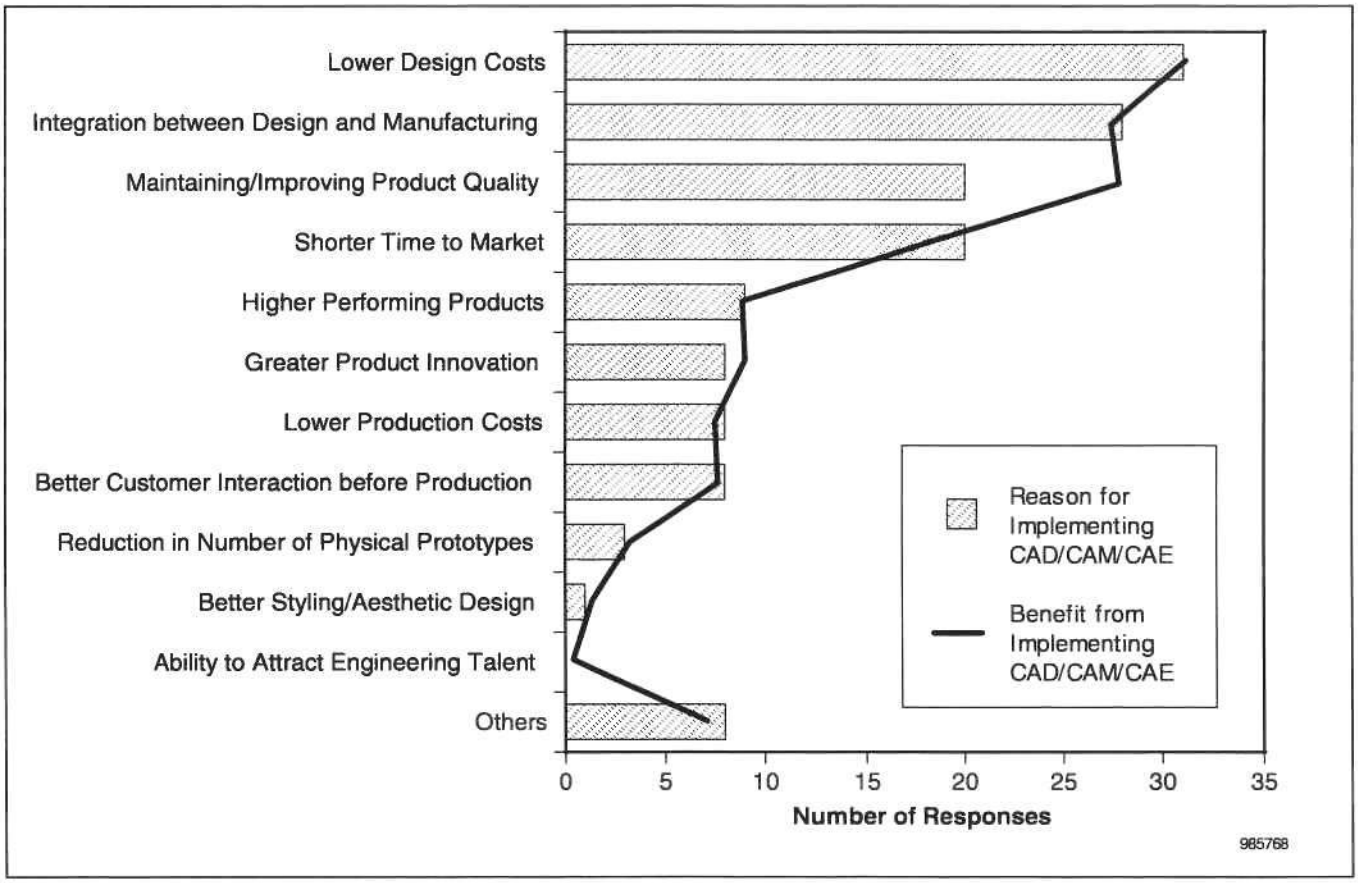
Source: Dataquest (September 1998)

Once Implemented, Reap the Rewards

We asked respondents what the major reason was for implementing CAD/CAM/CAE technology at their company, and what the major system benefit was. Surprisingly, answers to the two questions were quite similar, indicating that users are getting "exactly" what they want (or at least close to what they want) from their CAD implementations. We have shown the results for CAD implementation reasons and benefits together in Figure 7.

The top reason and benefit for implementing CAD was lowering design costs, closely followed by integration between design and manufacturing. The only place where the implementation reasons and benefits diverged was concerning maintaining and improving product quality. Here, fewer respondents expected this to be a key reason for implementing CAD technology, but more respondents found this to be the most valuable benefit of CAD to the organization.

Figure 7
Benefits of CAD/CAM/CAE



Source: Dataquest (September 1998)

Attitudes toward CAD Technology

We asked respondents to what level they agreed or disagreed with a series of general statements focused on CAD technology and its role in the company. The idea is that those companies that have had more success in deploying CAD technology are better able to make the connection (or justification) between CAD investment (dollars spent) and meeting business objectives (profits returned).

The specific statements we asked respondents to rate (on a scale of 1 to 5 where 1 is strongly disagree and 5 is strongly agree) are as follows:

- CAD/CAM/CAE has been oversold by the vendors and media, compared to what can be accomplished for the investment required
- Information networks are strong in my organization
- Our organization's progress to date in making use of CAD/CAM/CAE technology has been excellent
- Our CAD software vendor is responsive to our needs
- The new generation of Windows-based CAD systems have enough functionality and reliability to handle our design needs

The weighted average of responses for the above statements ranged from 3.0 to 3.2, indicating that overall, respondents in this survey appear to be fairly content with their CAD/CAM/CAE systems. Figure 8 shows the responses to the first four statements above. The statements that drew the widest range of responses were "Information networks are strong in my organization," and "Our progress to date using CAD technology has been excellent." Nevertheless, we can safely say there are no seriously disgruntled CAD managers out there.

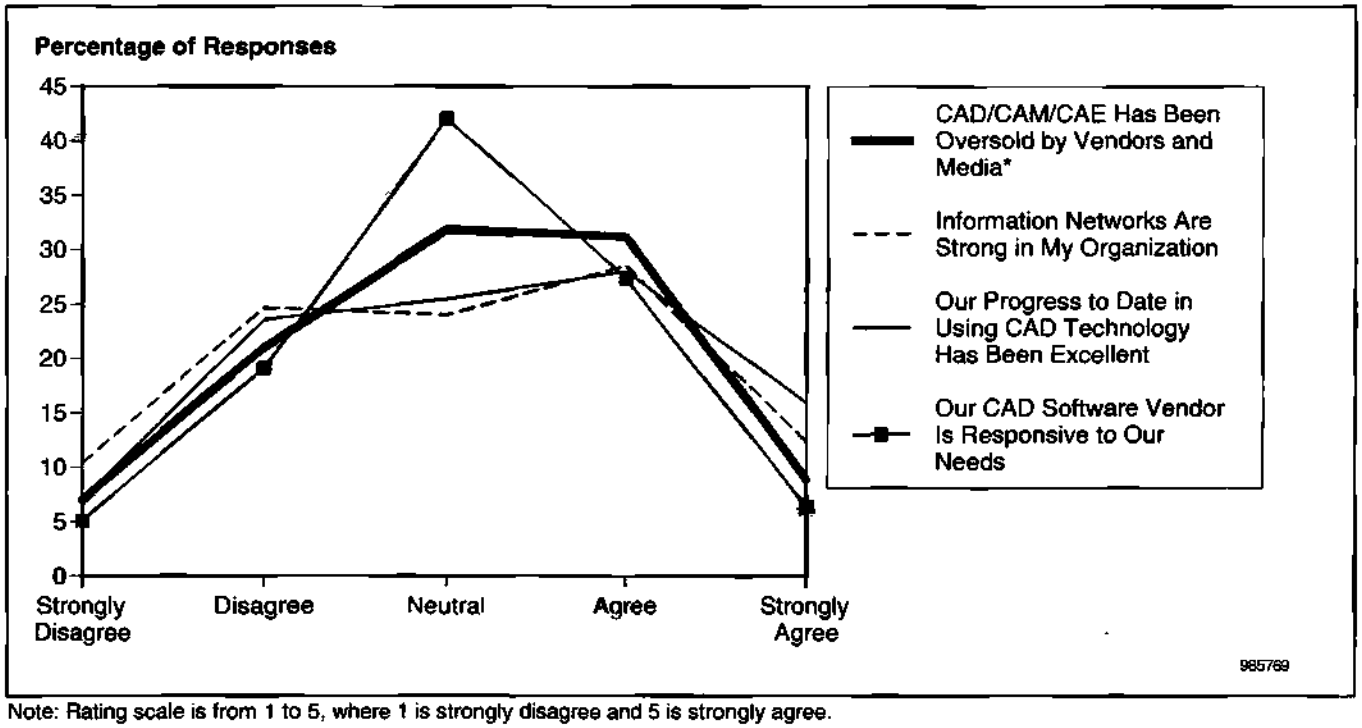
In fact, our respondent group might be characterized as highly optimistic. When we asked for their agreement/disagreement with the statement, "The new generation of Windows-based CAD systems have enough functionality and reliability to handle our design needs," we were quite surprised to see so little disagreement to that statement—only 18 percent of our survey respondents disagreed or strongly disagreed (see Figure 9). Clearly, this next generation of Windows-based CAD systems, namely the midrange systems that have hit the market in full force, have a lot to live up to as expectations are already high for the performance of these systems.

Dataquest Perspective

Despite the length of time CAD technology has existed, large CAD/CAM/CAE seat installations are not the norm. Vendors who make a living in this market must learn to cater to both the small user with a limited CAD budget as well as the large corporation with a correspondingly larger budget. Justification for CAD, too, varies by company spending for CAD—organizations with smaller CAD budgets justify CAD by citing competitive needs, while organizations with larger budgets will also justify CAD with ROI criteria and team recommendations.

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Figure 8
CAD Perceptions

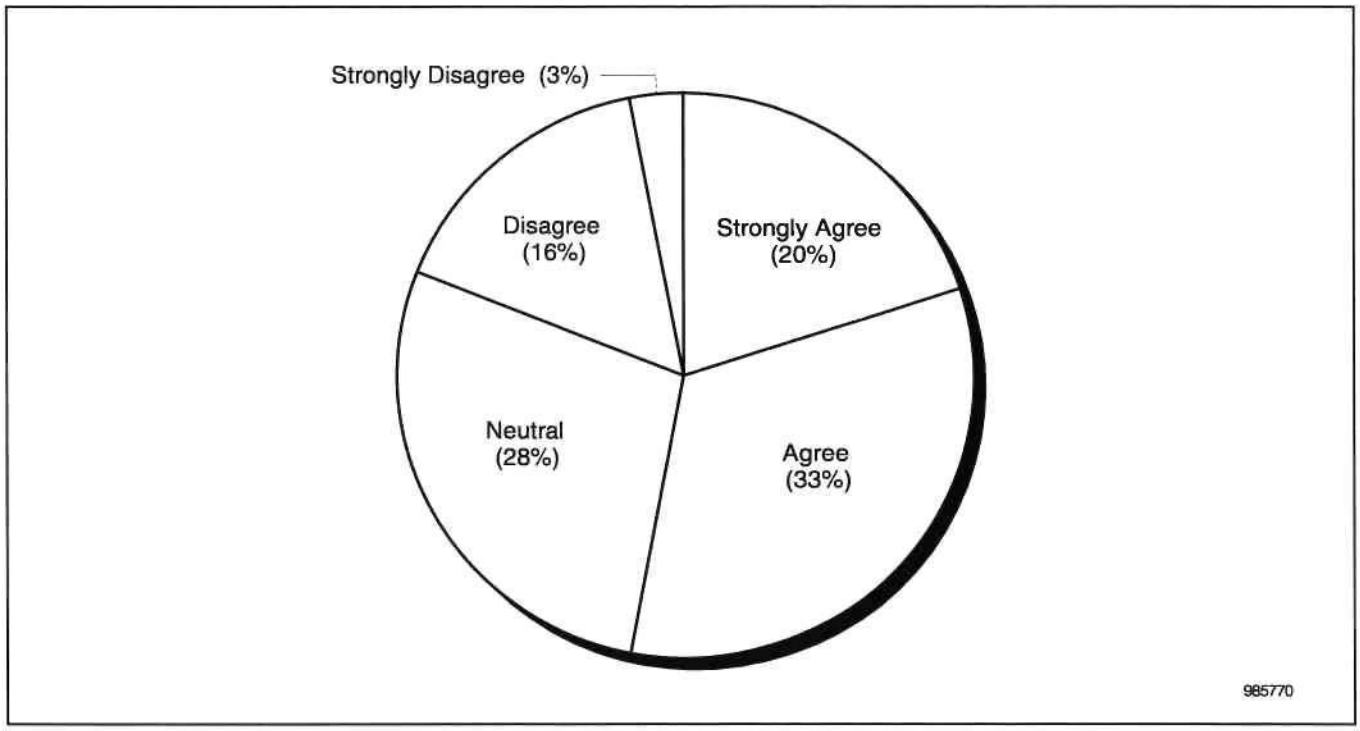


Note: Rating scale is from 1 to 5, where 1 is strongly disagree and 5 is strongly agree.
*Full statement is "CAD/CAM/CAE has been oversold by the vendors and media, compared to what can be accomplished for the investment required."
Source: Dataquest (September 1998)

While we expect to see user migration to NT-based CAD systems, there will be some difference in migration speeds, depending on a user's industry. The bellwether industries of mechanical CAD, aerospace and automotive, will be the UNIX holdouts, while other industries will move more quickly to the new operating systems.

Nevertheless, our respondent group on the whole is content with their CAD installations and technology; their systems seem to be delivering exactly what they want in terms of benefits and CAD perceptions. The 30-year history of CAD technology has witnessed an amazing progression of technologies and applications developed for the benefit of engineers, designers, and technicians. Today, CAD/CAM/CAE technology has proved its value to discrete manufacturing companies, as evidenced by the survey responses seen here.

Figure 9
New Generation of Windows-Based CAD Systems Has Enough Functionality for Our Needs



Notes: Rating scale is from 1 to 5, where 1 is strongly disagree and 5 is strongly agree.
Full statement is "The new generation of Windows-based CAD systems have enough functionality and reliability to handle our design needs."
Source: Dataquest (September 1998)

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Dataquest
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Perspective



Mechanical CAD/CAM/CAE Worldwide

Market Analysis

Market Evolution: Engineering Modeling for the Enterprise

Abstract: *In this Perspective, we examine the new face of engineering applications. A host of new technologies are available today that will bring CAD beyond its design-centric view. If the mechanical and AEC markets are to continue to attract new users, they must evolve into something beyond just design, perhaps bifurcating into two markets: CAD and engineering modeling for the enterprise.*

By Sharon Tan

Introduction

The 30-year history of CAD technology has witnessed an amazing progression of technologies and applications developed for the benefit of engineers, designers, and technicians. While the earliest stages of CAD technology were focused on drafting (that is, the "electronic pencil"), CAD technology is now changing its face, evolving into a new set of technologies catering to a larger audience.

This Perspective discusses this new face of engineering design, how CAD is evolving, and the various technologies that will affect the transition from CAD to engineering modeling for the enterprise. Because this Perspective talks generally about the issues facing enterprise engineering (regardless of whether the design is architectural, mechanical, or civil in nature), it has been published to clients of both Dataquest's CAEC and CMEC Worldwide services.

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Bottlenecks in Current Engineering Processes

Design/Construction/Build Processes

Many of the problems in today's design/construction/build processes stem from the fact that what is being constructed—a building, plant, ship, or roadway—is essentially a prototype build, the first and only entity built following initial design. The one-design/one-build model makes the processes that much more difficult to automate, and CAD products were never designed to support this one-design/one-build methodology.

Moreover, many of today's CAD solutions for the architecture/engineering/construction (AEC) community are largely focused on one thing—design. But the AEC user community actually faces a host of concerns outside of the design phase of a project, like responding to government and regulatory requirements, producing timely and accurate bids, and reducing rework at the construction site. Further complicating things, designs are often split among several companies responsible for different aspects of the design process. Each of these companies involved in the design often has a different CAD system, and together these systems do not communicate well with one another.

Design/Manufacturing Processes

Like the building/construction industry, the manufacturing industry faces similar process bottlenecks. Here, the problems occur among the fairly serial processes of design, analysis, and manufacturing. What's important to a designer may not be relevant to a manufacturing engineer. While collaborative and concurrent engineering are the latest buzzwords aimed to describe a more ideal working scenario that gets products out the door faster, the reality is that collaborative engineering has largely been focused on design and only design bottlenecks. Previous Dataquest surveys have shown that some of the real issues in getting a product manufactured and out the door center on poor interdepartmental communications, which ranked higher in importance than other reasons such as faults in the original design or last minute engineering change orders.

The Enabling Technologies

Today CAD software is so engrained in engineering design that it is virtually impossible to develop any products without the assistance of computer-aided design tools. However, the markets to which CAD caters, namely AEC and mechanical applications, are quite mature, leaving little opportunity for real vendor growth. Market share is to be gained only by consolidation, niche market specialization, or a fundamental change in the way CAD technology is used. It is this fundamental change, the emergence of a new market—engineering modeling for the enterprise—that we are focusing on here.

In the past few years, there have been a handful of technologies that have the potential to shape (or are already shaping) the future of CAD. Dataquest believes that the CAD market is evolving, and a new market is developing before our eyes. We have loosely termed this new market "engineering

modeling for the enterprise." The enterprise is key to this new market—design information can no longer stay behind the engineering walls. The information can, and should, be leveraged throughout the organization. In this section, we identify the technologies that we believe will most affect the future engineering landscape.

Internet, Intranets, and Web Technology

To date, the primary use of the Internet in engineering has been for e-mail or electronic transferring of files, and not for project Web sites, project home pages, or perusing supplier catalogs. However, this doesn't mean that the potential isn't there. In fact, a handful of vendors have already integrated Web technology into their products. For instance, product data management vendors and project management vendors were among the first to integrate a Web-based front end to their systems. Other vendors, such as Adaptive Media, have developed a proprietary data streaming technology to deliver 3-D data over the Internet. Newcomer Cubus is targeting architects with its design review service through which engineering design teams (primarily architects) in effect register a project with Cubus, which then hosts the project on a Cubus server.

What intranets and the Web mean to the engineering community is easier collaboration. The Internet, intranets, and internal Web sites are knocking down the traditional walls and barriers within companies, making it easier to see what other groups, such as marketing, engineering, and technical publications, are up to and how far along they are. Instead of working in silos, everyone is exposed. Consequently, collaboration becomes more the default behavior.

Taking this one step further, central Web sites for engineering projects would allow everyone involved in a worldwide project to simultaneously access up-to-date project information from a single central location. These sites may offer many types of data, including engineering files, site photographs, reports, project schedules, project specifications, and meeting minutes. Companies can begin wiring their far-flung extended enterprises together, turning a project Web site into an invaluable project design, management, communication, and marketing tool.

Objects and Components

Object technology promised to help software vendors bring software to market faster by exploiting reusable code. However, what object/component technology in the engineering design worlds has evolved to is the embedding of smart objects or "components" within a CAD model. The term "smart" is used to denote objects that carry knowledge about themselves with them. This knowledge can be business, design or manufacturing, or regulatory information (for example, a door knows it can't be placed in a firewall, a sheet metal screw knows it can't be used in wood). In the object scenario, the engineer or architect begins thinking less in terms of lines, arcs, and circles and more in terms of objects—for example, doors, windows, motors, and pumps.

The beauty of objects is that they can contain information—engineering and nonengineering information, hence providing a vehicle for information to be brought to all disciplines. Objects in engineering applications 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. We expect this infiltration to first take place in AEC and then eventually filter over to the mechanical world.

Role of Java

While we must admit we can't fully predict the impact of Java in engineering yet, it is worth noting that vendors are coming at it from different schools of thought. Most notably, Autodesk sees Java as another application programming language (much like Visual Basic or AutoLISP). On the other hand, Bentley Systems sees Java and its Java extensions (specific to engineering and CAD applications) becoming directly embedded within its flagship MicroStation products. The reality is that some vendors have begun selling "light" applications developed in Java primarily for delivery via the Web (hence, easier access to engineering information throughout the enterprise), but full-blown Java-developed applications for engineering and CAD—where the Web is *not* involved—have not yet hit the market—and we don't know if they ever will.

Capturing Design Know-How

Three years ago, we were describing knowledge-based engineering (KBE) as a productivity multiplier for any CAD system, where rules are developed that can drive automated applications, capture design intent, and automate sharing of data between applications and departments. On paper, KBE looks like the perfect solution for getting products, current and future ones, out the door faster. In reality, KBE has not taken off (witness Concentra's rise and stumble), partly because of the fact that the technology has been costly and not well understood. For a company to implement KBE in the first place, it needs to have a good understanding of its design knowledge (in order to capture it) and design processes (in order to automate them).

Nevertheless, we still believe KBE is a useful technology that will have its place in the engineering landscape, if it is taken in smaller chunks. Invention Machine is a good example of a company that has developed a database of scientific "knowledge," or principles, that can be used to evaluate and solve design problems at a very high level. Other software vendors, particularly those focused on mechanical applications, have incorporated KBE-related technologies into their software. A good example is manufacturing, where toolpath generation has been tied together with in-house libraries of machines, schedules, and manufacturing knowledge.

Corporate Repositories of Information

In order to further expand what has traditionally been called CAD, the CAD data and engineering models can no longer sit in isolation. As discussed earlier, it's easier to see what other groups are up to if silos are removed and problems are identified earlier. While CAD vendors have always wanted to hold onto their proprietary databases, it's becoming apparent that in some disciplines, these databases are becoming more "open." The best example of

this is in the geographic information systems (GIS) discipline, where the likes of Oracle and Informix have developed technologies that allow users to deposit their spatial GIS data into a relational database. It's no different in CAD, where putting CAD data models on the corporate database will let others use that information for marketing purposes, supplier purchasing, and manufacturing process development. The real advantage to any vendor's teaming with a large database vendor like Oracle is that these database vendors have the ability to drive the creation of large, enterprisewide solutions.

Visualization and Simulation Technologies

Although rapid prototyping and physical mock-ups may be a reality in engineering today, what has been deemed virtual prototyping has not been widely embraced yet. CAD vendors have ventured in this direction, adding some capabilities to their software so users can design and visualize assemblies within a virtual environment. Hardware vendors have seen their customers use workstations to complete virtual tasks, such as fly-throughs of complex product assemblies or process plants. But, the likelihood of bringing a product to market without a physical prototype or of building an office complex without an architectural model is small.

There are a number of software vendors that have developed the enabling technologies to allow engineers to create, interact with, manipulate, share, and analyze a virtual product in real time. Division, Engineering Animation, and Tecnomatix are among those vendors with products aimed specifically at virtual prototyping. Making CAD models easier to visualize makes the information that much more accessible to those outside of engineering.

Other Issues

Even if every single technology just outlined was incorporated into an engineering application, there are other issues that will continue to cause bottlenecks. These include the following:

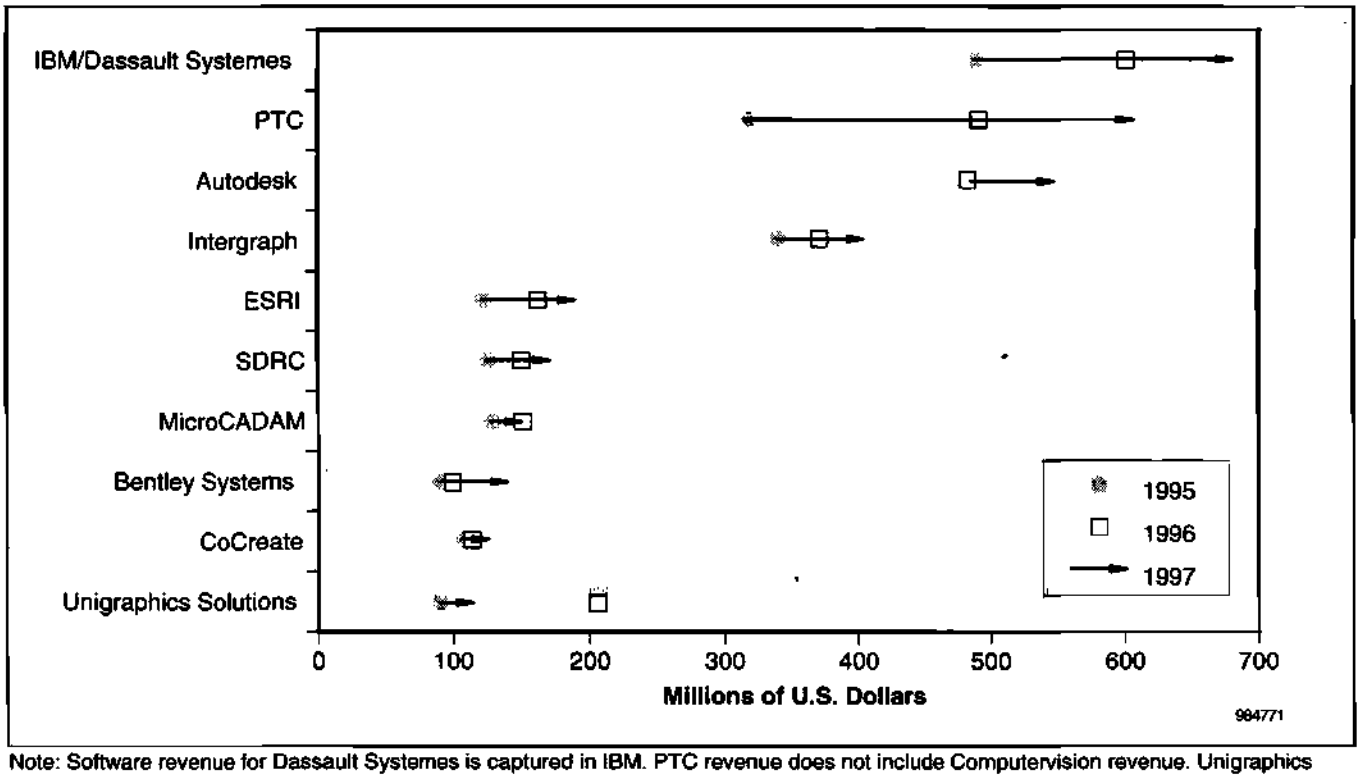
- How does an end-user company migrate to a new enterprise engineering environment when access to legacy data, which might not be compatible with the new environment, is still needed?
- Who really controls CAD and engineering data? Is it the engineering group, which has traditionally controlled its own data, or is it the IT organization, which might control the data just as it might control other corporate information?
- When does cost become an issue? Much of what we have outlined would not come cheaply. We have seen the rapid emergence of the midrange mechanical CAD/CAM/CAE market, where solutions are priced somewhere between the typically higher-priced UNIX-based solutions and the lower-priced PC-based solutions. Similarly, we have seen the continued interest in the PC-based CAD market, where solutions might sell for U.S.$500 or less. Obviously, users are price sensitive, or at least price aware. At what point do the benefits outweigh the increased costs, and how do users justify this increase to management?

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Who Is Positioned for Leadership in the Future?

Given the technologies identified, the other issues that still exist, and the bottlenecks in current design methodologies, just who is positioned for leadership in the enterprise engineering environment of the future? In this section, we examine strategies of some of the leading vendors in the CAD market today. The vendors represented in the following discussion are currently market-leading companies from a software revenue viewpoint. Figure 1 shows the position of the market leaders today, from a software revenue viewpoint. Figure 2 shows their position and growth trend from a software and software services viewpoint combined. Provided that these companies begin to look outside of design and to the enterprise opportunities, we fully expect these companies to remain dominant market players three to five years from now.

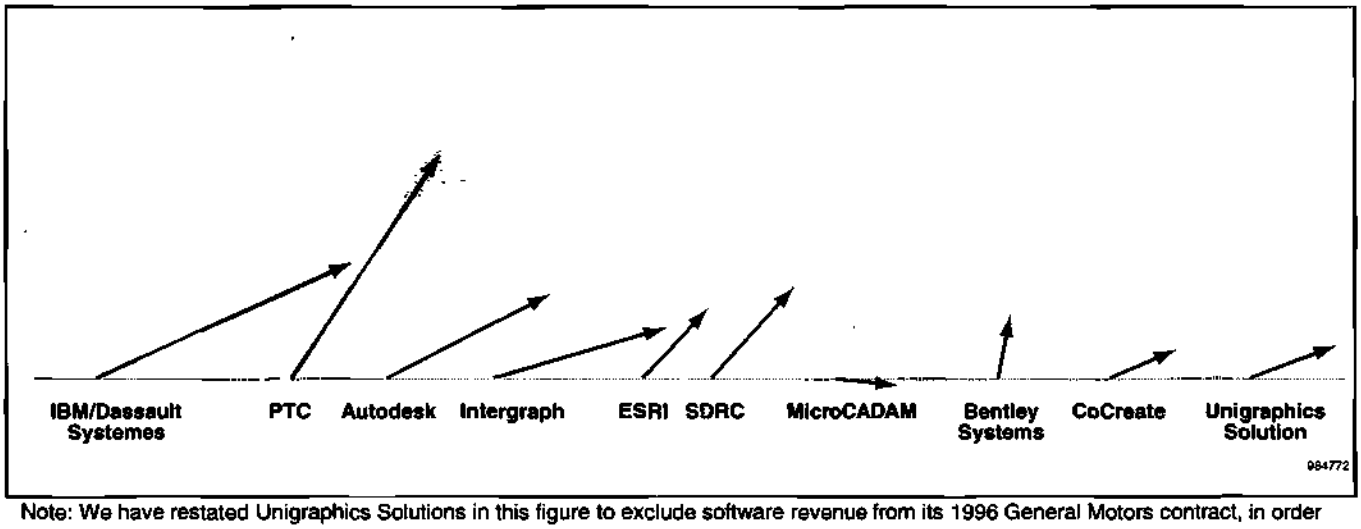
Figure 1
Software Revenue of the Leading CAD Vendors



Note: Software revenue for Dassault Systemes is captured in IBM. PTC revenue does not include Computervision revenue. Unigraphics Solutions revenue does not include Solid Edge acquisition. Intergraph revenue includes Solid Edge revenue.
Source: Dataquest (August 1998)

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Figure 2
Relative Strengths of the Engineering Applications Vendors



Note: We have restated Unigraphics Solutions in this figure to exclude software revenue from its 1996 General Motors contract, in order to give better insight into Unigraphics Solutions' potential.
Source: Dataquest (August 1998)

Dassault Systemes and IBM

Dassault Systemes, in conjunction with IBM (sole reseller of Dassault Systemes' flagship CATIA and CADAM products), has dominated the CAD markets for years. Dassault Systemes has had much success selling to large enterprise accounts in automotive and aerospace. The newest additions to its product lines, CATweb (a Web-based viewer that allows real time navigation of a CATIA model) and ENOVIA (enterprisewide product data management), are further testament to the fact that Dassault Systemes is making real steps toward getting the design and engineering information out of the silo in which it has typically sat.

Parametric Technology

Parametric Technology (PTC) stirred up the mechanical CAD/CAM/CAE markets when it came onto the scene with its parametric-based design system, which was unique at that time. Since then, PTC has risen to the top of the pack from solid growth and acquisitions (most notably, Computervision). Prior to its acquisition of Computervision, the company had limited success selling large, enterprisewide deployments to aerospace and automotive companies, the premier buyers of mechanical CAD technology. However, with the acquisition of Computervision and its customer base, PTC is now finding itself right smack in the middle of large, top-tier accounts. PTC recently unveiled Windchill, its Web-centric enterprisewide PDM system, based on technology purchased in 1998. PTC's suite of products today rivals that of anyone else in the market in terms of completeness of vision.

Autodesk

Autodesk's decision to refocus into market groups, its purchase of Softdesk in early 1997 (and other niche players in GIS and mechanical design), and its rearchitecting of AutoCAD to incorporate object technology have brought Autodesk up to the playing level of many of its competitors.

It took Autodesk two full releases of AutoCAD to build its underlying object technology. Autodesk sees object technology as a key to sharing project information among all disciplines. Further, Autodesk has talked about some of the issues facing its users (such as addressing problems in communication among architects and constructors; customer needs for better sharing of project data; and building owners as market drivers). But there has been only limited discussion of exactly how to tackle such problems. Of course, that may change in the future. We hope so—Autodesk is one of the few companies that can actually influence what users purchase and how they work.

Intergraph

Intergraph is one of the original pioneers of the CAD market, with offerings in all design disciplines. Some years ago, Intergraph made the move to its new product architecture, then called Jupiter, and the company has been busy building Jupiter-based products while maintaining and further developing its core product lines.

Intergraph understands the need for project life cycle management, as evidenced in plant design with its Notia data warehouse, some of the SmartPlant products, and its alliances with vendors that address plant operations and maintenance. Intergraph has made similar strides in the GIS world, with its GeoMedia technology reaching out to larger audiences of non-GIS specialists.

Intergraph has always had strongholds in winning large contracts, particularly as the prime contractor for government procurement. Its experience can only help to make the company better positioned to address enterprisewide deployments involving large seat counts and life cycle data management.

ESRI

ESRI, one of the leading GIS vendors, was a pioneer in the GIS market. While we have spoken little of the bottlenecks facing users in GIS, they do exist, particularly in GIS deployment, data management, and interdepartmental data access. ESRI has two products, Spatial Database Engine and MapObjects, both of which are aimed at bringing wider access and a bigger audience to GIS data and information. Spatial Database Engine is a technology that sits on top of a corporate database (say, Oracle) that allows multiple users (who may be GIS specialists or not) to access, store, and manage the spatial data. MapObjects is a collection of mapping and GIS objects for use in custom applications. Of course, there are other GIS companies with similar technologies that allow for access to spatial data from corporate databases. Smallworld and MapInfo are among these companies.

SDRC

SDRC is another full-line mechanical CAD/CAM/CAE/PDM player. While historically a technically strong company, its purchase of product data management company Metaphase in early 1997 (before that time, SDRC had an equity investment in Metaphase) gives SDRC a much stronger base from which to play in the future mechanical landscape.

MicroCADAM

MicroCADAM is a mechanical CAD/CAM player with a leading market position in Japan. We must admit that we see little activity from MicroCADAM regarding the future mechanical design landscape. However, we should note that MicroCADAM bills itself as a midrange player, where perhaps, enterprisewide thinking is not as crucial at this time.

Bentley Systems Incorporated

Bentley was among the first companies to begin talking publicly about how it views the evolution of CAD to enterprise engineering. Over the past two years, Bentley has slowly been unveiling pieces of its enterprise strategy: It was the first with server-side software (ModelServer technology and products); it was also the first to fully embrace Java as a native language with MicroStation/J, which includes the Java Virtual Machine (and extensions) embedded in it.

The ModelServer products allow engineering data to be managed and shared, including access via the Internet/intranets, where data is stored and brokered from an Oracle or proprietary database. Similarly, because of the embedding of Java into MicroStation/J, applications and components developed for MicroStation/J can be run across the enterprise and through project extranets, essentially widening the accessibility to data models beyond engineering and into the enterprise. Bentley believes that, because Java is a standard language in IT, these components will tend to travel across the enterprise with more ease.

CoCreate

CoCreate (formerly Hewlett-Packard's Mechanical Design Division) was among the first companies that talked of a truly collaborative environment intended to work outside of the traditional "electronic whiteboarding" ideas that were bandied about a few years ago. In late 1996/early 1997, CoCreate announced its concept of Shared-Space Design, which consists of technologies that allow for the simultaneous access to the same CAD model by multiple users via the Internet/intranets. The technology allows users to alter parts without knowing geometric history. What this means is that a designer can view a rib in a part as a rib, while a manufacturing engineer can worry not so much about manufacturing a part with a rib, but creating two pockets in the part.

CoCreate's vision of and solution for collaborative design is unique, and the company seems to understand design/manufacturing bottlenecks. However, to work smoothly, most companies would have to make some changes in the way they currently have implemented their design processes. They will at least be forced to examine their internal design processes, which can only help identify bottlenecks.

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Unigraphics Solutions

Unigraphics Solutions only recently spun off from EDS Unigraphics, after acquiring Intergraph's mechanical design group and products (Solid Edge). Unigraphics is in a unique position, in that its solid modeling engine, Parasolid, is the driver for many of the midrange systems out there today. Parasolid's prevalence, combined with Unigraphics Solutions' full line of CAD/CAM/CAE/PDM products, gives the company a secure position for leadership in the future.

Dataquest Perspective

Clearly, most of the leading CAD companies are taking steps to address some of the issues we have outlined in this Perspective, in order to position themselves for the enterprise engineering market. There is still money to be made in traditional CAD sales to customers, and the vendors must learn to balance that with their ventures into new areas and new technologies.

We fully expect the design-centric viewpoint, particularly prevalent in the mechanical and AEC markets, to disappear in the future. Expanded vision by the CAD solution providers, much as we have outlined here, and use of newer technologies in different ways will attract a host of interested potential customers.

During the past five years, the dominant focus of engineering application investment was centered on capturing, simulating, and communicating design intent. During the next five years, we expect that priorities will swing toward leveraging intellectual capital and widening the collaborative landscape, bringing engineering information throughout the enterprise.

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Perspective



Mechanical CAD/CAM/CAE Worldwide

Competitive Analysis

1998 Mechanical Landscape

Abstract: *This Perspective outlines the mechanical CAD/CAM/CAE market by subapplication and vendor as it looks in 1998. 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, shows their respective 1997 software revenue, 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. As always, comments and corrections are welcomed.

Mechanical Subapplication Definitions

Computer-Aided Design—CAD

- Design applications—Software applications used in the design of components and assemblies. This is a very broad subapplication that includes software for styling, conceptual design, assembly modeling, component design, and manufacturing tool and fixture design

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(For Cross-Technology, file in the Client/Server Software and Technical Applications binder)

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The Mechanical CAD/CAM/CAE Landscape

CAD

Design Applications—$1,497 Million

3D/Eye
Adra Systems
Alias Research/SGI
Applicon
Ascad
Ashlar
Autodesk
Baystate Technologies
Bentley Systems
Cad Distribution
Cad.Lab
Cimatron
Cimlinc
Cocreate
Computervision
Dassault Systemes/IBM
Delcam International
Dp Technology
Gerber Systems
Hitachi Zosen
Icem Technologies
Intergraph
Investronica SA
Isd Software
Matra Datavision
MCS
MicroCADAM
NEC
Nihon Unisys
Parametric Technology
PROCAD GmbH
Radan Computational
SDRC
Serbi
Sharp
Tebis
Tecnomatix Technologies
Toshiba
Unigraphics Solutions
Vero International
Wiechers Datentechnik
Ziegler Informatics

Drafting and Documentation—$765 Million

3D/Eye
Applicon
ASCAD
Ashlar
Autodesk
Autotrol
Baystate Technologies
BCT GmbH
Bentley Systems
Cad Distribution
Cad.Lab
CIMLINC
Cocreate
Computervision
Dassault Systemes/IBM
debis Systemhaus
Gerber Systems
Hitachi Zosen
ICEM Technologies
IMSI
Gerber Systems
Hitachi Zosen
ICEM Technologies
IMSI
Intergraph
ISD Software
Just In Time Systems
Matra Datavision
MCS
MicroCADAM
NEC
Nihon Unisys
Omron
PAFEC
Parametric Technology
PROCAD GmbH
Radan Computational
SDRC
Serbi
Sharp
Tebis
Toshiba
Unigraphics Solutions
Viagrafix
Wacom
Whessoe Computing Systems
Wiechers Datentechnik
Ziegler Informatics

CAE

Analysis—$471 Million

Adam Net
Adina
Algor
Altair Computing
Ansys
Cadsi
Computational Mechanics
Computervision
Engineering Mechanics
ESI Group
Hitachi Zosen
ICEM Technologies
Intergraph
Livermore Software
MacNeal-Schwendler
MARC
NEC
Nihon Unisys
Parametric Technology
SDRC
SRAC
Toshiba
Unigraphics Solutions
Variation Systems Analysis

Linkage/Mechanism—$48 Million

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

Dassault Systemes/IBM Mechanical Dynamics

Manufacturing Process Simulation—$369 Million

Other Manufacturing Applications—$51 Million

CAM

Numerical Control

Adra Systems
Anilam Electronics
Applicon
ASCAD
CG Tech
Cimatron
Cimlinc
CNC Software
Computervision
Dassault Systemes/IBM
Delcam International
DP Technology
Exapt
First Cadcam
Gerber Systems
Gibbs & Associates
Hitachi Zosen
ICEM Technologies
ISD Software
Matra Datavision
MCS
MicroCADAM
NEC
Nihon Unisys
Open Mind
Pathrace Engineering
Radan Computational
SDRC
Sescoi
Sharp
Surfware
Toshiba
Unigraphics Solutions
Vero International

Part Processing Design

Dassault Systemes/IBM
DP Technology
Exapt
Matra Datavision
Nihon Unisys
Parametric Technology
SDRC
Tecnomatix Technologies
Unigraphics Solutions

Coordinate Measuring Machines

Dassault Systemes/IBM
Delcam International
Matra Datavision
Parametric Technology

Offline Robotics

Dassault Systemes/IBM
Deneb Robotics
Tecnomatix Technologies

Other—$310 Million

MISC.

Knowledge-Based Engineering

Concentra

Application Development Environments

Dassault Systemes/IBM
Matra Datavision
Parametric Technology
SDRC
Unigraphics Solutions

Product Data Management—$277 Million

Agile Software
Applicon
Ascad
Autotrol B.A.
Autodesk
Intelligence Networks
BCT GmbH
CMstat
CoCreate
Computervision
ConsenSys Software
Dassault Systemes
Eigner + Partner
Formtek
IBM
ICEM Technologies
Intergraph
ISD Software
MatrixOne
Modultek OY
NEC
Novasoft
PAFEC
Parametric Technology
PROCAD GmbH
SDRC
Sherpa
Toshiba
Unigraphics Solutions
Workgroup Technology

Component Information Systems

Aspect Development/Cadis
Autodesk
Information Handling Systems

Note: Revenue represents 1997 software revenue

984186-7

- 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. 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/mechanisms—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 an NC machine tool or automated processing system
  - Part processing design—Design of a series of manufacturing steps
- Other manufacturing applications
  - Coordinate measuring machines—Software used to program 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—Management of data within an engineering or manufacturing environment. Product data management includes tools to manage product structures, workflow and work processes, and CAD/engineering data, files, and documents.
- Component information systems—Software used to navigate within and manage a repository of mechanical engineering parts and associated data

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The Mechanical CAD/CAM/CAE Landscape

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CAE

Analysis—$471 Million

Adam Net
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Sescoi
Sharp
Surfware
Toshiba
Unigraphics Solutions
Vero International

Part Processing Design

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Eigner + Partner
Formtek
IBM
ICEM Technologies
Intergraph
ISD Software
MatrixOne
Modultek OY
NEC
Novasoft
PAFEC
Parametric Technology
PROCAD GmbH
SDRC
Sherpa
Toshiba
Unigraphics Solutions
Workgroup Technology

Component Information Systems

Aspect Development/Cadis
Autodesk
Information Handling Systems

Note: Revenue represents 1997 software revenue

Perspective



Mechanical CAD/CAM/CAE Worldwide

End-User Analysis

CAD Perceptions among European Mechanical Designers

Abstract: *In this Perspective, we examine the attitudes and CAD satisfaction of European-based mechanical designers and engineers. Much of the data is based on a survey of European designers that was performed in May 1998. The information presented in this Perspective is a synopsis of a longer report titled,* The European Mechanical Designer, *published June 1998.*
By Sharon Tan

Introduction

In this Perspective, we examine the attitudes and CAD perceptions of European-based users of mechanical CAD/CAM/CAE systems in France, Germany, Italy, and the United Kingdom. The data in this Perspective is based on the results of a May 1998 telephone survey of 324 European-based engineering professionals involved in the mechanical design process. The information presented in this Perspective is a shortened version of a longer report titled, *The European Mechanical Designer* (CMEC-WW-UW-9801, published June 1998).

In particular, we highlight survey results that reveal 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 list" for CAD applications (for example, application stability and ease of use). The results are explored here.

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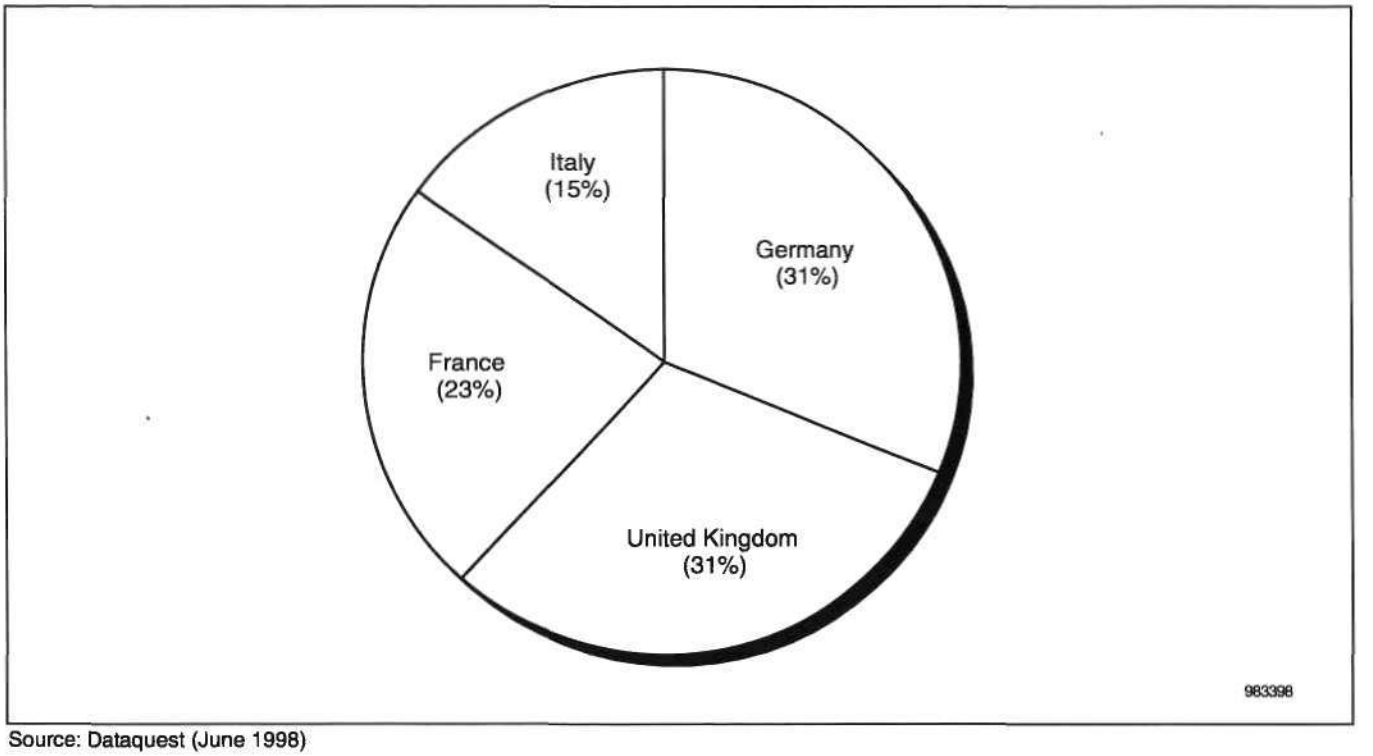
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Survey Respondents

As we stated earlier, our survey focused specifically on those mechanical CAD/CAM/CAE users in France, Germany, Italy, and the United Kingdom. A breakdown of survey respondents by country is shown in Figure 1. Our decision to focus on these countries was driven largely by the fact that these countries are the biggest purchasers of mechanical CAD/CAM/CAE systems in Europe.

Figure 2 gives the respondent breakdown by industry. Because many of the mechanical CAD/CAM/CAE software and hardware purchases are made by a few key industries, we consequently focused on those industries—specifically aerospace, automotive, electrical/electronic machinery, fabricated metal, and industrial machinery—in this survey. While some may argue that our focus on specific industries may skew the results, our aim in conducting the survey is to understand users and decision makers involved in the mechanical design process in key industries. The category "others" in Figure 2 consists of those respondents in services/design/consulting, telecommunications, government, and education.

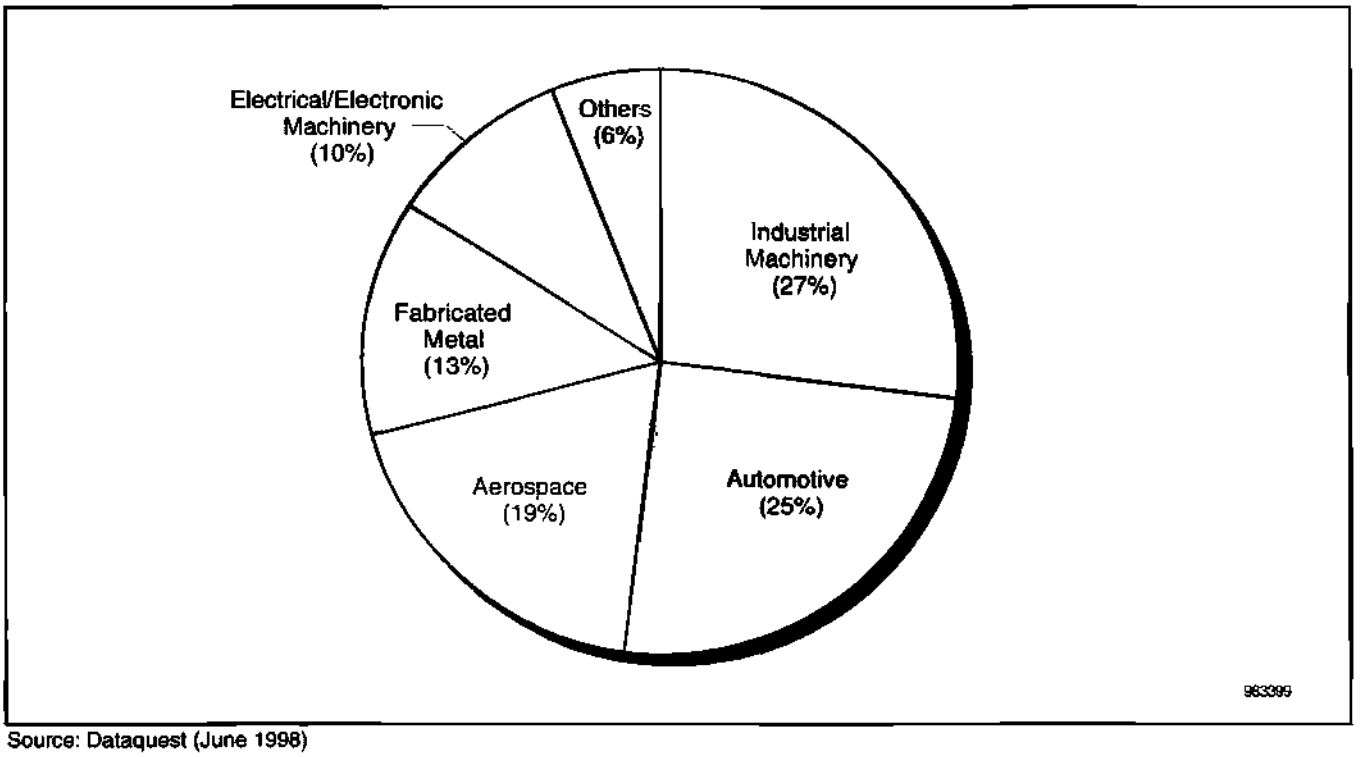
Figure 1
Respondents by Country



Source: Dataquest (June 1998)

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Figure 2
Respondents by Industry



Source: Dataquest (June 1998)

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 that 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).

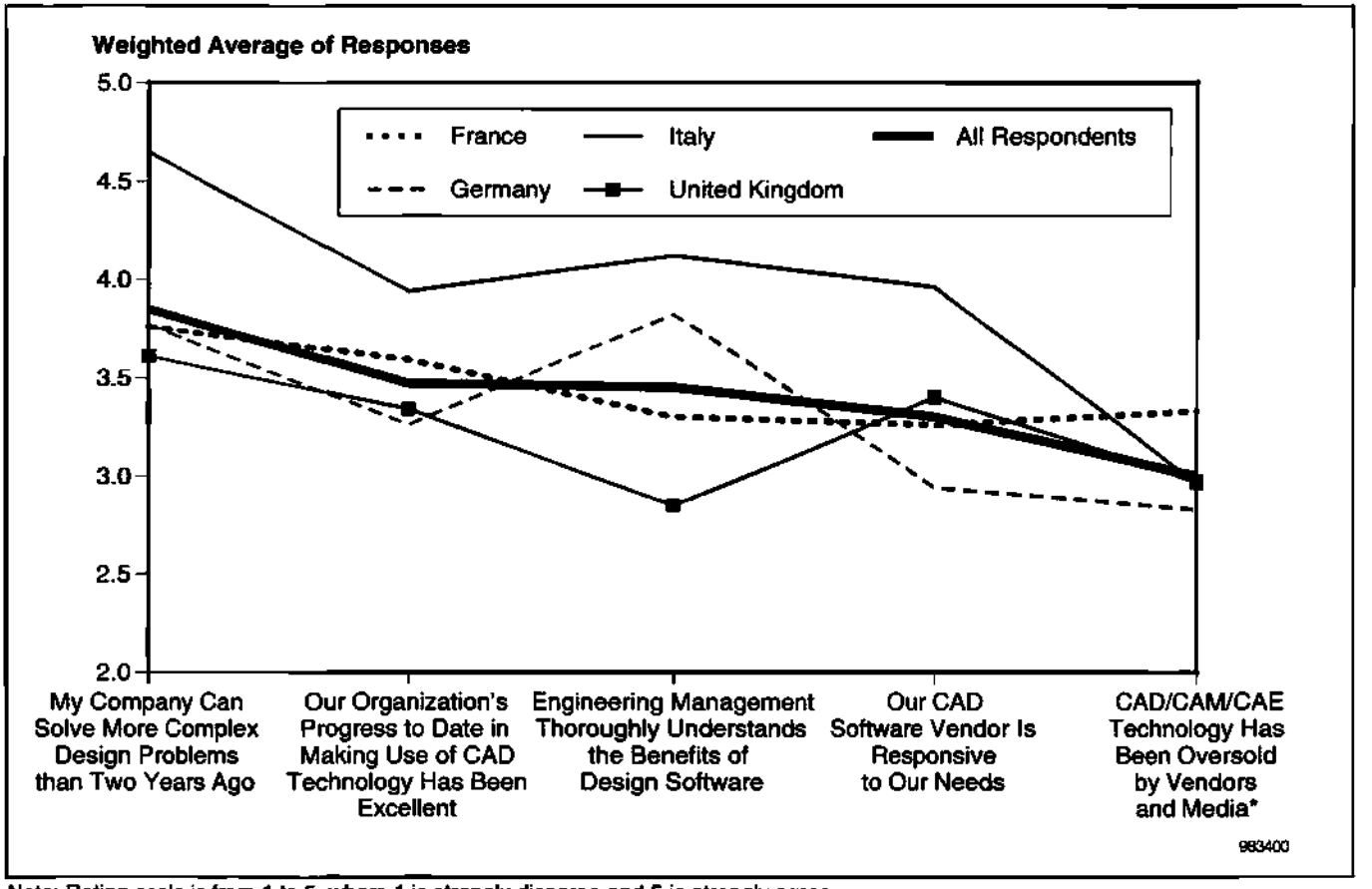
Dataquest asked respondents to what level they agree or disagree with a series of general statements concerning CAD/CAM/CAE, its role in the company, and its benefits—not just to engineering design, but to the company's overall business processes. The weighted average of the results, by country, is displayed in Figure 3. Overall, respondents in this survey are fairly happy with their CAD/CAM/CAE systems with respect to their company's business goals, with the Italian respondents clearly the most satisfied of the group.

The results seen here do not differ greatly from what we have seen in other end-user surveys. While we could safely say that CAD technology has helped our European designers and engineers to tackle more complex designs, we can't say that their engineering management understands the benefits of design automation. From a country perspective, the widest range

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of responses was seen when users responded to the statement "Engineering management thoroughly understands the benefits of design software," with respondents in the United Kingdom falling short of even agreeing (rating of 3) with that statement.

Figure 3
CAD Perceptions, Weighted Average of Responses



Note: Rating scale is from 1 to 5, where 1 is strongly disagree and 5 is strongly agree
*Full statement is "CAD/CAM/CAE technology has been oversold by the vendors and media, compared to what can be accomplished for the investment required."
Source: Dataquest (June 1998)

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 and computer-aided engineering (CAE) applications

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- Computer-aided manufacturing (CAM) applications and numerical control (NC) software
- Product data management (PDM)
- Data exchange and translation

Figure 4 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 4 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 4 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. Vendors should read the gray shaded areas as opportunities for software/system improvement.

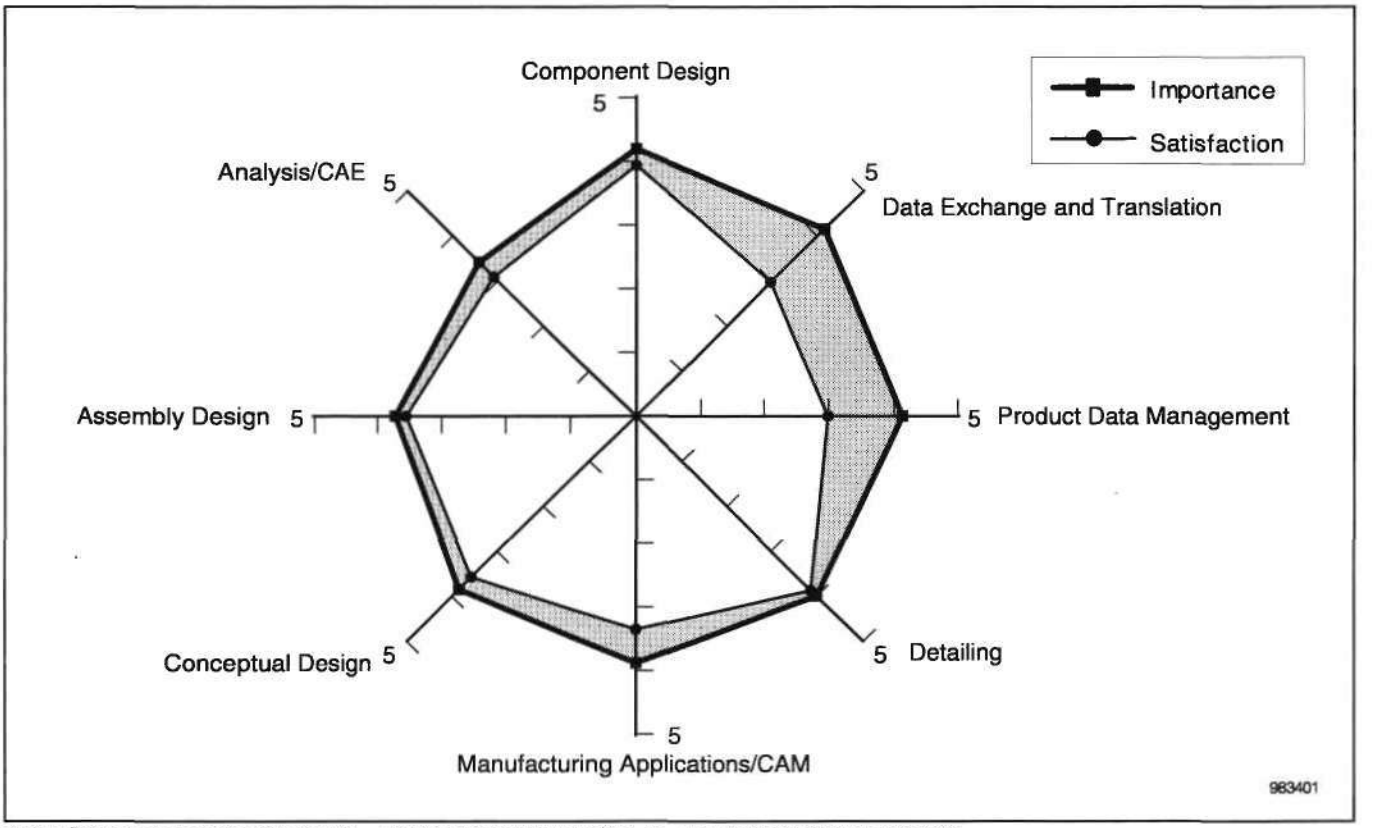
While most of the gaps in Figure 4 are not large, there are clearly some unmet needs out there. Once again, the importance of data translation software to designers and engineers becomes apparent. It was ranked high in importance by survey respondents, but this same group of people is very unsatisfied—a negative 1.2 difference, or gap. Data translation is one area that has always demanded attention from users, and these European users are much more unsatisfied with their translation and data exchange mechanisms than we typically see.

The high importance ranking given to detailing (ranking of 4.0) underscores the importance in mechanical design of this very basic application. However, in comparison to other applications, the gap here, negative 0.1, is not large.

Contrary to what we have seen in North American survey results, product data management ranked quite high in importance among these European survey respondents and low in satisfaction. By country, the German and French survey respondents showed the greatest dissatisfaction with PDM technology, where the gaps were negative 1.3 for each group. Data management is a much larger issue in Europe than in North America, partly driven by the fact that European governments often incorporate standards as mandates. Also, CAD investment in Europe is typically part of a global corporate strategy. This means that when orders are placed in Europe, generally they are of a much greater magnitude than in the United States, and data management becomes part of that strategy.

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Figure 4
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 1998)

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 photorealistic 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
- Photorealistic imaging
- Sharing of design files via Internet or intranet
- Accessing design information via a project Web site
- CAD to CAM integration
- CAD to CAE integration

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Figure 5 outlines user ratings for the items listed above. Clearly, these designers and engineers want a lot of performance from their CAD solutions—tight integration among modules (especially CAD to CAM integration), good graphics, and design optimization capabilities.

Integration of CAD with both CAM and CAE ranked high in importance and also showed sizable importance-satisfaction gaps. The user-perceived dissatisfaction with CAD to CAM and, to a lesser extent, CAD to CAE integration, is consistent with the importance-satisfaction gap we discussed earlier concerning data exchange and translation.

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 designers and engineers. (Surprisingly, however, photorealistic 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.

Mechanical designers are beginning to use the World Wide Web, intranets, and the Internet for design- and engineering-related activities. Here, survey respondents are interested in sharing design files via the Internet or intranet and are interested in project Web sites, but their satisfaction with their abilities to do so today is less than satisfactory. Readers should note, however, that such capabilities aren't at the top of these user importance rankings.

Characterizing the Ideal Software Solution and CAD Vendor

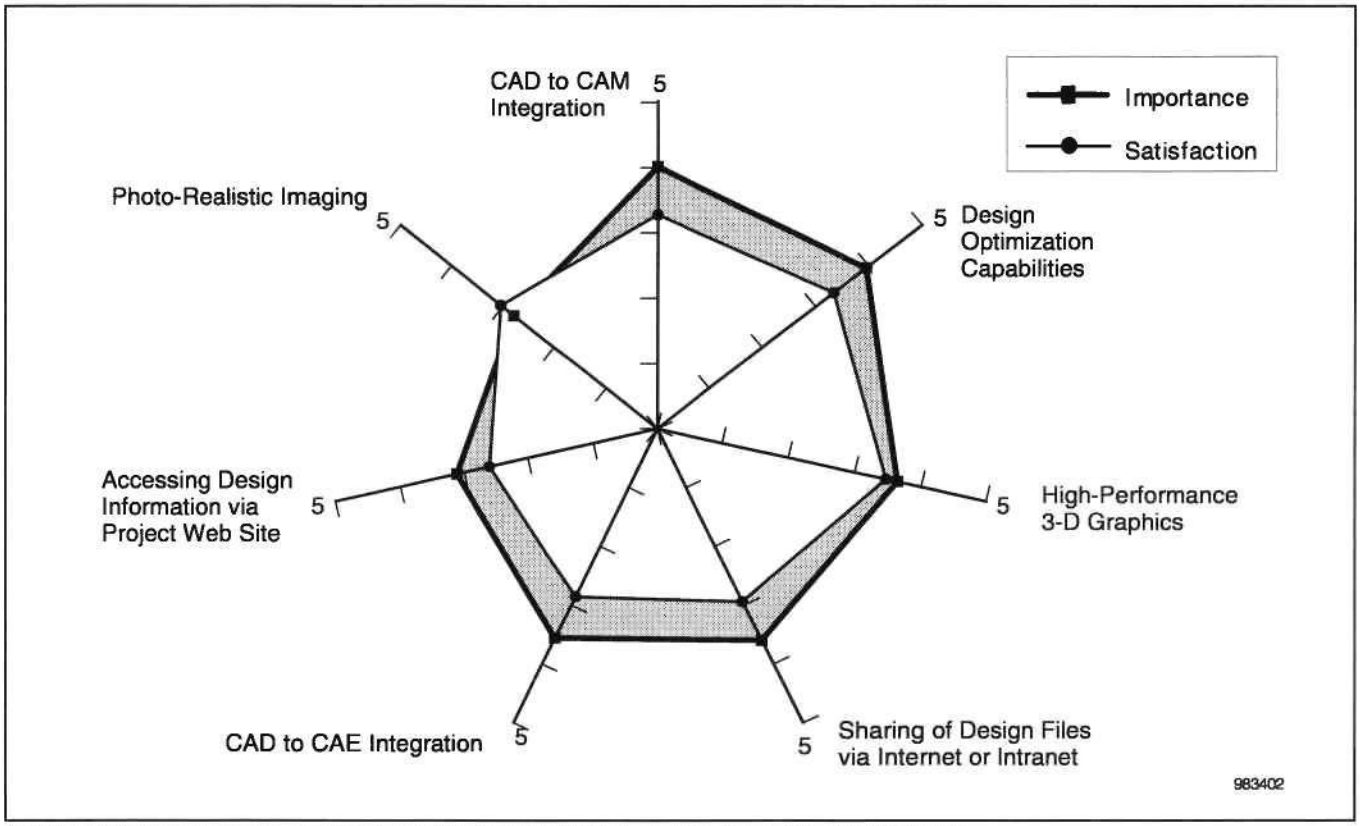
When it comes to CAD/CAM/CAE solutions, one can look at user-rated importance and satisfaction from one of two angles. The first one is concerned with specific mechanical applications and CAD-related technologies. Dataquest explored these areas earlier in this chapter. The other angle is concerned with 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

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Figure 5
Importance/Satisfaction Gap Analysis of CAD-Related Technologies



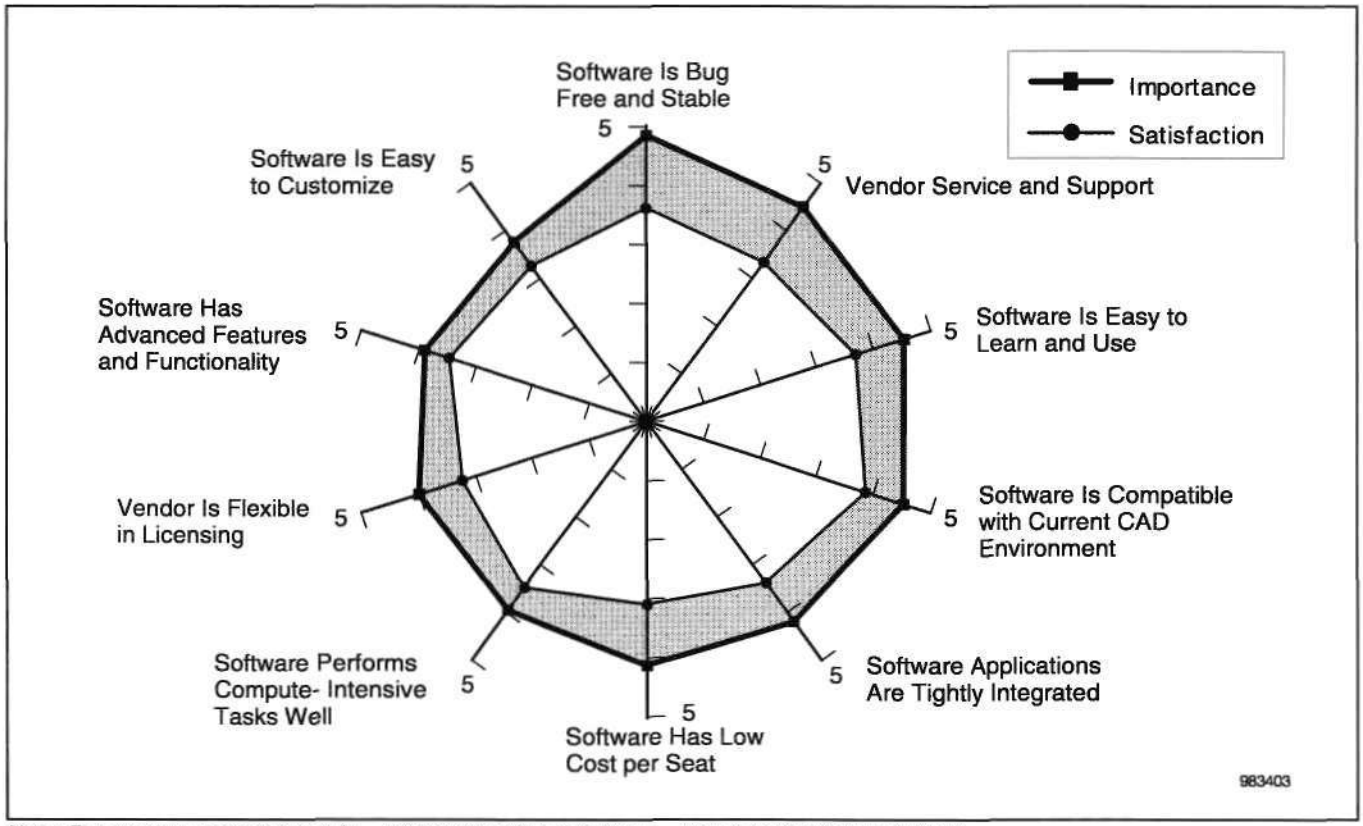
Note: Ratings on a scale of 1 to 5 (1 = not important/not satisfied, 5 = very important/very satisfied)
Source: Dataquest (June 1998)

- Vendor service and support
- Software is easy to customize
- Vendor is flexible in its licensing policies
- Software applications 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 6). 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 wish for software that is bug free and stable. The gap here is quite large—negative 1.2—and the importance rating is extremely high (importance rating of 4.9). 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.

Figure 6
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 1998)

Software that is easy to learn and use is also important to the European 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 with the onset of the midrange mechanical design packages, have vendors really begun to concentrate on ease-of-use issues in earnest.

Of particular interest is the relatively large importance-satisfaction gap (negative 1.0) given to the statement "Software has a low cost per seat." In previous North American surveys, this item has ranked high, but not quite as high as the European respondents have ranked it. Nor has the importance-satisfaction gap been as great. Examining the data by country reveals that respondents in France and Germany are particularly dissatisfied with CAD cost per seat (importance-satisfaction gaps of negative 1.4 and negative 1.2, respectively). Further, our European survey respondents, as a whole, appear to be more price sensitive than their North American counterparts. This sensitivity may be related to the tendency to make CAD purchases in large quantities in Europe (in particular, in Germany), versus the smaller sales that often occur in North America.

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.

Dataquest Perspective

Despite the maturity of the technology, European users are still not completely satisfied with their mechanical CAD/CAM/CAE solutions. Satisfaction ratings are still lower than importance ratings for all basic CAD/CAM/CAE software functions, such as assembly design and product data management. There is plenty of real dissatisfaction with CAD/CAM/CAE solutions among European end users, when it comes to such basic issues as bug free, stable software, vendor service and support, and software cost per seat.

Further, European designers and engineers want a lot of performance from their CAD solutions—tight integration among modules (especially CAD to CAM integration), good graphics, and design optimization capabilities. Survey respondents show an interest in sharing design files via the Internet or intranet and in project Web sites, but such capabilities aren't at the top of user importance rankings.

Clearly, user experiences with CAD are not perfect in the European mechanical design community. Opportunities exist for those vendors willing to address issues outside of pure design and in areas where real user dissatisfaction lies.

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Perspective



Mechanical CAD/CAM/CAE Worldwide

Market Analysis

System-Level Design Automation

Abstract: *Creating virtual prototypes, streamlining the design and manufacturing process through greater automation, and promoting system-level integration are very important issues that companies are facing as they constantly try to reduce the time to market, reduce design and manufacturing costs, and improve product quality. This Perspective looks at the forces that are pushing for system-level design and integration, examples of successful system-level design automation (SDA) projects, and what software vendors are doing to respond to the needs of users who are demanding more and more sophisticated tools. This Perspective also looks at a special market within the electromechanical domain, that of the cabling tool vendors.*

By Daya Nadamuni

The Flow

System-level design automation brings together mechanical design and electronic design. This Perspective covers the mechanical and electronic aspects of the system-level design automation market.

The idea of being able to create a virtual product with all the associated parts and subassemblies, integrate the products and processes and test the product before a physical prototype is created is a very attractive one for the following reasons:

- Market forces are imposing shorter design cycles, faster time to market, and helping to drive down manufacturing costs, making it easier for companies to stay competitive.
- The move to more complex technologies and the increasing use of electronics in aerospace and automotive applications is magnifying existing problems and bringing up new problems in design and analysis at the micro and the macro level. At a micro level, shifts to more complex

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ICs and advanced technology packaged into smaller form factors is causing various interconnect problems, requiring the use of more sophisticated analysis tools that can solve problems related to power, time, and electromagnetic interference, among others, simultaneously. At a macro level, for example, the increasing use of devices such as cellular phones, laptops, and other portable electronic devices means that aircraft cables and control systems need more shielding than ever before from radio frequency (RF) emissions. The reliability and stability of the product are important at micro and macro levels.

- The availability of system-level tools with varying degrees of capabilities
- The drive toward reuse of existing designs or modifications of existing designs and greater use of outsourcing
- The push by various national and commercial consortia to sponsor research and development in the areas of virtual prototyping and digital product definition.

It is estimated that there are more than 50 semiconductors in the average high-end car today: chips that control the ignition, the air-conditioning, the anti-lock braking system, and GPS system, to name a few.

The increasing use and complexity of devices with ever-increasing electrical and mechanical content, across industries, is making companies take a good look at their design processes with a view to enabling concurrent design in the electronic and mechanical design of the product. For the purposes of this Perspective, virtual prototyping can be loosely defined as modeling, simulating, and analyzing a model on a computer.

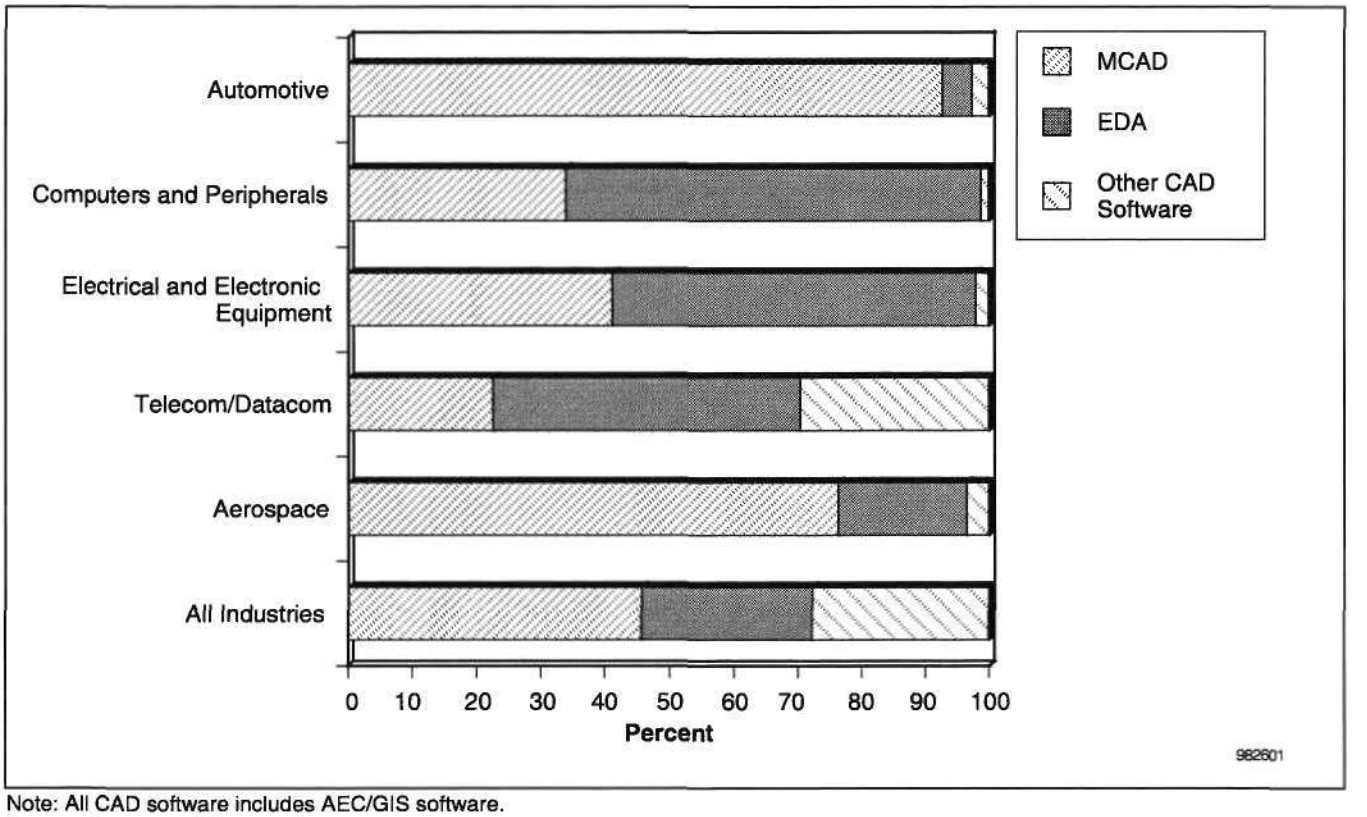
System-Level Design by Industry

In looking at system-level design, the aerospace and automobile industries are two of the biggest areas where mechanical and electrical systems must be merged. Not surprisingly, these two industries are among the largest users of mechanical CAD and electronic design automation (EDA) tools. The market for mechanical CAD and EDA software accounted for U.S $5.2 billion in revenue in 1996 as shown in Figure 1. Design cycles in these industries have been historically between 5 and 10 years and it is only recently that these industries have begun trying to make their business and engineering processes more lean and mean and to pull in design and manufacturing times.

All these different forces are bringing down the walls between what have essentially been two connected but separate design and test processes: mechanical design and assembly and electronic design and assembly. System-level design automation is an attempt to bring these and several other related processes together and create a design environment where it is possible to create a digital version of the product and to integrate and test it before it ever reaches the manufacturing floor.

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Figure 1
Applications by Industry in 1996 (Millions of U.S. Dollars)



Note: All CAD software includes AEC/GIS software.
Source: Dataquest (May 1998)

Of course, this is easier said than done. There are several levels of complexity that immediately become apparent. Applications and processes need to be integrated. Each process is a complex hierarchy of subprocesses reflecting subassemblies, and all of this needs to be integrated and managed in a unified environment. There are differences between the mechanical and electrical worlds in terms of their approach to all these issues. The mechanical design world operates in 3-D. EDA is a 2-D world. Mechanical designers deal with very complex part geometries, the EDA designers use simple shapes and are more concerned with connecting components and dealing with minimum physical constraints than the mechanical designers. Finally, the data generated at each stage of the project needs to be integrated as well. In an ideal world, the design process would be as shown in Figure 2.

SDA Projects

Some Drivers for Success in Implementing SDA Projects

Concurrent Engineering and Collaborative Engineering

Any large project, especially in the automotive or aerospace industries, uses several design teams that are focused on different facets of the design and assembly process. Collaborative engineering efforts are necessary for reducing design cycle times by allowing different teams access to the most recent data at all times and creating a process where there is tight control of

the design check-in and check-out. Design teams are often dispersed geographically, which means that the process needs to be tied together even more tightly. The rapid acceptance of the Internet as a collaborative environment is helping to solve some of the problems associated with designing products in different locations. Software is currently available to create a Web site for a given project within the intranet domain. It can also be made accessible to third-party suppliers, if necessary, over the Internet.

Tighter Links to Other Parts of the Enterprise

The design and manufacturing process cannot take place in a vacuum. The workflow needs to incorporate the constraints placed on the design by manufacturing processes, the business rules of the enterprise, and other competitive outside influences. This means that there must be tight links to the financial systems in the company: manufacturing resource planning (MRP), enterprise resource planning (ERP), accounting, finance, and sales. Many software vendors in the CAD industry are now providing interfaces to the different systems that are used in the enterprise in response to the growing demand from users for tighter integration with the other parts of the corporate enterprise.

Standards for Exchanging Data

The use of first- and second-tier suppliers is common in the automotive and aerospace industries. Electronic data interchange of documents and models is important. Standards have to be set for the data interchange process to happen as smoothly as possible so that there is minimal loss of data during transmission or translation between different CAD systems. Some automobile and aerospace companies require their premier suppliers to use the same CAD software as they do. Others are willing to accept parts and models generated from other CAD software environments so long as the part meets the required specifications. It goes without saying that the larger the financial and commercial clout of the company, the more it can dictate to its suppliers.

Good Product and Process Data Management

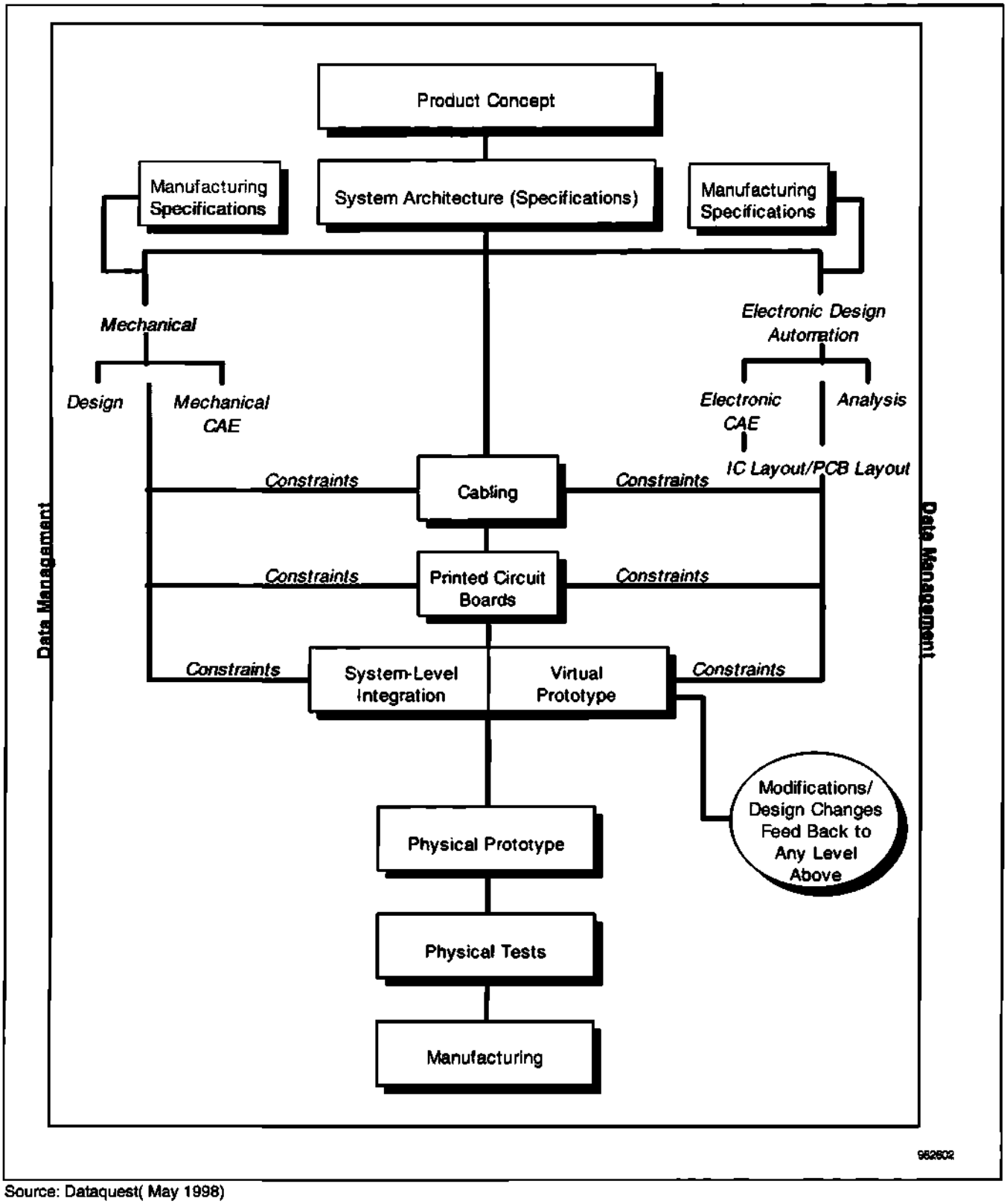
Good data management is critical for the success of any such large-scale integrated project. The amount of data that is generated by a project in the automotive or aerospace industry is huge. On the Boeing 777 project, it was estimated that 3TB or more of data were generated by the design process. This means that the product data management (PDM) system used to manage all this data has to be very robust. Users have indicated that the PDM systems that they have bought from commercial CAD vendors have been inadequate for their needs and they have had to supplement these with in-house tools to fill the gaps.

Examples of SDA Projects

Aerospace: The Boeing 777

The Boeing 777 project was one of the first examples of a major, large-scale project that followed the principles of system design automation. According to the Boeing Company, the aircraft was designed, assembled, and tested in a virtual environment before the complete physical prototype was produced.

Figure 2
The Design Flow in an Ideal World



Source: Dataquest(May 1998)

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The process itself was fairly complex, not only because of the magnitude of the project, but also because of distributed design teams, and the use of outside suppliers, among other factors. The main design software used for the mechanical design and assembly was CATIA from IBM/Dassault Systemes. The body of the plane was built in Kansas, while the rest of it was designed and manufactured in Seattle. The Boeing Company estimates that 238 design teams collaborated on the project. The project took about five years to complete, compared to about seven-to-10 years for the previous design and manufacturing cycle. However, the savings in time was an additional bonanza, as the primary goal of the 777 project was to focus on the quality of the end product. Tools from commercial CAD vendors for cabling to finite element analysis, among others, were supplemented by several internally developed tools to fill in the gaps that commercial companies could not provide. These included product data management tools, and simulation tools that were necessary for creating a virtual prototype. IBM RS/6000 machines were used for the CATIA software, and high-end UNIX machines from Silicon Graphics were used for the most graphically compute-intensive applications.

Functional testing and verification of the different parts, assemblies, and subassemblies was done for each part, and then abstract models were used for higher levels of testing. Boeing did make a mock up of the nose of the 777 to verify that digital preassembly would work. Boeing suppliers also opted to use CATIA as the mechanical CAD software of choice, which simplified part and data exchange and created fewer translation errors.

As a result of its experience and the outcome of the 777 project, the Boeing Company has now embarked on the digital prototyping of the 737 family and on some military projects as well. Other programs that are using this digital approach to aircraft design and construction are the development of the joint strike fighter with Lockheed Martin, and military aircraft such as the F-22. Boeing is using more commercially available CAD tools in its test division and in the commercial and military divisions, while continuing to improve some of its in-house CAD tools like the Wires 2000 product that is used in conjunction with LogicalCable from Mentor Graphics for cabling and design.

Automotive: Ford C3P

If aerospace is using SDA, can automobiles be far behind? Major automobile companies have announced their own versions of the digital prototyping process for the next generation of cars. In the United States, the most notable of these is the Ford 2000 program, also known as Ford C3P. The three Cs stand for CAD, CAM, CAE and P stands for product information management. There are two major forces driving the automobile industry (no pun intended) to the virtual prototyping paradigm. One is the requirement for greater fuel economy and the increasingly power-hungry automotive functions in new cars. The second is the statutory requirements by states like California for a percentage of cars sold in the state to be electric cars by the year 2000.

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The Ford C3P program is based on the idea of building cars designed and manufactured in multiple countries. The lead mechanical CAD provider is Structural Dynamics Research Corporations I-DEAS Master series. Cabling tools are being provided by Transcendent Inc. (the new incarnation of Viewlogic's Quad Design subsidiary). Transcendent's tools have a link to the Saber tool from Analogy for simulating the power environment. Saber is being used by university programs that are collaborating with the Ford 2000 project.

C3P aims to be computer design-aided everything: engineering, manufacturing, and information management. So far, the C3P program has cost nearly $100 million and the first product is due out in 2000. The ultimate goal of the project is to integrate the design manufacturing and product information into a single electronic interface that can be used globally by Ford and its suppliers. Ford is focusing on trying to simultaneously achieve the goals of improved quality, shorter time to market, and lower manufacturing costs by implementing the C3P program. Ford estimates that it can bring down the design and manufacturing cycle for each new car model from five years or more before the implementation of the C3P program to 24 months or less by the time the entire project is implemented.

Other companies such as Chrysler, Toyota, and General Motors have adopted the paradigm of digital manufacturing to differing degrees. Chrysler, for example, has embarked on what the company has termed a digital manufacturing and assembly process applications (DMAPS) program together with Dassault Systemes, as CATIA is being used for design and assembly. For visualization, Chrysler has developed and its own tool known as the Chrysler Data Visualizer. Ford has chosen to go with SDRC's I-DEAS tool suite for mechanical design and assembly.

Consortium/Government-Sponsored Projects

DARPA RaDEO Program

The rapid design exploration and optimization program is funded by Defense Advanced Research Projects Agency (DARPA) with the objective of integrating CAD/CAM/CAE systems in the electromechanical domain. The program is concerned with developing the comprehensive information modeling and design tools needed to support rapid design of electromechanical systems comparable in capability to the tools being used in the design of microelectronics. The program has four major objectives: capturing design intent, design exploration, integration, and the creation of interfaces for manufacturing simulation, mapping between the requirements of the design and manufacturing and creating virtual design workspaces. Capturing the design intent is geared toward the use of more intelligent, knowledge-based engineering tools. Integration includes and integrated product design environment and virtual reality and simulation tools for electromechanical systems.

AIT

The AIT is a consortium of European manufacturers in the automotive and aerospace sector brought together to develop requirements and specifications for future information technology tools and to promote the adoption of

relevant international standards such as STEP, and CORBA, among others. The scope of AIT is the complete cycle of the design and manufacturing process.

The project is now in the second phase, having completed its pilot phase in late 1997. The goals of the pilot project were to demonstrate interoperability among different CAD systems and to integrate manufacturing with the design process.

The pilot project has brought up the same needs that have been identified elsewhere in this Perspective: the need for advanced workflow management tools and better tools for product and process data management. Better visualization and simulation tools are also needed for creating digital mock-ups and virtual prototypes.

There are also several related projects that are being conducted under the auspices of the European Strategic Program for R&D in Information Technology (ESPRIT) framework directly related to putting together a workable system-level design framework. Some of the projects, such as the open toolset for the mixed simulation of multidomain systems, the digital mock-up modeling methodologies, tools for product conception and downstream processes, and flexible digital signal processor (DSPs) for space and automotive applications, are being conducted under the BRITE/EURAM (Basic Research in Industrial Technologies for Europe/European Research on Advanced Materials), which is one of the projects under the ESPRIT umbrella. The objective of the BRITE/EURAM program is to develop a technology that allows designers and manufactures to create a digital design and manufacturing process that follows the ideal workflow depicted in Figure 1. Similarly, there are industry-specific initiatives to facilitate and promote concurrent engineering between European automotive manufacturers and their suppliers and European aerospace companies and their suppliers. The goals of these programs are to improve the business process by reducing time to market, improve the quality of information exchanged between suppliers and manufacturers, and vice versa to improve product quality.

What Do Users Want

In talking to companies that are currently engaged in the virtual product development process, Dataquest has found that engineers, designers, and project managers all have wish lists for software products that can help them to better automate the process. A few of these are as follows:

- Knowledge-based engineering tools to automate the design process and shorten the product development cycle. Knowledge-based tools can capture the design and incorporate the rules that drive the design process. These can be engineering rules, business rules, manufacturing rules, among others. As functional requirements change during a current or future design process, the model can automatically generate new product designs with minimal input. Not only do the tools facilitate

design reuse, but also allow engineers to use alternative scenarios much more easily.

- Better data management products that can capture all the data generated by the process and product. The currently available commercial PDM systems, according to the users, are not scalable and extensible enough to handle the enormous volumes of data generated by large-scale projects.
- Better analysis tools at the micro level and at the system level
- Better system-level integration tools

How Are CAD Vendors Responding

Software vendors are moving to address the needs of the users in many of the following key areas:

- In response to the need for better data management tools, many CAD and PDM vendors are coming out with new and improved versions of their PDM software with a view to replacing the in-house tools that have been used in an ad hoc fashion with previous versions of their data management tools. The EDA world has also seen several recent announcements by leading vendors to provide data management tools that are able to capture and store the data generated during the process of design in an integrated circuit (IC) or a printed circuit board (PCB). For example, one such product is Design Exchange from Viewlogic. Information generated over the lifetime of the product during its design, manufacture, use, and disposal needs to be captured, used and reused. The data can be created by different groups using different computer systems. It is important to be able to capture and store all of this data and to be able to share this data when necessary. This is why users are asking for PDM and electronic document management systems that have a lot of functionality.
- Knowledge-based engineering tools: Leading CAD vendors from both the mechanical CAD world and the EDA world are rapidly improving their software packages to capture design intent in a better fashion. Software packages like ICAD from Concentra Corporation (which has now been spun off and licensed to Knowledge Technologies International) and STONErule from Prescient Corporation are tools that belong to this new generation of knowledge-based engineering tools that are increasingly being used to efficiently automate the design and manufacturing process.
- Industry consortia are working with academic institutions on developing an electronic system-level description language to be available in 2002 and a mechanical system-level description language slated to be available in 2006.
- Vendors like The Mathworks are introducing tools that enable engineers to model and simulate complex power systems and control systems for the aerospace and automotive industries. Companies like Engineous software are providing tools like iSIGHT, which are a first step toward providing a way for integrating mechanical, electrical, and electronic design at the system level. Ansoft has a tool called EMSS that is to be

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used to analyze the interactions of the control system components and subsystems. Analogy's Saber software for mixed signal simulation can now be used with its newly introduced LSA software for control system design. EDA vendors are moving beyond point-tool solutions and trying to provide tools that can solve the six analysis problems simultaneously.

- Better, cheaper, and more advanced simulation and visualization tools are available today as compared with what was available at the time of the Boeing 777 project. For example, companies like Division and Engineering Animation are providing tools that are able to animate large virtual models and provide walk throughs and fly throughs.
- Better system-level design tools like Statemate Magnum from I-Logix and RDD-100 from Ascent Logic, which treat the entire design as a complex embedded system.

Cabling Tools

A typical car of today may have 1.2 miles of cables, while a commercial jetliner has several times that length. As complexities of the electrical assemblies increase, electromechanical issues such as the design and routing of wires and cables between connectors become more and more important. In addition, the knowledge that the electrical system accounts for a large portion, by some estimates 20 percent to 30 percent of the total warranty costs for tracing electrical faults, for example, has led vendors to provide design automation tools that can do wire harness design, replace hand-wired nailboards, and automate cable routing, schematic editing, and signal tracing. Table 1 shows the product offerings for this market. This is not meant to be an exhaustive list. It is just a sample of the tools available today.

Table 1
Cabling Tool Vendors and Products

Vendor	Product
Linius Technologies	EMBassy
Mentor Graphics	LogicalCable
Transcendent Design Technology	TransCable
Parametric Technology Corporation	Pro/Cabling
SDRC	I-DEAS/Harness
Dassasult Systemes	E3D
Debis	Ruplan
Unigraphics	UG/Harness

Note: This is not a complete list of all the products or companies.
Source:Dataquest (May 1998)

The electronic design automation vendors have links to the cabling software modules that are provided by the mechanical software vendors so that there is a complete transfer of specifications and constraints from one domain to the other. Mechanical attributes of a wire such as length, thickness, and minimum bend radius can be exported to a tool such as LogicalCable or TransCable and used to perform analyses such as signal tracing and voltage

drop calculations. Similarly, electrical connectivity information from the electrical tools can be used as specifications for laying the wire harness. Given the need for increased RF shielding, identifying and troubleshooting the analysis problems that arise at this stage, such as cross talk and electromagnetic interference (EMI), not only do automated cabling tools reduce time to market, but they also bring down costs by getting the design validated in the first run. They also fit into the new paradigm discussed earlier of automating the entire design process and creating the virtual prototype before going to manufacturing.

Dataquest estimates that the cabling market is currently about U.S.$50 million, but it has the potential to grow rapidly as the complexity of electromechanical design systems grows.

Dataquest Perspective

Complex electromechanical systems and devices have equally complex architectures and state-dependent behaviors, which may not be intuitively obvious. Virtual prototypes of such systems and devices can eliminate costly design errors and problems before the product is in production.

The evolution to virtual prototyping before the physical mock-up is constructed is a reflection of the evolution of the design process from paper-based schematics to the electronic creation and verification of designs. Design intent that used to be conveyed through drawings it is now being conveyed through CAD models. Engineers are now designing in a top-down fashion starting with system-level design, continuing to assembly modeling, and finishing with part design. New versions of CAD software have evolved to the point where they are now capable of capturing design intent and design knowledge, and thus have essentially become the enablers for virtual prototyping today. However, virtual prototypes can still achieve only a certain level, given the existing technological capabilities. It is not possible to provide a prototype of all the assemblies, subassemblies, and parts of an airplane, and simulate its behavior in a given computer system at a given time. The best that can be done today is to virtually display and simulate models of these parts at high levels, or to functionally simulate the behavior of the aircraft by using abstract mathematical models. Vendors have found ways to minimize the processing requirements of large models by using place holders in the assembly model for each component and loading the information about those components as needed. Hewlett-Packard's recently introduced DirectModel software is one such example, a toolkit for creating 3-D graphics for technical applications built around the objective of managing large 3-D models that typically have millions of polygons.

Companies are in the throes of re-engineering their business process to new ways of doing business. The move to the new or modified way of doing business, during the early stages of implementation, will still raise many questions and be disruptive. But the payoff once the project is completed will be worthwhile in terms of the efficiencies achieved in the process, cost controls, and better quality of the finished product.

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Physical prototypes will still continue to be built and tested in order to satisfy federal rules and regulations for safety and durability. Virtual prototyping is a way of making sure that the physical prototype is correct the first time around, so there are fewer costly repairs and reworks of the design and tangible savings in time and money.

A by-product of this move to a digital definition of the design, assembly, and manufacturing process, paperless cars, and systems on a chip, is the rising interest in mechatronics, defined as the integration of mechanical and electrical engineering disciplines.

As the process evolves and becomes more refined and sophisticated, system-level design automation will become the paradigm for bringing products to market. The issue that remains to be seen is how quickly this process will be adopted as the standard business model and how software tools will evolve in response to user needs. An interesting trend to watch will be the continuing consolidation in both the vendor domain and the user domain, especially in the automotive industry.

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Dataquest
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Perspective



Mechanical CAD/CAM/CAE Worldwide

Market Analysis

A New Platform Takes Shape

Abstract: *Windows NT-based mechanical CAD/CAM/CAE applications have stirred up the market over the last two years. This Perspective provides Dataquest's annual update on just how far Windows NT-based applications have made it into the traditionally UNIX-based mechanical design market and our predictions of just how far they will go.*
By Sharon Tan

What We Said Last Year ...

Last year, Dataquest predicted that Windows NT-based mechanical CAD/CAM/CAE applications would continue to lay down a strong foundation in the low-end and midrange mechanical CAD/CAM/CAE market and would begin impacting the high-end market—but not until 1998 at the earliest. We were partly right. Clearly, these applications have made their mark on the low end and have really defined the meaning of midrange mechanical CAD/CAM/CAE. However, their impact on the high end became apparent last year, with sales of NT-based mechanical applications growing 138 percent to reach nearly $700 million in 1997.

Although Dataquest believes that $700 million in sales is somewhat overstated (we will begin to refine this number during our second round of market share surveying this month), the fact remains that NT-based sales have skyrocketed, grabbing market share at both ends of the spectrum.

Table 1 shows the percentage of Windows NT-based software sales by CAD application for 1996 and 1997. It is important for readers to remember that Dataquest's definition of NT-based CAD software includes only CAD software that is deployed on a machine running the Windows NT-based operating system and excludes Windows 95. Sales of Windows 95-based

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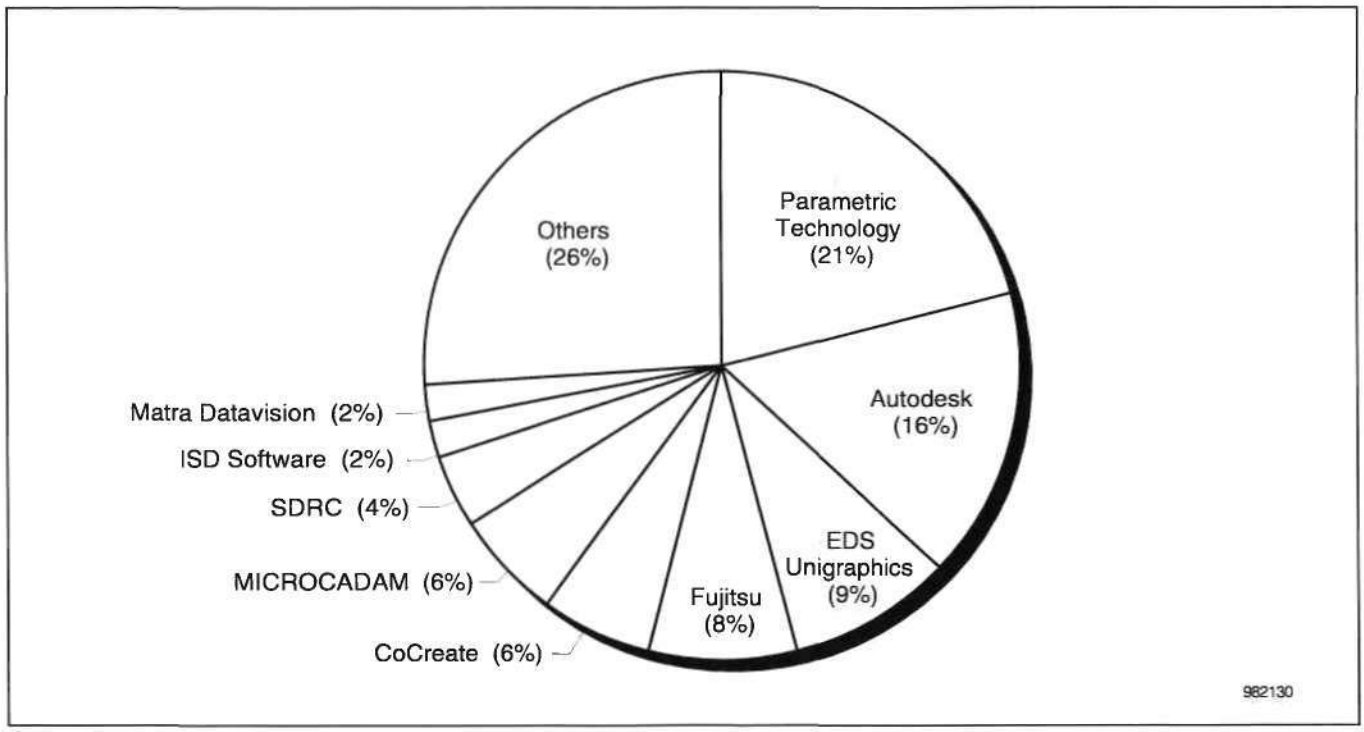
CAD software deployments are categorized in our "personal computer" operating system (which includes DOS, Windows 3.x, and Macintosh operating systems, among others). Market share for the NT-based mechanical CAD/CAM/CAE market is shown in Figure 1.

Table 1
1997 Windows NT-Based Sales in CAD Applications

Application	1996 Windows NT-Based Software Sales (Percentage of Total Market)	1997 Windows NT-Based Software Sales (Percentage of Total Market)
AEC	17.3	30.7
GIS	19.1	23.2
Mechanical CAD/CAM/CAE	8.9	19.6
EDA	4.5	7.3
All Applications	**10.1**	**17.9**

Source: Dataquest (April 1998)

Figure 1
1997 Market Share for NT-Based Mechanical CAD/CAM/CAE Software



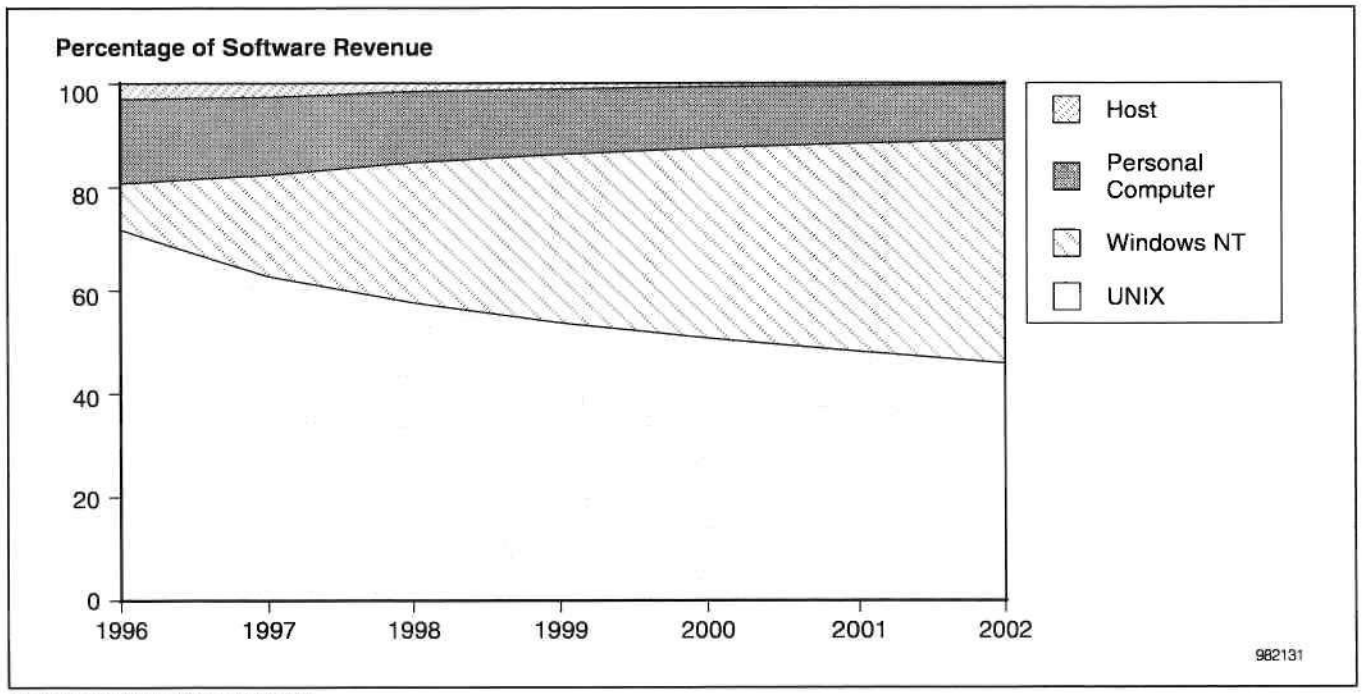
Source: Dataquest (April 1998)

Dataquest's Revised Forecast for NT-Based Mechanical CAD/CAM/CAE

Dataquest's forecast for the mechanical CAD/CAM/CAE market by operating system is shown in Figure 2. As stated earlier, we have upped our forecast for NT-based sales over the next five years (somewhat at the expense of UNIX-based sales). Also, we believe our 1997 number for NT-based sales overrepresents the true NT-based sales for 1997, and we will revise this number in an upcoming market share report.

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Figure 2
Mechanical CAD/CAM/CAE Forecast by Operating System



Source: Dataquest (April 1998)

Based on Dataquest's current numbers, we expect the market to comprise about 50 percent UNIX-based software revenue and 40 percent NT-based software revenue by the year 2002. Our forecast stands in contrast to the current 1997 mechanical CAD/CAM/CAE revenue numbers of 63 percent UNIX-based revenue and nearly 20 percent NT-based revenue. In the next few sections, we will explore from where we expect this growth to come.

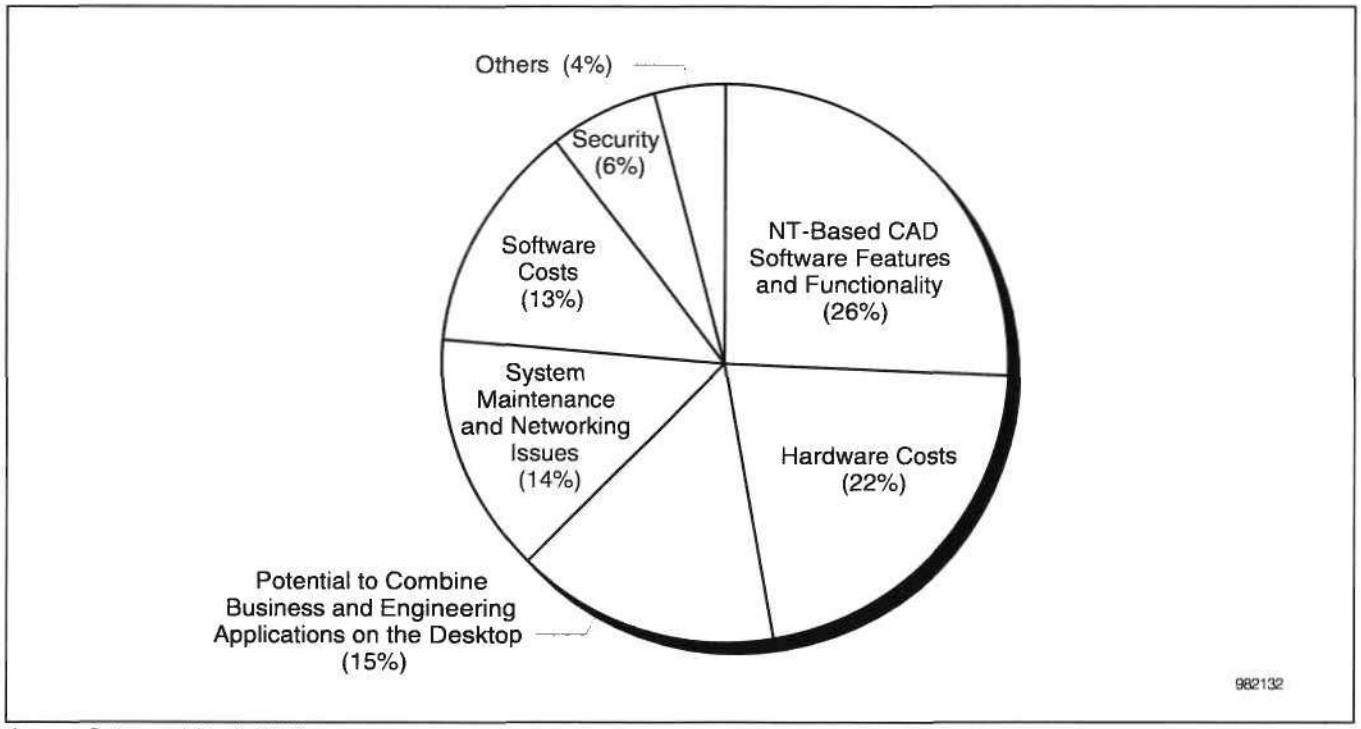
A Designer's Perspective

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 North American mechanical designers 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, these 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 respondents in automotive tend to be more guarded about their transition to NT.

User-cited reasons for moving or not moving to an NT-based mechanical CAD solution are shown in Figures 3 and 4, respectively. It is interesting to note that NT-based CAD software features were prime reasons in both cases.

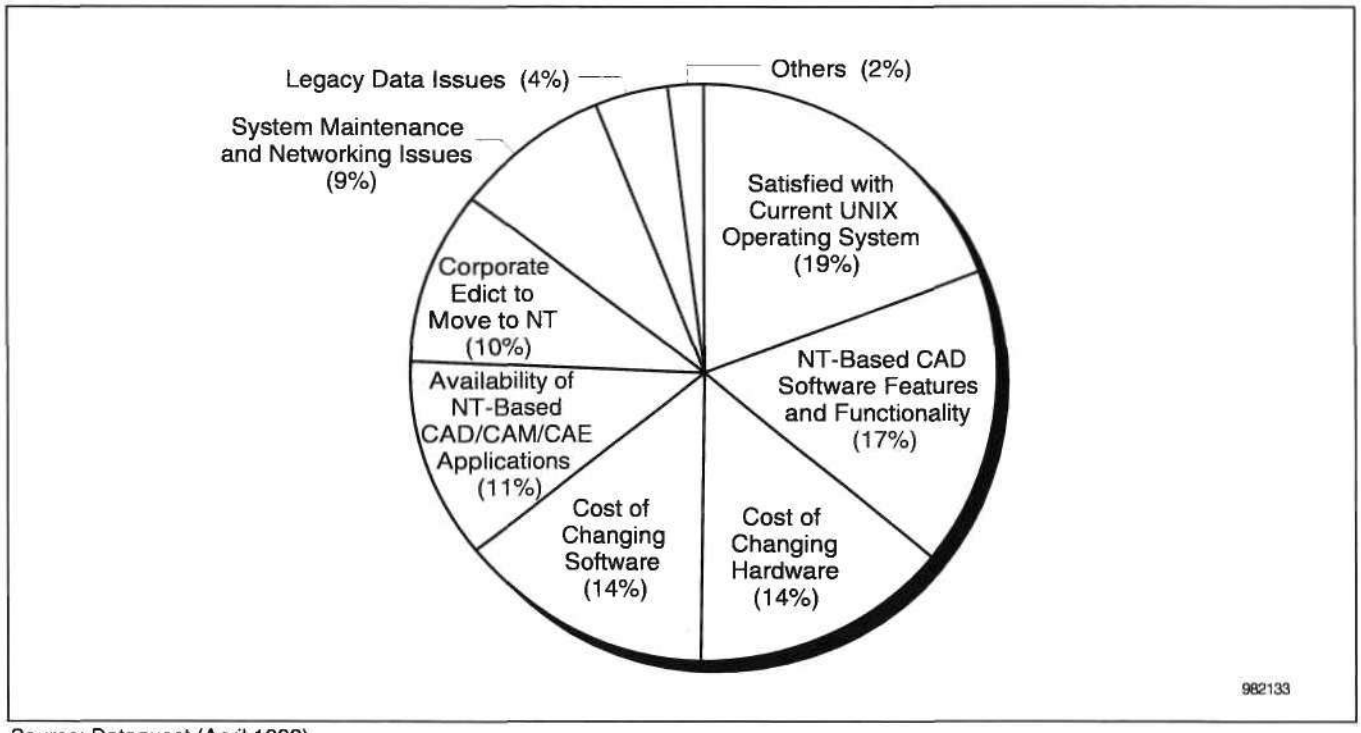
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Figure 3
Reasons to Move to NT



Source: Dataquest (April 1998)

Figure 4
Reasons to Not Move to NT



Source: Dataquest (April 1998)

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It is important to keep in mind that 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 in a survey than in reality. Dataquest expects actual movement to NT within the base of UNIX users to be slower than the rate that users predict. We still have yet to see these UNIX users actually standardize on an NT CAD solution companywide in lieu of their UNIX solutions; instead, they seem to be taking a "seat here, seat there" approach.

A Hardware Perspective

Dataquest still expects the mechanical applications market to remain dominated by UNIX-based software sales in the near 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 Equipment Corporation, Hewlett-Packard Company, and IBM—have released Intel and Windows NT-based workstation product families along with their UNIX-based systems. Other vendors, such as Intergraph and NeTpower Inc., have adopted an exclusively Intel/Microsoft strategy. What's more, new players have entered the market, most notably Compaq Computer Corporation.

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 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.

Emergence of the Midrange Market

From a product standpoint, the midrange mechanical CAD market emerged literally overnight with the introduction of the many NT-based mechanical design solutions. Generally, the NT-based packages available today offer solid modeling capabilities, integration with downstream and upstream design/manufacturing processes, and a midrange price point (about $4,000 to $7,500). This stands in contrast to their UNIX counterparts, which generally offer a higher level of functionality, integration, and, of course, price.

There is no shortage of midrange mechanical design packages on the market today, ranging from Autodesk's Mechanical Desktop to Dassault Systemes'

SolidWorks to Matra Datavisions' Euclid products. Table 2 outlines some of the key NT-based design packages available today, but it does not include midrange analysis or CAM packages. The following sections identify the issues facing expansion of the midrange market, which in turn will affect growth of the NT-based mechanical CAD/CAM/CAE market.

Table 2
NT-Based Offerings from Leading Mechanical CAD Vendors

Vendor	Midrange Offering	High-End Offering
Autodesk	Mechanical Desktop	NA
Bentley Systems	MicroStation Modeler	NA
Cad.Lab	Eureka Gold	NA
CoCreate	SolidDesigner	SolidDesigner
Dassault Systemes	SolidWorks	CATIA
EDS Unigraphics	Solid Edge, UG/Creator	UG
Matra Datavision	EUCLID QUANTUM	PRELUDE
MICROCADAM	Helix Design System	NA
Parametric Technology	DesignWave, PT/Modeler	Pro/ENGINEER
SDRC	I-DEAS Artisan Series	I-DEAS Master Series

NA = Not applicable
Source: Dataquest (April 1998)

Understanding the Two Tiers

At this time last year, the midrange market was too immature to define clearly. Although the products were available, the end user was not well defined. What will develop over the next year is a midrange market with two distinct tiers. The first tier comprises those users who are looking to move from 2-D design to 3-D design. This group may use one of the various versions of AutoCAD and may be 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 use a full-blown UNIX-based system for its 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, those users moving from 2-D to 3-D, is characteristized by the following:

- Do not have budgets for more expensive UNIX-based CAD systems
- Do not have 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, are characterized by the following:

- Do not have 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 the second tier. In particular, EDS Unigraphics, Parametric Technology Corporation, 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 Inc. and Bentley Systems Inc. sell midrange products today almost exclusively through the indirect channel and typically in smaller, five-to-10-seat deals.

For some of these vendors—namely, Dassault Systemes, EDS Unigraphics, and Parametric—future product positioning will be interesting to watch. Each of these vendors has an interesting mix of a UNIX-based solution, a scaled-down UNIX/NT-based solution for enterprise midrange, and a native NT-based midrange solution for the reseller market. Dataquest wonders just how long this positioning will hold out. Over time, these midrange packages will approach the functionality of their UNIX-based counterparts.

Indirect Channels, 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 undoubtedly have to work to attract and retain qualified dealers. Nevertheless, CAD VARs are becoming more sophisticated, either offering software products themselves (as Visionary Design Systems is doing) or expanding their network through acquisition (a la Rand Technologies). Meanwhile, mechanical CAD users will become more sophisticated and demanding as well.

One thing is clear on the channel front: UNIX-based vendors playing in the midrange will need to define clearly what the direct salesforce can sell and what VARs can sell. Alienating one at the expense of the other is a risky proposal.

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Of Special Note: Microsoft's Latest Program

At the Workstation Leadership Forum in early March, Intel and Microsoft announced a Migration Assistance Program (MAP) to assist workstation ISVs in developing and optimizing their applications for the Microsoft Windows NT operating system and the 32-bit Intel architecture/upcoming 64-bit Intel Merced processor. The MAP will provide direct support to selected ISVs in various application segments, among them EDA and mechanical design. To be considered for the program, ISVs must have submitted an application before the end of March.

It is no secret that CAD ISVs have been busy porting their largely UNIX-based applications to the Windows NT operating system for at least three years. Although NT-based CAD sales have taken off, it has largely been through the efforts of independent software vendors (ISVs) taking a leadership role here and not Microsoft. With the introduction of MAP, it looks as though things might finally be changing. Dataquest wonders why a program like this wasn't started a few years ago.

On a side note, it is unfortunate that Intergraph, one of the first CAD ISVs to develop applications for the Windows NT operating system and a worldwide leader in CAD software sales, was not part of the announcement. Although the Intel/Intergraph lawsuit might have been part of that decision, Intergraph really should have been at the party.

Dataquest Perspective: Where Are the Opportunities for Vendors?

Windows NT is emerging as a real platform for mechanical CAD/CAM/CAE applications. Although there is room for both NT and UNIX-based solutions, the uptake of NT-based applications will be strong over the next five years. There are still many opportunities for software vendors looking for a piece of this market. Vendors should keep the following in mind:

- The Windows NT landscape is nearly complete. Dassault Systemes will release C-Next before the end of 1998, and most of the historically UNIX-based vendors now have at least one midrange/NT-based offering.
- Some industries will be easier to penetrate than others. The aerospace and automotive industries today comprise substantial UNIX-installed bases, and this is not expected to change dramatically in the near future. Here, vendors should view the opportunity as one in which UNIX and NT-based systems will need to coexist.
- Midrange CAD systems are ideally suited for those 2-D designers looking to move into solid modeling. Pricing and resellers will be key to penetrating this group of users.

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Dataquest
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Perspective



Mechanical CAD/CAM/CAE Worldwide

Channels Analysis

The Mechanical CAD/CAM/CAE Market by Channel

Abstract: *The mechanical CAD/CAM/CAE market is a rich amalgamation of mechanical applications software sold through a number of different channels. This Perspective presents several channel-dependent metrics used to rank mechanical CAD/CAM/CAE vendors.*
By Sharon Tan

Introduction

Understanding revenue by channel is key to resolving market positioning statements made by many of the leading CAD vendors. For instance, comparing revenue between one company that sells primarily through direct sales with another that sells primarily through resellers distorts the view of both actual market share and true market opportunity. Dataquest has been tracking the CAD market by channel to help clarify the confusion caused by extensive use of complex distribution channels throughout the CAD world. This Perspective provides a quantitative analysis of which vendors dominate the mechanical CAD/CAM/CAE market, depending on the distribution channel being considered.

The Metrics

In order to accurately represent the market, Dataquest reports revenue as it accrues in the following ways:

- As direct software revenue for software sold through a direct salesforce
- As indirect software revenue for software sold indirectly via dealers and other resellers. Our definition of indirect revenue does not include revenue from an OEM channel.

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- As software product revenue (the sum of direct and indirect sales for products that a company owns)
- As reseller revenue for revenue earned as a reseller of another company's products (for instance, Fujitsu's reselling of a number of CAD products developed by other companies)
- As OEM revenue for revenue earned by supplying OEM software products that are sold under another name by a separate company (for instance, Autodesk's AutoCAD OEM version)
- As company software revenue for revenue a vendor earns from software sales through all distribution channels (that is, the sum of direct, indirect, reseller, and OEM software sales)
- As dealer revenue for revenue earned by a vendor's dealers for selling a product. Dealer revenue is based on indirect revenue multiplied by a dealer markup
- As end-user spending, which is the total amount of money actually spent by end users for a company's products (that is, the sum of direct and dealer revenue)

Figure 1 shows each of the revenue sources that contribute to the total mechanical CAD/CAM/CAE software market. The left side of Figure 1 is revenue that mechanical CAD/CAM/CAE vendors actually accrue in the bank. Dataquest eliminates double-counting when calculating the total market size by only summing revenue from the direct and indirect channels. We do not add in revenue from dealer and OEM sales in sizing the total mechanical CAD/CAM/CAE market.

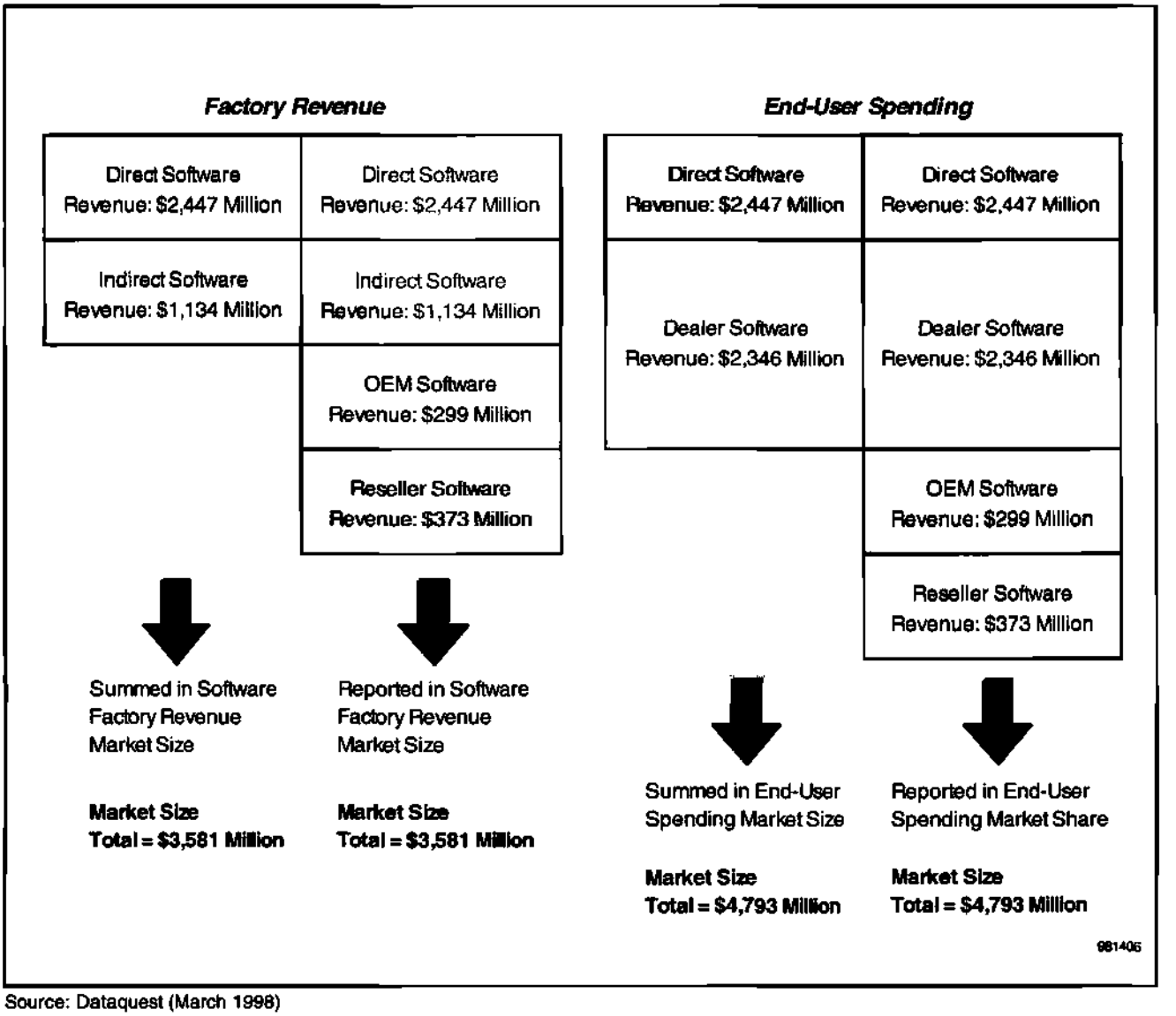
However, a given company's individual market share is based on the sum of software revenue from all channels—direct, indirect, reseller, and OEM. This means that the sum of all companies' market shares will be somewhat greater than 100 percent. We have chosen to slightly overstate a company's market share in order to give representation in our market share statistics for companies like Dassault Systemes, whose main source of revenue is via the OEM channel.

The right side of Figure 1 is money that end users actually spend for mechanical CAD/CAM/CAE software. The same methodology used for vendor-accrued money is used to calculate end-user spending. The only difference is that instead of using indirect revenue, we use dealer revenue. Thus, the total market size for end-user spending is the sum of revenue from the direct and dealer channel.

Dealer revenue is calculated from indirect revenue, and calculation of the dealer markup coefficient varies by company, region, and platform. Dealer revenue always exists for every vendor with indirect sales, and it is always equal to or greater than indirect revenue. Again, a company's individual end-user market share is based on the sum of direct, dealer, reseller, and OEM revenue, so that the sum of all companies' end user market shares is slightly greater than 100 percent.

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Figure 1
Mechanical CAD/CAM/CAE Software Market by Channel, 1997 (Millions of Dollars)



Source: Dataquest (March 1998)

Who Is the Market Leader in Mechanical CAD/CAM/CAE?

Table 1 outlines the market position in software for the top mechanical CAD/CAM/CAE companies. Although the 1997 mechanical CAD/CAM/CAE market is sized at about $3,581 million, users actually spent 1.34 times more on mechanical CAD/CAM/CAE software, once dealer markups are taken into consideration.

Autodesk and IBM are good examples of companies whose market position is dependent on the channel metrics being considered. For instance, Autodesk relies almost exclusively on the dealer channel, whereas many of the other mechanical CAD/CAM/CAE players sell primarily via a direct salesforce. Autodesk ranks as the No. 4 vendor with 6.1 percent market share when company software revenue is considered, but it jumps up to the No. 3 spot with 9.4 percent market share when end-user spending is

calculated (see Tables 2 and 3). From this perspective, it is easy to see how Autodesk can command more mind share in the mechanical market than its company software revenue would lead one to believe.

IBM, too, fluctuates in the rankings depending on the measurement metric employed. IBM receives revenue credit for selling a number of products, including direct revenue for selling Dassault Systemes' CATIA and reseller revenue for selling MicroCADAM. Although IBM holds bragging rights for the No. 1 ranking in both company software revenue and end-user spending, it drops to the No. 2 spot (and is replaced by Parametric Technology) in software product revenue (see Table 4). In the software product revenue scenario, IBM no longer gets revenue credit for reselling MicroCADAM, so its revenue drop accordingly.

Similar comparisons in market rankings can be made for the other vendors. For instance, Dassault Systemes appears among the top five companies in both company software revenue and end-user spending. However, because it sells very little of its software directly and most of it goes through the OEM channel (and is sold directly by IBM), Dassault Systemes will not appear in any top 10 ranking based on software product revenue (sum of direct and indirect revenue) alone.

Table 1
1997 Mechanical CAD/CAM/CAE Market Leaders by Channel (Millions of Dollars)

	End-User Spending	Company Software Revenue	Direct Software Revenue	Indirect Software Revenue	OEM Software Revenue	Reseller Software Revenue	Dealer Software Revenue	Software Service
IBM	656	656	583	NA	NA	73	NA	281
Parametric Technology	648	606	569	36	NA	NA	79	242
Autodesk	451	218	23	193	2	NA	426	2
Dassault Systemes	291	291	20	NA	271	NA	NA	45
EDS Unigraphics	275	208	138	70	NA	NA	137	37
SDRC	243	171	112	59	NA	NA	131	181
MicroCADAM	226	157	8	149	NA	NA	218	NA
Hitachi	149	69	24	45	NA	NA	125	23
CoCreate	131	99	20	79	NA	NA	111	37
Info. Services Int'l. Dentsu	127	127	NA	NA	NA	127	NA	NA
MacNeal-Schwendler	126	99	75	24	NA	NA	51	29
Matra Datavision	125	85	56	29	NA	NA	68	14
Fujitsu	122	104	95	9	NA	NA	27	135
Computervision	93	67	45	22	NA	NA	48	79
NEC	89	71	63	8	NA	NA	26	NA
All Companies	**4,793**	**3,579**	**2,447**	**1,134**	**299**	**373**	**2,346**	**1,472**

NA = Not applicable
Source: Dataquest (March 1998)

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Table 2
1997 Mechanical CAD/CAM/CAE Market Share Based on Company Software Revenue

Rank	Company Name	1996 Revenue ($M)	1997 Revenue ($M)	1996-1997 Growth (%)	Market Share (%)
1	IBM	580	656	13.2	18.3
2	Parametric Technology	495	606	22.4	16.9
3	Dassault Systemes	244	291	19.2	8.1
4	Autodesk	176	218	23.6	6.1
5	EDS Unigraphics	161	208	28.8	5.8
6	SDRC	164	171	3.9	4.8
7	MicroCADAM	152	157	3.1	4.4
8	Info. Services Int'l. Dentsu	117	127	8.5	3.6
9	Fujitsu	107	104	-2.7	2.9
10	CoCreate	87	99	14.4	2.8
	All Companies	**3,284**	**3,579**	**9.0**	**100.0**

Source: Dataquest (March 1998)

Table 3
1997 Mechanical CAD/CAM/CAE Market Share Based on Software End-User Spending

Rank	Company Name	1996 Revenue ($M)	1997 Revenue ($M)	1996-1997 Growth (%)	Market Share (%)
1	IBM	580	656	13.2	13.7
2	Parametric Technology	556	648	16.5	13.5
3	Autodesk	366	451	23.2	9.4
4	Dassault Systemes	244	291	19.2	6.1
5	EDS Unigraphics	184	275	49.0	5.7
6	SDRC	256	243	-5.4	5.1
7	MicroCADAM	220	226	2.7	4.7
8	Hitachi	77	149	93.5	3.1
9	CoCreate	116	131	12.6	2.7
10	Info. Services Int'l. Dentsu	117	127	8.5	2.7
	All Companies	**4,378**	**4,793**	**9.5**	**100.0**

Source: Dataquest (March 1998)

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Table 4
1997 Mechanical CAD/CAM/CAE Market Share Based on Software Product Revenue

Rank	Company Name	1996 Revenue ($M)	1997 Revenue ($M)	1996-1997 Growth (%)	Market Share (%)
1	Parametric Technology	495	606	22.4	16.9
2	IBM	486	583	20.1	16.3
3	Autodesk	175	216	23.6	6.0
4	EDS Unigraphics	161	208	28.8	5.8
5	SDRC	164	171	3.9	4.8
6	MicroCADAM	152	157	3.1	4.4
7	Fujitsu	77	104	35.6	2.9
8	CoCreate	87	99	14.4	2.8
9	MacNeal-Schwendler	109	99	-9.0	2.8
10	Matra Datavision	92	85	-7.1	2.4
	All Companies	**3,284**	**3,579**	**9.0**	**100.0**

Source: Dataquest (March 1998)

Dataquest Perspective

Dataquest has outlined a number of different reporting schemes in this Perspective, each of which is a sound way of looking at the mechanical CAD/CAM/CAE market. We have been careful not to double-count the worldwide mechanical market opportunity of $3.581 billion in 1997 software. Although one may argue that overstating a vendor's market share (in those cases where market share is based on revenue from all distribution channels and market size is based on the sum of direct and indirect revenue) is misleading, we believe that our methodology is preferable because it allows all vendors to be represented. Without such a reporting scheme, companies like Dassault Systemes and Fujitsu would not appear among the top 10 in our statistics, when clearly these companies are important to understanding the dynamics in the mechanical market.

As the mechanical CAD/CAM/CAE market evolves, the indirect and dealer channels will become more important, particularly with the emergence of the so-called "midrange" market. Indirect software revenue grew slightly faster than direct software revenue in 1997 (10.4 percent versus 8.4 percent, respectively).

Indeed, leadership in the worldwide mechanical CAD/CAM/CAE market is dependent on what metrics are being used to rank the vendors. It is not realistic to reduce market leadership in CAD to a single data point. Understanding how revenue is accrued from the end user to the vendor is important to understanding the complexities of the mechanical CAD/CAM/CAE market.

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Perspective



Mechanical CAD/CAM/CAE Worldwide

Market Analysis

CAD Chugs Along

Abstract: *Worldwide CAD/CAM/CAE, AEC/GIS, and EDA markets chugged along in 1997, according to preliminary market statistics from Dataquest. Growth slowed down in all markets. GIS grew at 12.8 percent, AEC at 4.6 percent, mechanical CAD at 9.8 percent, and EDA at 16.2 percent. Asia/Pacific showed the fastest rate of growth, followed by North America. IBM retained its leadership in the market, and Parametric Technology Corporation placed second. This Perspective presents preliminary 1997 market data for the CAD/CAM/CAE, AEC/GIS, and EDA markets by application, region, and vendor.*
By Laurie Balch, Emma Gage, Petra Gartzen, Daya Nadamuni, Gary Smith, Sharon Tan, and Jim Tully

Slower but Steady Growth

Presented here is the first cut of Dataquest's market data for the worldwide CAD/CAM/CAE, AEC/GIS, and EDA markets. Preliminary estimates show these industries chugged along at a steady pace, but growth slowed down from the rate set in 1996. Worldwide, the software market grew 11.2 percent for the year, and the size of the market was U.S.$7.8 billion.

Growth by Application

Table 1 shows the preliminary estimates by application. Markets continued to show patterns of growth by application similar to that seen in 1996, except for the AEC market, which grew at 4.6 percent—a reversal from the negative growth rate posted last year.

The GIS market, which grew well at a rate of 15.4 percent in 1996, slowed down to 12.8 percent. EDA and mechanical CAD/CAM/CAE continued to show double-digit growth rates, though again the growth rate was slower than the rates achieved in 1996. Electronic CAE grew at 16.0 percent as

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compared with 22.4 percent in 1996, and IC layout grew at 26.6 percent. The PCB market grew at 1.5 percent as compared with 8.9 percent for 1996.

The trend toward consolidation in some of the markets that was noted in 1996 continued in 1997, especially in mechanical CAD/CAM/CAE and EDA. Some of the significant mergers that occurred in 1997 were Dassault Systemes' merger with SolidWorks and Deneb Robotics, Parametric Technology Corporation's merger with Computervision, and Synopsys' merger with Viewlogic Corporation.

Also noteworthy is the continuing strength of the U.S. dollar against the Japanese yen and the European Community Unit (ECU), affecting growth in the Japanese and European markets, respectively. Growth in local currency terms would have been slightly higher for these regions. For the Japanese market, the exchange rate at the end of 1997 was ¥119.9 to the U.S. dollar compared with ¥108.8 at the end of 1996. The exchange rate for the ECU was at ECU 0.89 at the end of 1997 as compared with ECU 0.80 at the end of 1996.

Table 1
Growth Rates by Application (Millions of U.S. Dollars)

	1996 Software Revenue	1997 Software Revenue	1996-1997 Growth (%)
Mechanical	3,303	3,627	9.8
AEC	925	968	4.6
GIS/Mapping	927	1,046	12.8
Electronic CAE	1,172	1,360	16.0
IC Layout	433	548	26.6
PCB/MCM/Hybrid	295	299	1.5
EDA	1,900	2,207	16.2
All Applications	7,056	7,848	11.2

Note: Numbers presented in the table are Dataquest's best estimates as of the time of publication.
Source: Dataquest (February 1998)

Growth by Region

Table 2 shows Dataquest's preliminary estimates for growth by region. In terms of software revenue, Asia/Pacific, which accounts for about 7 percent of the software revenue for all applications, grew at 16.0 percent, while North America grew at 14.0 percent. Europe grew at about 9.1 percent, and the Rest of the World, which includes Africa and Latin America, grew at 13.3 percent.

The European Monetary Union (EMU) planned for 1999 has depressed gross domestic product (GDP) growth in Europe, increasing consumer uncertainty. 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. Some of the visible symptoms of convergence are restrained corporate investment and professional spending and suppression of government/public sector spending.

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Table 2
Growth of All Applications by Region (Millions of U.S. Dollars)

Region	1996 Software Revenue	1997 Software Revenue	1996-1997 Growth (%)
North America	2,514	2,866	14.0
Europe	2,199	2,398	9.1
Japan	1,748	1,897	8.5
Asia/Pacific	469	544	16.0
Rest of World	127	144	13.3
Worldwide	**7,056**	**7,848**	**11.2**

Note: Numbers presented in the table are Dataquest's best estimates at the time of publication
Source: Dataquest (February 1998)

Growth by Vendor

The top 10 vendors with the most market share are shown in Table 3. The table includes companies that resell products from other vendors as well as their own products (primarily Japanese companies) and companies that resell to other vendors, such as Dassault Systemes. Dataquest believes this reporting more accurately reflects the activity of all the vendors in the market.

The market share is calculated based on the company software revenue, which is the sum of direct, indirect, OEM, and reseller channel revenue. Market size is based on the sum of direct and indirect market revenue. We have made this distinction between market share and market size in order to avoid double-counting the market while showing the activity of all vendors in the market.

It is important to remember that the sum of the individual software vendor revenue and market share could be greater than the overall market size. On an inquiry basis, Dataquest can always produce market share data that excludes OEM revenue or reports only OEM revenue.

On February 10, Dataquest froze its CAD/CAM/CAE, AEC/GIS, and EDA database. Beginning immediately, market statistics for 1997 will be available to our clients through our inquiry service. Inquiries for market statistics should be directed to Dataquest Industry Analyst Daya Nadamuni at (408) 468-8290 or at daya.nadamuni@dataquest.com.

Dataquest expects to ship our market statistics books to clients in March. For those who wish to store an entire book of our statistics on desktops, Dataquest can send any volume via the Internet as an attached spreadsheet. We send out statistics in the form of Microsoft Excel worksheets.

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Table 3
Top 10 CAD/CAM/CAE, AEC/GIS, and EDA Companies Worldwide Software Revenue (Millions of U.S. Dollars)

	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
IBM	619	697	12.7	8.9
Parametric Technology	495	606	22.4	7.7
Autodesk	510	606	18.8	7.7
Cadence	422	530	25.6	6.7
Synopsys	367	474	29.1	6.0
Intergraph	385	427	10.9	5.4
Dassault Systemes	249	296	19.3	3.8
ESRI	185	223	20.5	2.8
Mentor Graphics	208	220	5.8	2.8
EDS Unigraphics	161	208	28.8	2.6
All Companies	**7,056**	**7,848**	**11.2**	**100.0**

Note: Numbers presented in the table are Dataquest's best estimates at the time of publication.
Source: Dataquest (February 1998)

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Perspective



Mechanical CAD/CAM/CAE Worldwide

Market Analysis

Component Information Systems—Who's Playing?

Abstract: *In this Perspective, Dataquest takes a look at component information systems (CIS) – including Dataquest's definition of CIS, who the players are, and outlook for the future of CIS.*

By Sharon Tan

Dataquest's Definition of CIS

Component information systems (CIS) is a unique application within CAD that straddles both mechanical, electronic, and architectural/construction design. CIS has also been referred to as CSM, or component supplier management. Dataquest uses the term CIS as opposed to CSM because we believe that the products and services today are not focused exclusively on supplier management. CIS is a broader term that enables us to include vendors that offer content (that is, CD-ROM titles of manufacturers' parts) software (that is, search engines and tools that enable searches using an in-house or external database of parts), and/or services. In some cases, vendors provide all three parts, creating intricate, enterprisewide systems that have links to things such as product data management systems, purchasing systems, and accounting systems.

Currently, Dataquest sizes the CIS market within the mechanical CAD/CAM/CAE space. As a result, most of the CIS vendors we currently track are focused on users in discrete manufacturing industries. Our current vendor coverage includes CADIS Inc. (which was purchased by Aspect Development Inc. in late 1997) and Autodesk Inc. If Dataquest were to include CIS vendors geared toward electronic design, the market would expand to include all of Aspect Development's products and Information

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Handling Services (IHS) products. Including architectural/construction vendors would add The Sweet's Group and other Autodesk products.

This Perspective covers vendors that supply either content or software to engineers and designers, regardless of whether they are focused on mechanical designers, architects and construction engineers, or, to some extent, electronic designers.

CIS players today differentiate themselves along a number of different lines, including the following:

- Mechanical, materials, or electrical components emphasis
- Interfaces to product data management (PDM), CAD, or MRP systems, or purchasing and accounting systems
- Delivery vehicle—Web/Internet/intranet or CD-ROM
- Search/retrieval methodologies

Business differentiators include the following: a focus on building customized solutions and in-house CIS systems or providing off-the-shelf solutions; legacy data conversion projects; and annual subscription-based services or "pay-as-you-use" services. Vendors are coming out with new revenue models for their CIS businesses, which Dataquest briefly explores later in this Perspective.

Who Needs CIS?

Studies have shown that engineers and designers can spend anywhere from 5 percent to 25 percent of their time identifying the right part for their design and redrawing it. What used to be a paper-intensive process is slowly becoming automated. CIS users, similar to PDM users, fall into two groups: those in smaller engineering workgroups who might use primarily content-oriented CIS products, and those who are part of a larger, enterprisewide organization that might have a CIS system complete with external and internal parts information, purchasing information, PDM links, supplier tie-ins, and CAD integration. Dataquest has found that those in AEC tend to focus more on content-based CIS solutions and those in mechanical design are interested in both content-based as well as full-blown CIS solutions.

Of course, pricing plays a large role in who buys what. Most content-based CIS solutions are delivered on CD-ROM (or, more recently, the Internet) and are priced well under U.S.$500, if not free. Such pricing fits within the typical AEC user's budget, where an AEC CAD seat might sell for U.S.$3,500 or less. In contrast, full-blown CIS systems can cost U.S.$100,000 to implement, which is much more palatable to UNIX-based mechanical users who will pay upwards of U.S.$20,000 per CAD seat.

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Major CIS Players

This section briefly discusses key CIS players and their product offerings. The list here is not meant to be comprehensive. The companies identified in this section are those that Dataquest considers to be the major or up-and-coming players in this market. We have included both content and software/service providers.

Aspect Development

Aspect Development is the largest player in the CIS market, given its recent merger with CADIS in November 1997. Both Aspect's and CADIS' products are discussed here first, followed by merger issues.

Aspect Development has three main CIS products: Aspect Explore, an enterprisewide CIS system; Aspect VIP (Very Important Parts reference databases of mostly electrical components); and AspectOnline, a scaled-down, Web-based version of Aspect Explore. Although Aspect may appear to cater primarily to electronic designers, Aspect VIP does contain some electromechanical and mechanical components.

Aspect was one of the pioneers of what Dataquest considers to be the CIS market today. In addition to providing the software products just mentioned, Aspect provides services to convert in-house, legacy CIS systems to be compatible with Aspect Explore, and it has pursued links with PDM and enterprise resource planning (ERP) vendors. It also has spent time selling to both engineering and purchasing, and it has carved out a niche for itself within the organization. What used to be CAD and PDM is now CAD and PDM and CIS.

CADIS, too, is an early pioneer in CIS. Its two main products are CADIS-PMX, its enterprisewide CIS solution, and Krakatoa Web Catalog Publisher, a technology that allows for interactive access to catalog data over the Web. Similar to Aspect Explore, the CADIS-PMX solution includes search software, legacy data conversion services, and implementation services. The Krakatoa technology has been used to pursue a number of different partnerships, including one with IHS, where CADIS provides the web search technology, Krakatoa, and the partner provides the content.

In November, Aspect Development announced a merger agreement under which it will acquire CADIS. Under the agreement, Aspect will continue development, maintenance, and support of CADIS software products and services in addition to its own VIP product line and Explore. However, only Aspect's Explore will be sold to new customers.

The merger is indeed an unlikely one, but it does create one giant among a handful of smaller players. What were once two fierce competitors have now become one company. Although Aspect historically played on the electronic parts side of CIS and CADIS catered to the mechanical side, the two companies were competitors because often the customer did both—that is, the customer designed discretely manufactured products involving both electrical and mechanical components.

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Nevertheless, Dataquest suspects that Aspect has a keen interest in CADIS' customer base and, more importantly, its Krakatoa technology. A product involving Krakatoa as the underlying engine and Aspect's content databases would create some serious competition to existing products. Of course, this may indeed jeopardize the numerous relationships with content providers that CADIS has already established.

Information Handling Services

IHS has been in the information business for quite some time, originally offering microfiche-based catalogs of military specifications, manufacturers' catalogs, government parts, and electronic components on an annual subscription basis. Although the company is focused mostly on the electronic design world, it is worth mentioning here because of its ability to provide content to engineers. With an earnest effort in marketing and the appropriate partnerships, IHS could easily cater to AEC or mechanical designers.

IHS' most recent strategy has been to pursue links between its numerous databases and key electronic design automation (EDA) CAD vendors. On the electronic design front, IHS has forged with the likes of Mentor Graphics Corporation, Viewlogic Systems Inc., and Cadence Design Systems Inc. to integrate its databases with EDA CAD tools. Of particular interest to these EDA CAD vendors is IHS' main CIS database, CAPSXpert, a semiconductor database. Although CADIS used to resell CAPSXpert, its merger with Aspect has ended that resale agreement.

IHS is also expanding its ability to deliver its databases of information to users. In March 1997, IHS introduced the IHS Engineering Resource Center, a Web site that allows users to access many of the IHS databases (including CAPSXpert, part vendor catalog databases, and federal supply parts databases) via the Internet. This service was the result of a joint development effort combining CADIS' Krakatoa technology as the search engine with IHS' various databases of component information. Users pay for access to the information on an annual subscription basis. As Dataquest stated earlier, the nature of the relationship between CADIS and IHS remains unclear at this time, given Aspect's merger with CADIS.

InPart

InPart is the newest player on the CIS scene, having just unveiled its DesignSuite product this month. The company describes itself as "an Internet-based technical publisher serving the mechanical engineering market."

Instead of developing customized, in-house CIS systems that reside at the customer site, InPart is taking a slightly different approach on many fronts. It maintains a parts library on its own servers, which the engineer accesses via the Internet. (Although the database of parts resides at InPart, the application software resides locally on the user's desktop.) The parts library consists of 3-D CAD models of (mostly) mechanical parts from various manufacturers. What is also different about InPart's DesignSuite is that these 3-D models are delivered in standard file formats (like IGES) and in

Parametric Technology Corporation's Pro/ENGINEER format. InPart can also customize each model according to a company's design standards in real time, so that a model conforms to a user's internal CAD standards.

InPart's system architecture and vendor relationships allow the company to create models for delivery over the Internet in real time, ensuring that engineers have the most up-to-date information from a specific manufacturer.

InPart's revenue model is split between revenue generated from both end users and parts suppliers, a structure typically seen with many CIS vendors. As part of InPart's end-user revenue stream, the company plans to implement a model fee based on a pay-as-you-download basis.

Autodesk

Autodesk, one of the leading worldwide CAD software players, is a content player in the world of CIS. Autodesk has a business unit dedicated specifically to its content solutions, called Autodesk Data Publishing. Three main CD-ROM titles form Autodesk's Data Publishing arm today: PartSpec, aimed at mechanical designers; PlantSpec, aimed at plant designers; and DesignBlocks, aimed at architects and construction engineers.

In November 1997, Thomas Publishing Company and Autodesk announced an agreement in which Thomas acquired the rights to produce and publish CD-ROM and Internet-based libraries developed by Autodesk's Data Publishing business unit. Thomas also received a nonexclusive license to the underlying technology. PartSpec and PlantSpec are affected by this agreement, both of which will be offered free of charge by Thomas to buyers of Mechanical Desktop or AutoCAD Release 14. Autodesk and Thomas will work to ensure that future releases of both companies' products are compatible. Thomas will also be releasing a new title covering Construction Specifications Institute (CSI) Divisions 15 and 16.

This arrangement makes sense for both parties. Rather than having to cultivate each manufacturer relationship one at a time, as it has had to do in the past, Autodesk instantaneously expands the number of manufacturers represented in PartSpec and PlantSpec with its alliance with Thomas. Moreover, Thomas is better able to make new manufacturer relationships, given Autodesk's clout in the CAD market.

DesignBlocks, released in early 1997, is the result of a partnership between Autodesk and The Sweet's Group. DesignBlocks contains predrawn blocks in Autodesk's DWG format covering several CSI divisions. It also allows the user to access manufacturers' Web pages from within DesignBlocks. Despite the fact that Thomas plans to release a CD-ROM title with some potential overlap with DesignBlocks, Autodesk has stated that both products will continue to be developed in the future, as the two products will be slightly different in their capabilities and offerings.

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CenTOR

CenTOR Software Corporation offers both content, software, and services as part of its CIS solution. The software product is called CenWARE Docuristics Software System for creating and searching for product data in CenTOR's own HMORF format. HMORF, which stands for "hypermedia optimized retrieval format," is what CenTOR describes as an extension to HTML that allows for full text retrieval within a relational database.

CenTOR's content product, called CenBASE/Materials, is available on CD-ROM or through the Web. This product also formed the basis for Autodesk's MaterialSpec, which has now been rolled into PartSpec, as discussed earlier. CenTOR has also had OEM deals with mechanical software vendors The MacNeal-Schwendler Corporation, Structural Research and Analysis Corporation, and Structural Dynamics Research Corporation for selling part or all of the CenBASE materials database.

The Sweet's Group

Although there are several vendors in the AEC space that produce electronic catalogs (usually on CD-ROM) of various building manufacturers' parts, few are as well known as The Sweet's Group. The Sweet's Group caters primarily to the construction industry, with CD-ROM-based and online searchable catalogs of information for products used in the construction industry, such as masonry, wood, and windows. Data is searchable by a number of parameters, including the CSI 16 division format. Aside from the searching capabilities, the online database reads much like a paper catalog, with contact information and product information for each entry. The Sweet's Group was also closely involved with Autodesk's DesignBlocks product, as described earlier.

The EDA World

Dataquest has mentioned a few products that are targeted toward electrical engineers and designers. The EDA world also has Questlink Technology's EE Design Center. The Questlink EE Design Center includes current technical information such as data sheets, application notes, frequently asked questions (FAQs), design and support tools, and reference designs for analog and logic circuits. It is free of charge to users, vendor-sponsored, and primarily intended to help engineers research and select integrated circuits for product and system design. Different from any mechanical-oriented CIS systems, the QuestLink EE Design Center includes application notes to show how others have used a given part. Data sheets are cross-referenced to allow engineers to look up statistical and descriptive materials comparing different components.

Dataquest Perspective

CIS is clearly still in its infancy. Forecasting growth in a market that is currently sized approximately $50 million in software is not that meaningful—the CIS market will post healthy growth during the next five years, and the barriers to entry are not up yet.

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Players have been entering the market from a content perspective and a software/service perspective. On the content side of CIS—CD-ROM titles of manufacturers' catalog information—the value of the information to the engineer is limited. Just how much is it worth to an engineer if he/she selects a part but still has to go through the process of redrawing the part? Here, pricing of the CD-ROM (or whatever the delivery mechanism might be) has to be low enough (or even free) for engineers to buy the content. Revenue to vendors offering content will have to come from the manufacturers' side, who pay to essentially get free advertising of their products on the CD-ROM.

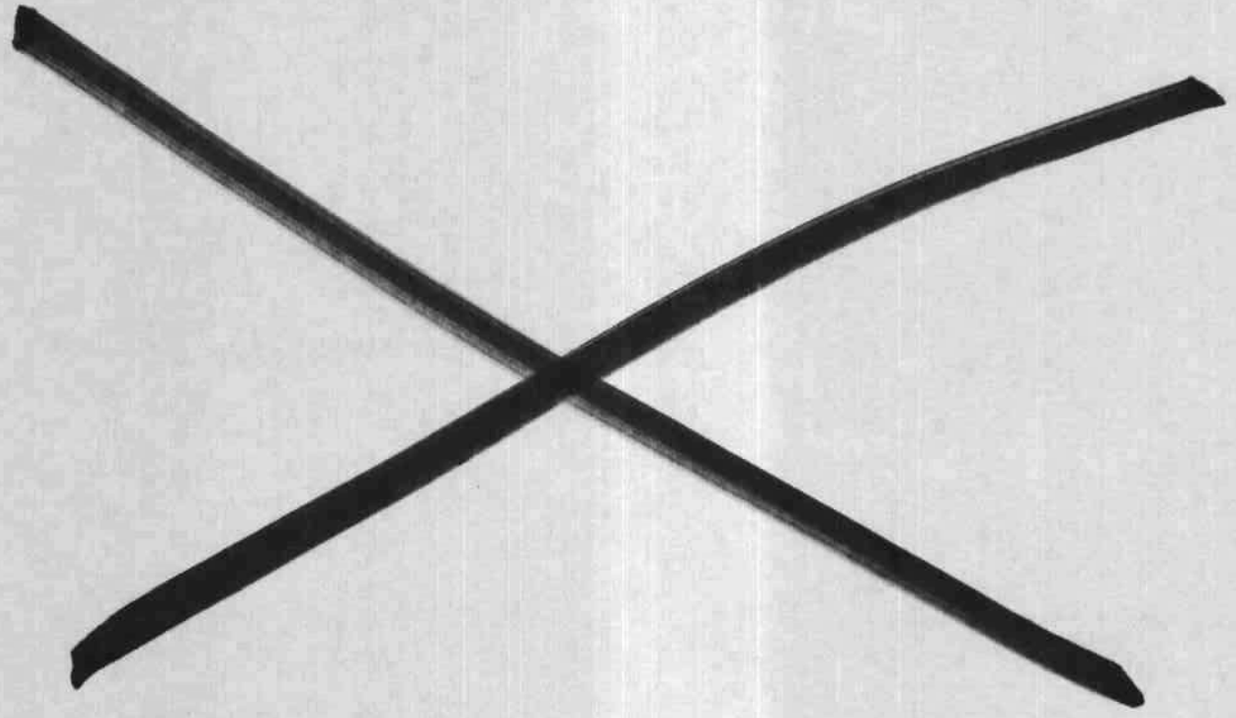
For enterprise-level CIS, there is still plenty of room for new products and new players. Products will have to add real value to the user—a CD-ROM of manufacturers' catalog pages may not be the answer here. Otherwise, CIS vendors will find it to be an even harder sell against the PDM and MRP budgets for which they are already competing. Thus far, Aspect Development and CADIS are the only two companies that have been successful with enterprisewide deployments. InPart's business model of a completely Internet-based architecture will be an interesting one to watch during the next few years.

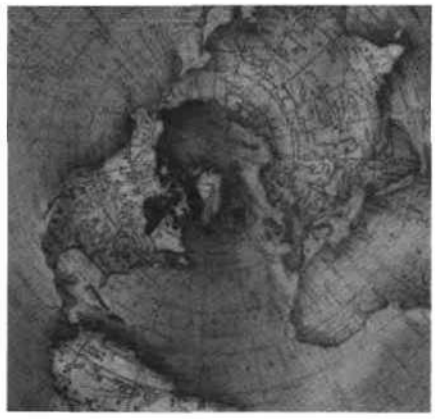
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Growth Prospects in a Mature Market



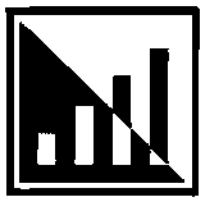
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Growth Prospects in a Mature Market



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Table of Contents

Page

1. Executive Summary 1
   - Study Objectives 1
   - Key Findings and Highlights 1
   - Dataquest Perspective 2
   - Report Description 2
2. Market Research Methodology and Market Definitions 3
   - Data Collection Process 3
     - Supply-Side Data 3
     - Demand-Side Data 4
   - Market Segmentation 4
     - Regions 4
     - Operating Systems 6
     - Distribution Channels 6
     - Mechanical Subapplications 7
3. The Mechanical CAD/CAM/CAE Market Today 11
   - Performance of the Market Leaders 11
   - Regional Differences 12
   - Channel Differences 12
   - Growth by Industry 15
   - The Hardware Playing Field 16
4. Market Drivers 19
   - The Market Leaders Tomorrow 19
   - Emergence of the Midrange 21
     - Understanding the Two Tiers 21
     - Indirect Channels; Qualified Dealers 22
   - Prognosis for Europe 22
   - Economic Turmoil in Asia/Pacific and Japan 23
   - System-Level Design 24
   - The Promise of Objects—If and When 24
     - The Confusion about Object Technology 24
     - Vendor Offerings Still Not Meeting User Needs 25
   - Role of Java 26
   - Virtual Prototyping 26
   - Market Evolution: Engineering Modeling for the Enterprise 27
     - Central Repositories for Engineering Information 27
     - Capturing Design Know-How and Bringing It to the Enterprise 28
5. Mechanical Market by Subapplication 29
   - Computer-Aided Design 29
     - Design Applications 29
     - Drafting and Documentation 32
   - Computer-Aided Engineering 33
     - Analysis 33
     - Linkage/Mechanism 34
   - Computer-Aided Manufacturing 34
     - Manufacturing Process Simulation 34
     - Other Manufacturing Applications 36

Table of Contents (Continued)

Page

Other Tools 37
Product Data Management 37
Component Information Systems 38
Application Development Environments 39
Knowledge-Based Engineering 40

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List of Figures

Figure		Page
2-1	1997 Software Revenue by Distribution Channel, Mechanical	7
2-2	Mechanical Subapplications	9
3-1	Historical Software Performance by Vendor	13
3-2	1997 Market Share, Software and Software Services Combined	14
3-3	1997 Mechanical Market Share by Industry	16
3-4	UNIX Mechanical Hardware Vendor Performance	17
4-1	Mechanical Applications Software Forecast by Region	19
4-2	Mechanical Applications Software Forecast by Operating System	20
5-1	Mechanical Subapplications	30
5-2	1997 Design Applications Market Share	31
5-3	1997 Drafting and Documentation Market Share	32
5-4	1997 Analysis Market Share	34
5-5	1997 Numerical Control Market Share	35
5-6	1997 Product Data Management Market Share	38

List of Tables

Table		Page
3-1	Mechanical Market Performance by Region	14
3-2	1997 Mechanical CAD/CAM/CAE Market Leaders by Channel	15
5-1	Mechanical Subapplications—Market Size and Forecast	31

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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 our ongoing research into mechanical CAD/CAM/CAE.

Key Findings and Highlights

The following are key findings and highlights of this report:

- Following two years of high, double-digit growth, the mechanical CAD/CAM/CAE software market hit a low of 6 percent growth in 1997. Vendor performance was all over the board, ranging from over 20 percent software growth to more than 50 percent decline in software sales. While North America showed under 4 percent growth, more robust growth in Europe and Japan is partly because of exchange rate differences and partly because of actual CAD investment.
- User investment is heavily concentrated in the automotive and aerospace industries, as these industries continue to hold over 32 percent of the worldwide mechanical CAD/CAM/CAE software market.
- The markets to which CAD caters are quite mature, leaving little opportunity for real vendor growth. Market share is to be gained only by consolidation, niche market specialization, or a fundamental change in the way CAD technology is used. Given the consolidation that occurred in 1997, we expect the big companies to be part of a fierce competitive environment over the next few years.
- The midrange market continues to take shape, attracting users migrating from 2-D to 3-D as well as making headway into extending the enterprise.
- Similar to what we saw last year, the promise of objects and object-oriented technology in CAD continues to be just that: a promise. 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.
- Virtual prototyping is becoming a reality, where it can enhance, but not replace, current design methodologies and physical prototypes. Eventually, virtual prototyping will be able to do everything that physical mockups can do. But, it will take some time for all of the tools to be developed and for the technology to win over the confidence of the engineers and designers.
- What was called concurrent engineering in the 1980s evolved to collaborative engineering in the 1990s and has now evolved into "engineering modeling for the enterprise," or EEM. The *enterprise* is key to this market—design information can no longer stay behind the engineering walls. This will be an interesting area to watch evolve.

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- While design and drafting applications are still the mainstay of the mechanical CAD/CAM/CAE market, we expect to see healthy growth in the more nontraditional areas such as linkage/mechanism, off-line robotics, and component information systems.

Dataquest Perspective

After enjoying two years of high, double-digit growth, the mechanical applications market is facing market maturity. Recent consolidations in the market will make it tough for new vendors to topple the big players. We expect a fierce competitive environment to dominate the landscape over the next few years, while smaller players look to niche markets for growth. Nevertheless, mechanical CAD/CAM/CAE technology has proved its value to discrete manufacturing companies, and there are many technological advances that are setting the stage for future growth.

Report Description

We have divided this report into four major sections. Chapter 2 includes an explanation of the market research methodology used in this report. Our 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 sub-applications in greater detail.

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Chapter 2
Market Research Methodology and Market Definitions

In this chapter, we briefly discuss Dataquest's CAD market research methodology and data collection methods. We also provide definitions for the various metrics and market segments that apply to mechanical CAD/CAM/CAE.

Data Collection Process

Fundamental to the way Dataquest conducts its 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, and balance between the perspectives of industry professionals and market researchers.

Supply-Side Data

Dataquest surveys all major participants in the mechanical CAD/CAM/CAE market two times each year, in order to obtain preliminary and final market share data for a given year. At the time of surveying, each vendor is given the opportunity to self-report the information required. The information in this document is based on final market share data for 1997.

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, which helps us to cross-check data on that company. Examples of job titles of people contacted for information include:

- 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 applications
- Market research analyst
- Product manager

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

- Revenue published by major industry participants
- Government or trade association data
- Annual reports, Securities 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

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. At least one major end-user survey is conducted each calendar year, and a number of informal surveys are conducted throughout the year.

We believe 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 in-depth market picture, which is particularly useful when comparing regions or applications.

Additionally, in the case that we learn more information about a company, we will restate the market size and market share information for all vendors, based on this new information. This change may affect *any* year within our database, depending on what new information is discovered. As a result, our database gives us the most accurate depiction of the market based on what we know at any given point in time.

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

The following regional hierarchy and definitions are used for Dataquest's geographic segmentation. Not all product categories and Dataquest services have the entire segmentation. Some may have a greater level and some may have less. The regions are as follows:

- North America region
  - United States: Includes the 48 contiguous states, Washington, D.C., Alaska, Hawaii, and Puerto Rico
  - Canada: Single-country region
- Latin America region: Countries covered include Argentina, Brazil, Chile, Colombia, Mexico, Peru, and Venezuela
  - Rest of Latin America: Anguilla, Antigua and Barbuda, Aruba, Bahamas, Barbados, Belize, Bermuda, Bolivia, Cayman Islands, Clipperton Island, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Falkland Islands (Islas Malvinas),

French Guiana, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Montserrat, Navassa Island, Netherlands Antilles, Nicaragua, Panama, Paraguay, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Tortola (British Virgin Islands), Trinidad and Tobago, Turks and Caicos Islands, Uruguay, and Virgin Islands (St. John, St. Croix, and St. Thomas)

- Europe region
  - Western Europe: Countries covered include Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and United Kingdom
  - Rest of Western Europe: Andorra, Cyprus, Faroe Islands, Gibraltar, Greenland, Guernsey, Iceland, Isle of Man, Jersey, Liechtenstein, Luxembourg, Malta, Monaco, San Marino, and Svalbard
  - Central and Eastern Europe: Belarus, Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Russia, Slovakia, and Ukraine
  - Rest of Eastern Europe: Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Croatia, Georgia, Kazakhstan, Kyrgyzstan, Macedonia, Moldova, Romania, Slovenia, Tajikistan, Turkmenistan, Uzbekistan, and Yugoslavia (Serbia and Montenegro)
- Japan: Single-country region
- Asia/Pacific: Countries covered include Australia, China, Hong Kong, India, Indonesia, South Korea, Malaysia, Singapore, Taiwan, and Thailand
  - Rest of Asia/Pacific: American Samoa, Ashmore and Cartier Islands, Baker Island, Bangladesh, Bhutan, Bouvet Island, Brunei, Cambodia, Christmas Island, Cocos (Keeling) Islands, Cook Islands, Coral Sea Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Howland Island, Jarvis Island, Johnston Atoll, Kingman Reef, Kiribati, Laos, Macau, Maldives, Marshall Islands, Midway Islands, Mongolia, Myanmar (Burma), Nauru, Nepal, New Caledonia, New Zealand, Niue, Norfolk Island, Northern Mariana Islands, North Korea, Pakistan, Palau, Palmyra Atoll, Papua New Guinea, Paracel Islands, Philippines, Pitcairn Islands, Solomon Islands, Spratly Islands, Sri Lanka, Tokelau, Tonga, Tuvalu, Vanuatu, Vietnam, Wake Island, Wallis and Futuna, and Western Samoa
- Rest of World: Afghanistan, Algeria, Angola, Bahrain, Bassas da India, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Cote d'Ivoire, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Europa Island, Gabon, Gambia, Ghana, Glorioso Islands, Guinea, Guinea-Bissau, Iran, Iraq, Israel, Jordan, Juan de Nova Island, Kenya, Kuwait, Lebanon, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mayotte, Morocco, Mozambique, Namibia, Niger, Nigeria, Oman, Qatar, Reunion, Rwanda, Saint Helena, Sao Tome and Principe, Saudi Arabia, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Syria, Tanzania, Togo, Tromelin Island, Tunisia, Turkey, Uganda, United Arab Emirates, Western Sahara, Yemen, Zaire, Zambia, and Zimbabwe

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

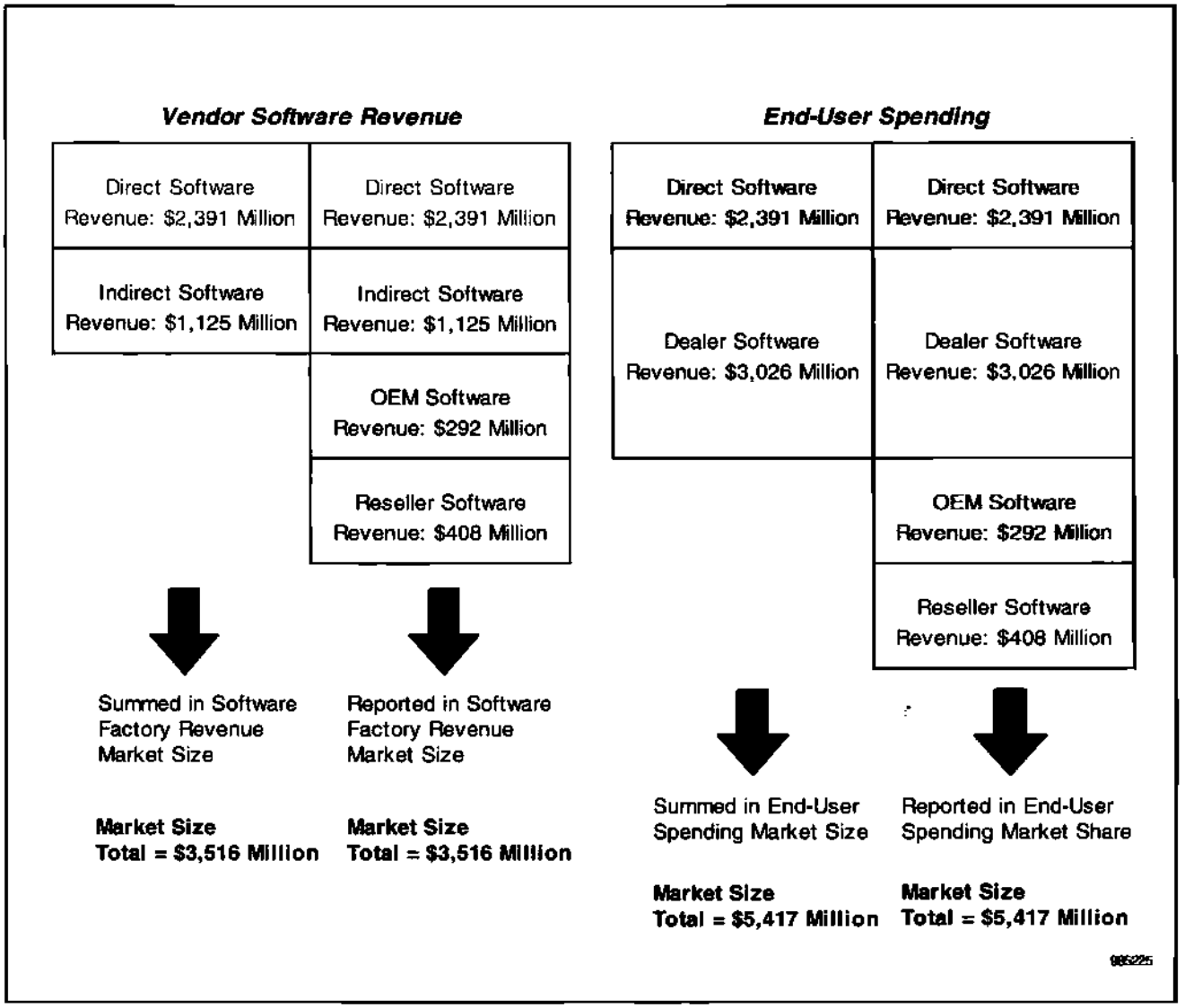
The CAD/CAM/CAE software industries make extensive use of complex distribution channels throughout the world. Our data architecture accurately reflects revenue flow from the CAD software vendor to the end user. Specifically, our database allows us to report software revenue as it accrues in the following 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 we account for all these elements in the mechanical applications market while not counting revenue twice. To calculate company software revenue for a named company, we add the sum of the 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, by region, and by operating system.

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Figure 2-1
1997 Software Revenue by Distribution Channel, Mechanical



Source: Dataquest (September 1998)

Mechanical Subapplications

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

Computer-Aided Design—CAD

CAD subapplications include the following:

- Design applications—Software applications used in the design of components and assemblies. This is a very broad subapplication that includes software for styling, conceptual design, 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. Also includes schematics and technical illustration.

Computer-Aided Engineering—CAE

CAE subapplications include the following:

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

Computer-Aided Manufacturing—CAM

CAM subapplications include the following:

- 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 processes or steps. Part processing design typically involves part processing application software, as well as a library of machines, schedules, materials, and manufacturing practices.
- Other manufacturing applications
  - Coordinate measuring machines—Software used to program machines to measure the physical dimensions of a part
  - Off-line robotics—A process simulation that graphically represents the sequence of steps that a robot goes through for a particular operation and downloads data to a robot to update its control program

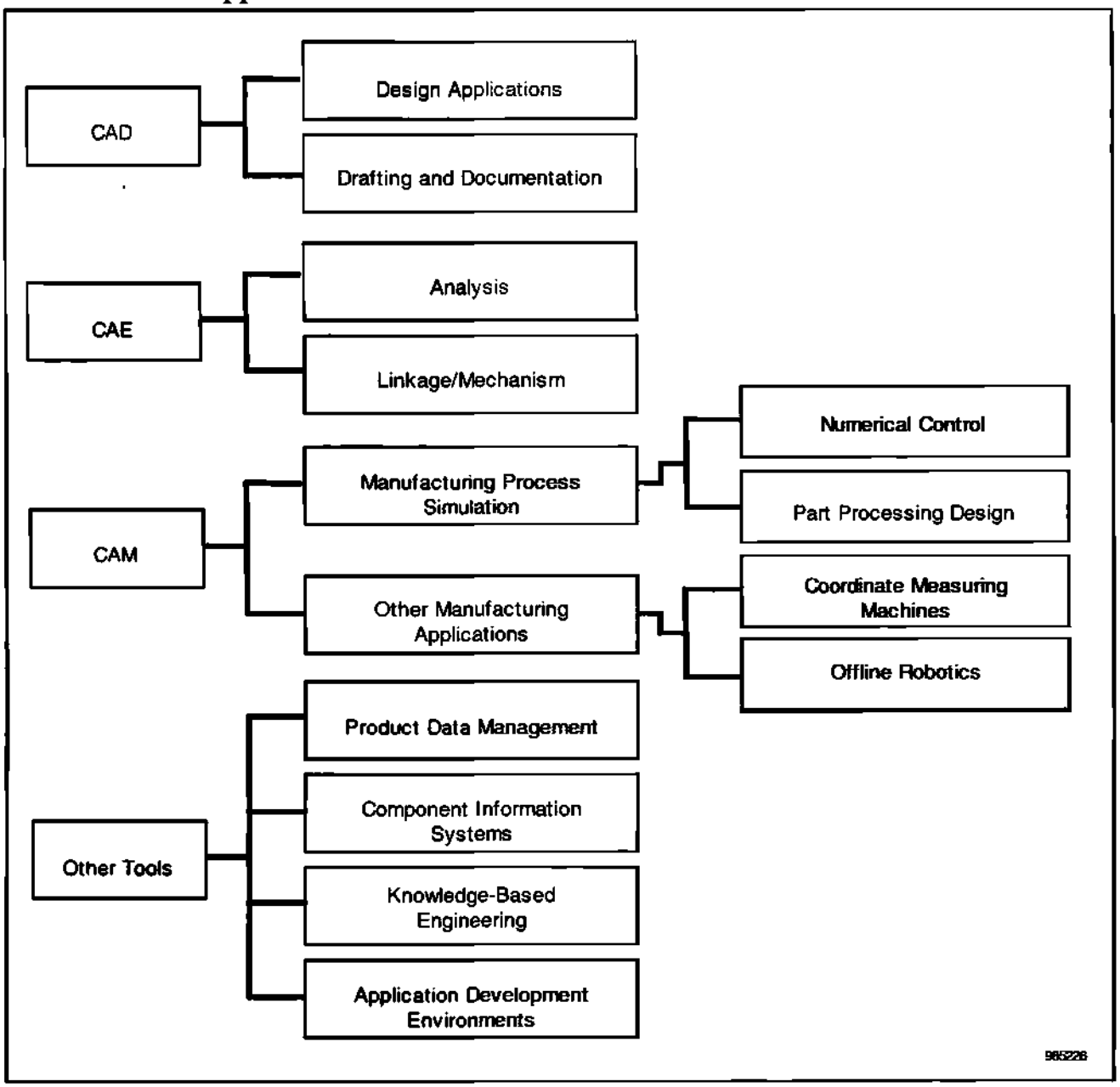
Other Tools

This category includes the following:

- Knowledge-based engineering (KBE)—The capturing of design intent and standard practices for controlling, modifying, and automating design and manufacturing activities
- Application development environments—Programming tools to aid in the generation of user-defined programs that drive or interface with CAD/CAM/CAE applications
- Product data management—Management of data within an engineering or manufacturing environment. Product data management typically includes tools to manage product structures, workflow and work processes, and CAD/engineering data, files, and documents.
- Component information systems—Software used to navigate within and manage a repository of engineering parts and associated data

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Figure 2-2
Mechanical Subapplications



Source: Dataquest (September 1998)

Chapter 3
The Mechanical CAD/CAM/CAE Market Today

In this chapter, we provide a mostly quantitative assessment of the mechanical applications market performance in 1997. Overall growth of slightly under 6 percent in software revenue for 1997 masks some of the real market dynamics occurring in this market. In this chapter, we look at some of these differences.

Performance of the Market Leaders

Following two years of high, double-digit growth, the mechanical CAD/CAM/CAE software market hit a low of 6 percent growth in 1997. Vendor performance was all over the board, ranging from over 20 percent software growth to below 50 percent decline in software sales. The top 10 vendors, as a group, seemed to have slowed down in taking market share at the expense of everyone else. This group, as a whole, accounted for 73 percent of the $3,510 million in revenue in 1997, about the same percentage as in 1996. However, readers should note two of the contributing factors to the somewhat sluggish mechanical market performance in 1997: Computervision's downfall and Unigraphics Solutions' General Motors contract, for which the bulk of the revenue (more than $100 million) was taken in 1996, thus causing significant hiccups in the company's revenue stream and somewhat smaller repercussions for overall mechanical applications market growth.

Parametric Technology's bid for the No. 1 spot in mechanical CAD/CAM/CAE may finally be over. Figure 3-1 shows software revenue for the top 10 vendors over the past three years. While we still show IBM to be the market leader for 1997, this will change next year when we restate Parametric Technology's historical revenue to include its Computervision acquisition, which is *not* included in the data shown in Figure 3-1 (this was because the deal was officially closed in calendar year 1998).

Similarly, Unigraphics Solutions' ranking will also inch up, once we include its acquisition of Intergraph's mechanical CAD business (we will report the combined Unigraphics Solutions/Intergraph entity next year, since the deal was officially closed in calendar year 1998). It is also worth noting that the drop in Unigraphics Solutions software revenue from 1996 to 1997 is somewhat of an anomaly: The company reported that it took most of the revenue from its General Motors contract in 1996 ($121 million in software revenue) and none of it in 1997.

Dassault Systemes/IBM continues to buck the trend, posting good growth in 1997, despite the fact that the company has not yet ported its flagship CATIA product to the NT platform (though Dassault Systemes receives credit for NT revenue from its SolidWorks subsidiary). The results of Autodesk's vertical market strategy are evident in the mechanical CAD space. Negative growth in 1996 has turned into high, positive growth in 1997, from sales of both Mechanical Desktop and base AutoCAD. Structural Dynamics (SDRC) has also been in a turnaround mode, now posting two years of decent growth in software revenue, driven not so much by sales of its Metaphase product data management software, but more by

sales of its core I-DEAS software. MicroCADAM's essentially flat growth is a reflection of the effect of exchange rates on market growth. MicroCADAM derives the bulk of its revenue from sales in Japan, where the exchange rate of the yen against the dollar is masking real, significant growth in the country in yen terms. CoCreate, MacNeal-Schwendler, and Information Services International Dentsu (largely a Japanese reseller) round out the top 10, as shown in Figure 3-1.

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 1997 market share by vendor for software and software services combined. Some shuffling by rank occurs, with Parametric Technology (PTC) taking the top spot, and SDRC moving up to number three. Of particular interest is the growth of service revenue compared to software revenue. While software revenue grew less than 6 percent in 1997, software service grew 16 percent. Growing service revenue usually means one of two things: a market in its infancy, or a mature market with a fairly saturated user base. The latter description certainly fits the mechanical CAD/CAM/CAE market.

Regional Differences

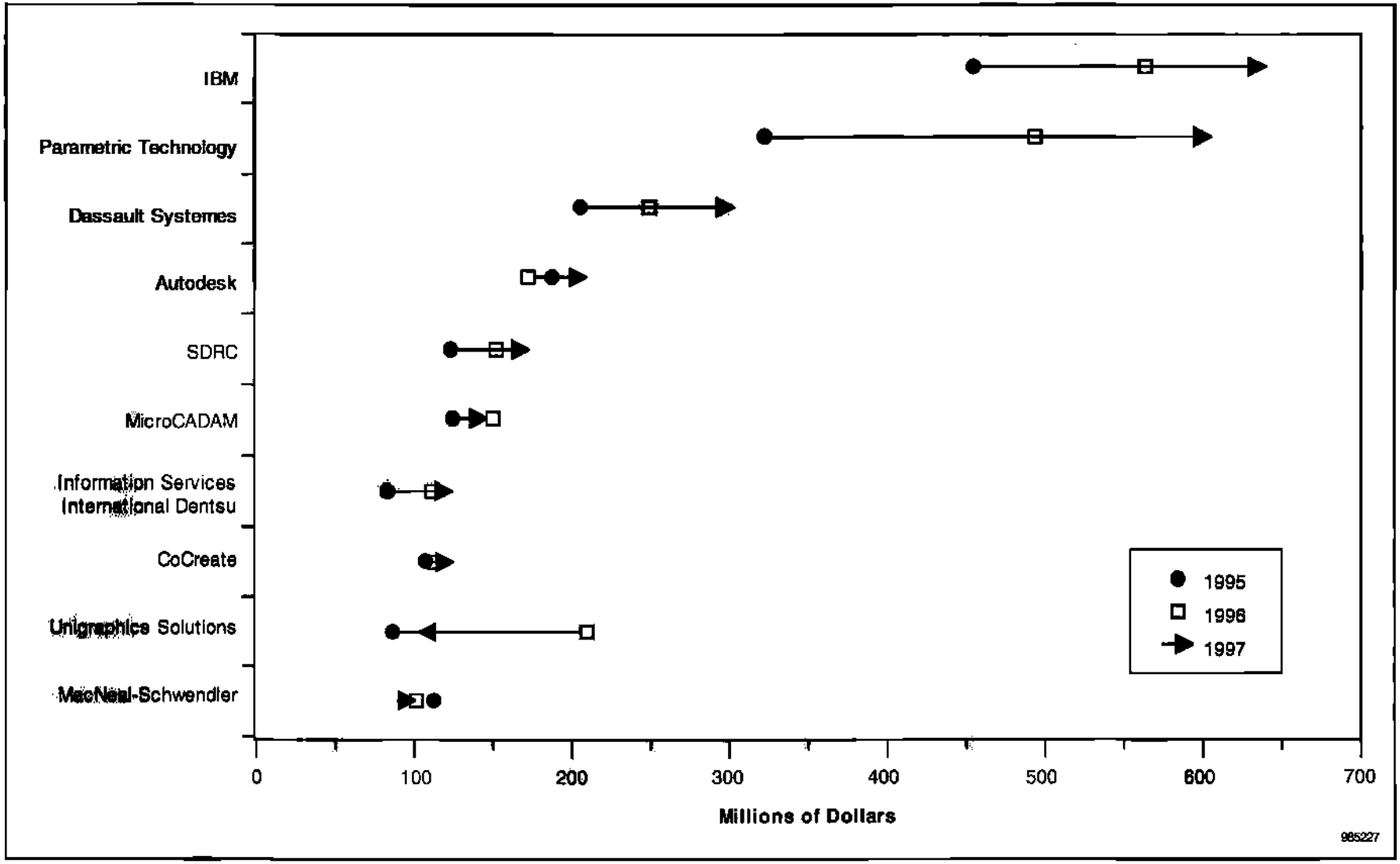
North America, Europe, and Japan are nearly equal in size; all three regions make up about 30 percent of the market. While the worldwide growth rate for mechanical CAD/CAM/CAE applications was only 6 percent, regional growth varied widely (see Table 3-1). Growth in Europe and Japan is partly because of exchange rate differences and partly because of actual CAD investment. The Japanese market grew only 10 percent when measured in U.S. dollars, but because of the yen depreciation against the dollar, it grew a whopping 23 percent in yen terms. Similarly, Europe grew only 2 percent when measured in U.S. dollars but grew 14 percent in ECU terms. In both regions, we expect growth to slow down over the next few years, because Europe has finished its latest CAD investment cycle, and economic turmoil in Japan will stall CAD purchases.

Channel Differences

As we 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 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.

Understanding revenue by channel is key to resolving market positioning statements made by many of the leading CAD vendors. Table 3-2 outlines the market position in software for the leading mechanical CAD/CAM/CAE companies according to these channel metrics.

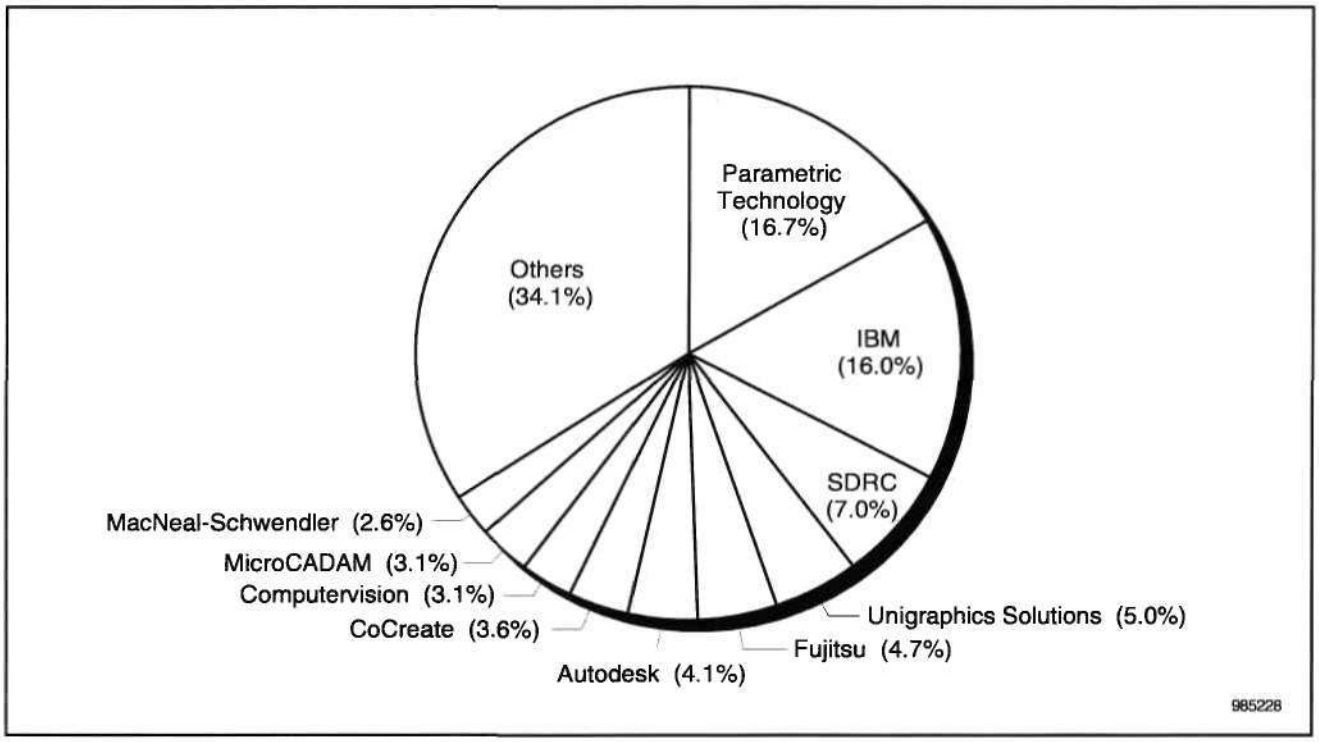
Figure 3-1
Historical Software Performance by Vendor



Note: Parametric Technology does not include Computervision revenue; Unigraphics Solutions does not include Intergraph revenue.
Source: Dataquest (September 1998)

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Figure 3-2
1997 Market Share, Software and Software Services Combined



Source: Dataquest (September 1998)

Table 3-1
Mechanical Market Performance by Region

Region	Software Revenue ($M) 1997	Growth in U.S. Dollars (%)	Growth in Regional Currency (%) 1996-1997
Japan	1,122	10.1	22.5
Europe	1,106	2.0	13.7
North America	1,033	3.6	NA
Asia/Pacific	212	10.9	NA
Rest of World	39	10.0	NA
Worldwide	**3,512**	**5.6**	**NA**

NA = Not applicable
Note: Regional currency is yen in Japan and ECU in Europe.
Source: Dataquest (September 1998)

While IBM and PTC (before Computervision's revenue is included) differ by about $40 million in software revenue accrued to the parent company in 1997, they are virtually tied for the No. 1 spot once end-user spending is considered. Also, both companies lose quite a bit of market share in the end-user spending scenario. Who gains? Autodesk, which almost exclusively relies on the indirect channel, jumps up to the No. 3 spot and gains a bit more market share in the process.

As the mechanical applications market evolves, the indirect and dealer channels will become more important in the future, particularly with the emergence of the so-called "midrange" market. Indirect software revenue, for all companies, grew slightly faster than direct software revenue in 1997 (5 percent versus 7 percent, respectively).

Growth by Industry

User investment is heavily concentrated in the automotive and aerospace industries, because these industries continue to hold over 32 percent of the worldwide mechanical CAD/CAM/CAE software market (see Figure 3-3), a figure that has remained steady over the last five years. Particularly in Europe, the automotive companies continued to place some large orders for CAD tools in 1997 (and some of these contracts are multi-year agreements, with revenue spread out over the agreement period), but the bulk of the automotive/aerospace cyclical investments in Europe are over for the next three years. After that time, we will begin to see an upswing in investment in these industries.

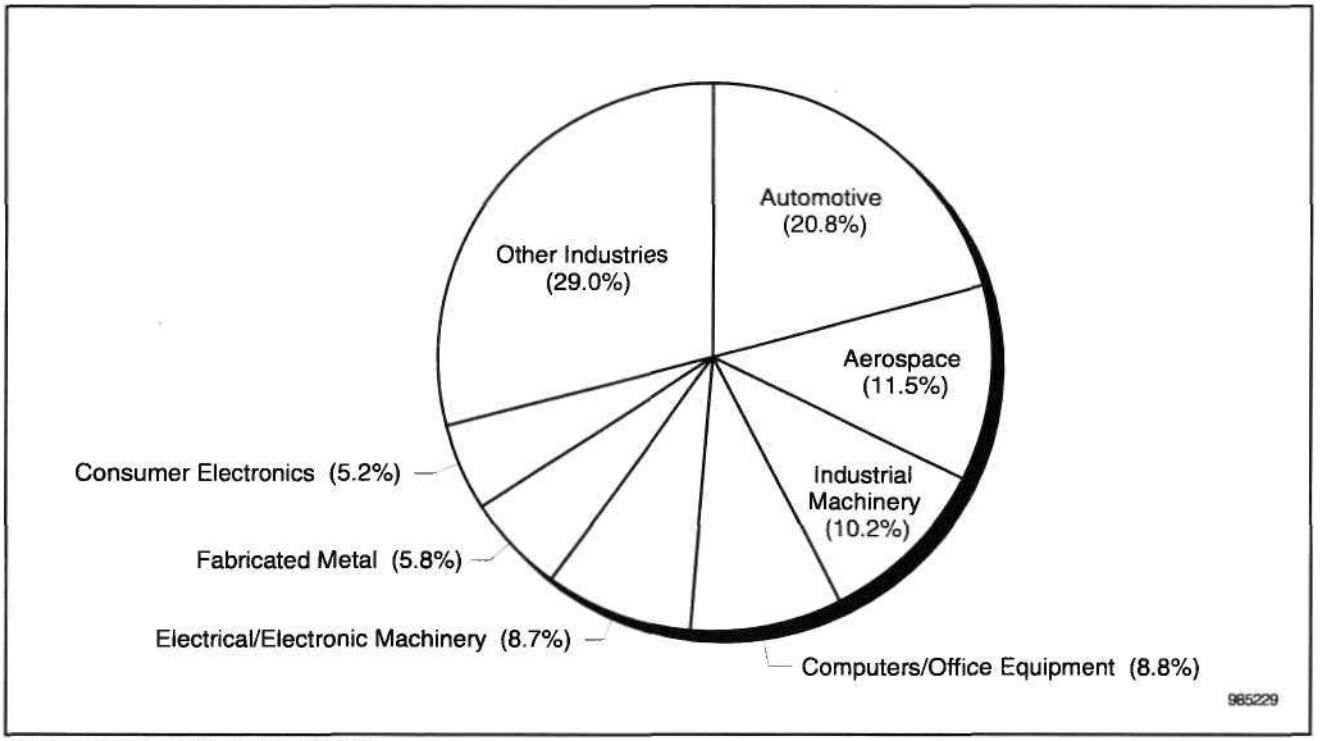
It is worth noting that users in the shipbuilding industry buy both mechanical and AEC (architecture/engineering/construction) software for similar design problems. While $39 million in mechanical software was sold to the shipbuilding industry in 1997, $72 million of AEC software was also sold. As a result, the shipbuilding opportunity is quite a bit larger, $112 million, keeping in mind that a significant portion of the revenue is generated by software normally sold by AEC vendors.

Table 3-2
1997 Mechanical CAD/CAM/CAE Market Leaders by Channel
(Revenue in Millions of Dollars)

	Direct Software Revenue	Indirect Software Revenue	OEM Software Revenue	Reseller Software Revenue	Company Software Revenue	Dealer Software Revenue	User Software Spending
IBM	567	NA	NA	75	642	NA	642
Parametric Technology	575	30	NA	NA	606	66	642
Autodesk	22	183	2	NA	206	397	421
Dassault Systemes	46	NA	258	NA	304	NA	304
SDRC	90	82	NA	NA	172	175	265
MicroCADAM	8	143	NA	NA	150	209	217
CoCreate	25	100	NA	NA	126	140	166
Fujitsu	76	27	NA	NA	103	81	157
Unigraphics Solutions	77	39	NA	NA	115	78	154
Hitachi	24	44	NA	NA	68	124	147
Matra Datavision	68	22	NA	NA	91	53	121
MacNeal-Schwendler	91	13	NA	NA	104	30	120
All Companies	**2,391**	**1,125**	**292**	**408**	**3,510**	**3,026**	**5,417**

NA = Not applicable
Source: Dataquest (September 1998)

Figure 3-3
1997 Mechanical Market Share by Industry



Source: Dataquest (September 1998)

The Hardware Playing Field

No analysis of the mechanical CAD/CAM/CAE market is complete without an understanding of 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 two bigger UNIX players, Hewlett-Packard and Sun Microsystems, continue to battle it out for market leadership and growth leadership. UNIX hardware vendor performance for 1997, from both a CPU revenue perspective and shipment perspective, is shown in Figure 3-4.

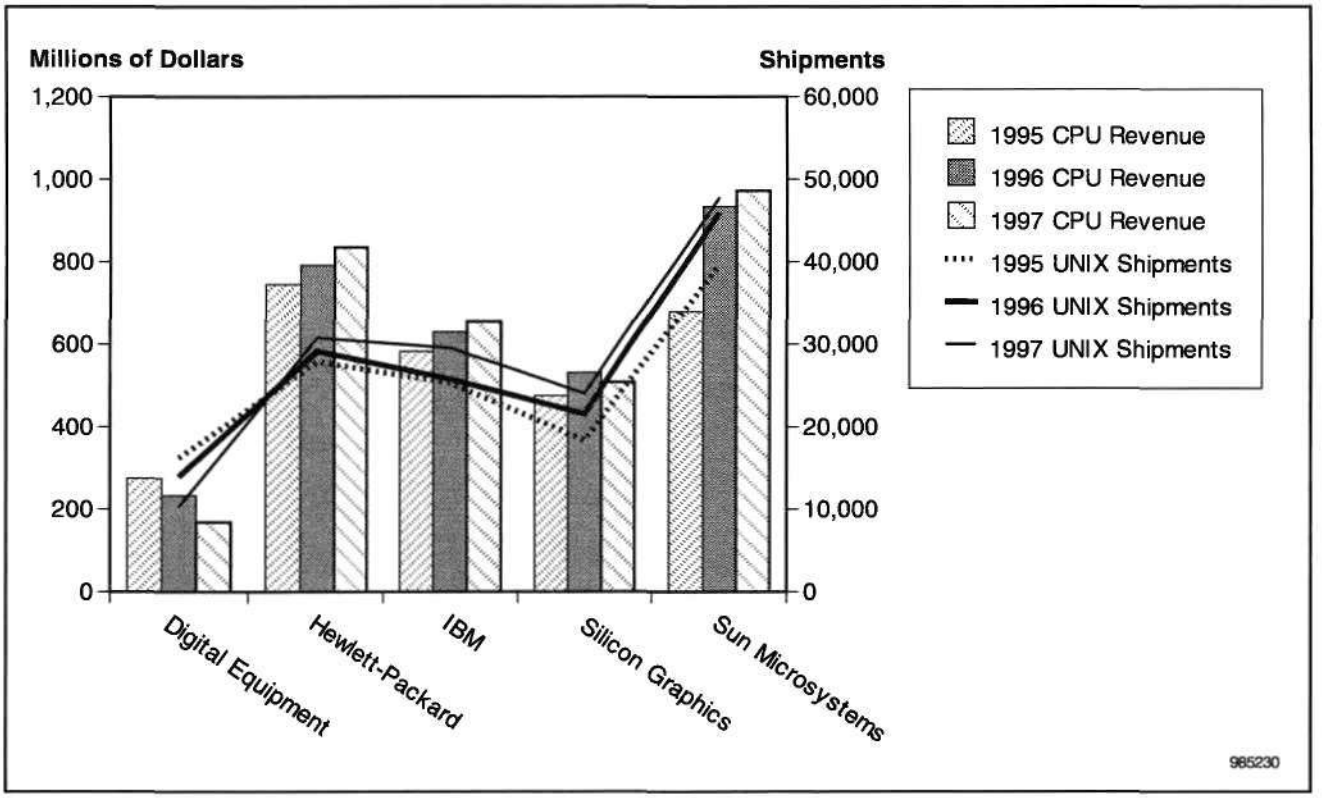
What is happening on the hardware front is key to the overall performance of the mechanical applications market over the next five years. The following information is taken from Dataquest's Advanced Desktops and Workstations service. For a full analysis of the technical workstation market, please see the report titled *Windows NT Sets the Pace as UNIX Continues to Slide* (WKST-WW-MT-9801).

In 1997, the introduction of second-generation Pentium II-based personal workstations from market leaders Hewlett-Packard, Digital Equipment, Compaq, and Intergraph combined with second-generation graphics systems set a new and significantly lower price/performance level for the industry, forcing RISC/UNIX vendors to reposition systems and faster, more expensive technologies at increasingly lower price points.

The trend is set inexorably toward the market being dominated by Intel architecture (IA)/NT systems. Although Dataquest expects the UNIX workstation market to experience a steady decline, it will still remain viable for several more years. Dataquest expects a reasonable demand for UNIX workstations until the second generation of IA-64 processor-based systems start shipping sometime around 2001 to 2002.

For the era when RISC/UNIX workstations dominated the market, an individual vendor's technological superiority was assumed to be the key to success in the workstation market, and the influence of sales and marketing was sometimes dangerously underestimated. The advent of Intel/Microsoft-based workstations has greatly diminished the potential for technology-based product differentiation and removed the "vendor lock-in" factor caused by proprietary implementations of the UNIX operating system. While Dataquest expects technological innovation to remain important in the workstation market and to play an increasingly influential role in the Intel/Microsoft workstation space in the future, for the next few years the winners and losers will be identified by their sales and marketing expertise and execution far more than any other single factor.

Figure 3-4
UNIX Mechanical Hardware Vendor Performance



Source: Dataquest (September 1998)

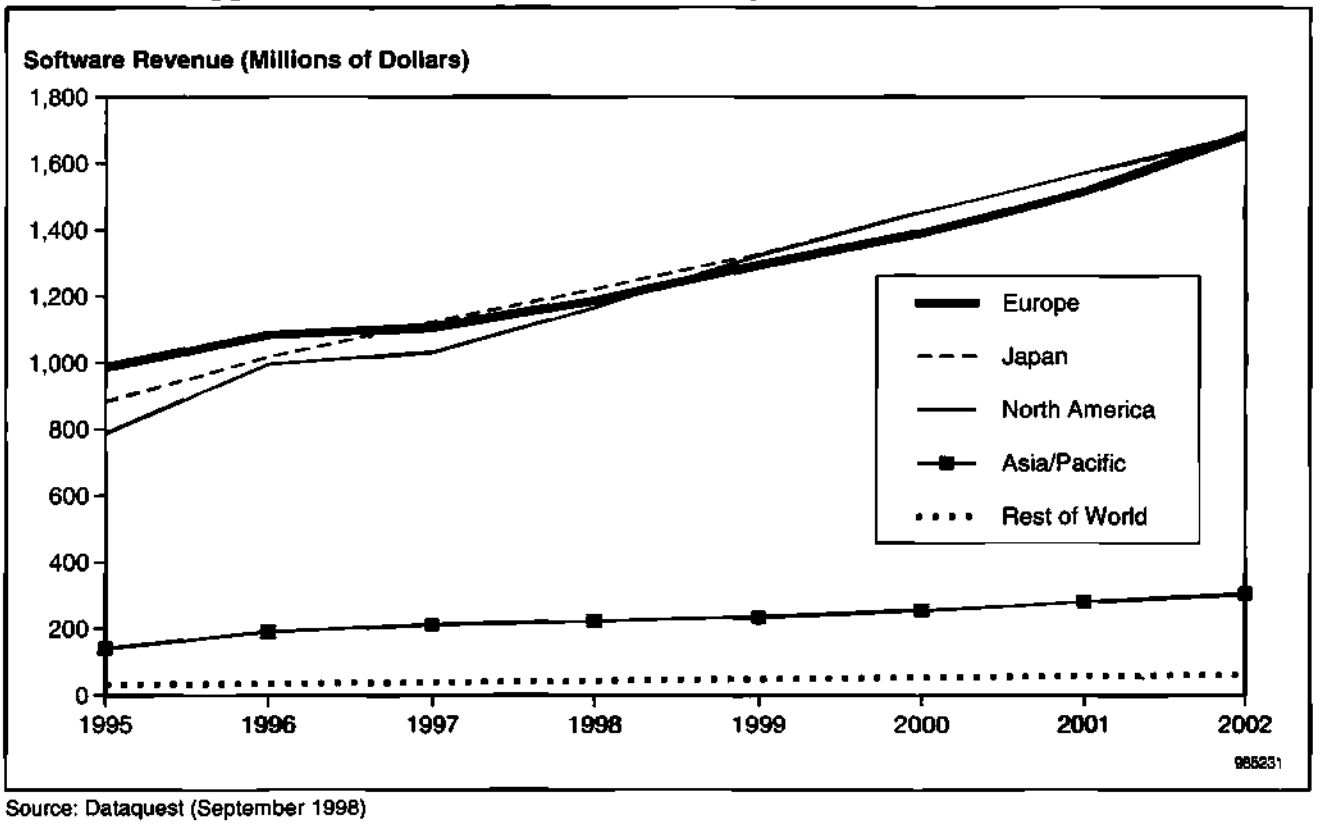
Chapter 4
Market Drivers

In this chapter, we discuss the trends that will most influence the mechanical CAD/CAM/CAE landscape over the next five years. While the market is indeed slowing down, many opportunities for vendors still exist—with certain emerging technologies, and in specific market segments. The trends we have identified in the following paragraphs give a flavor of what the mechanical applications market will resemble. As a point of reference, Figures 4-1 and 4-2 give our forecast for the mechanical applications market by region and by operating system.

The Market Leaders Tomorrow

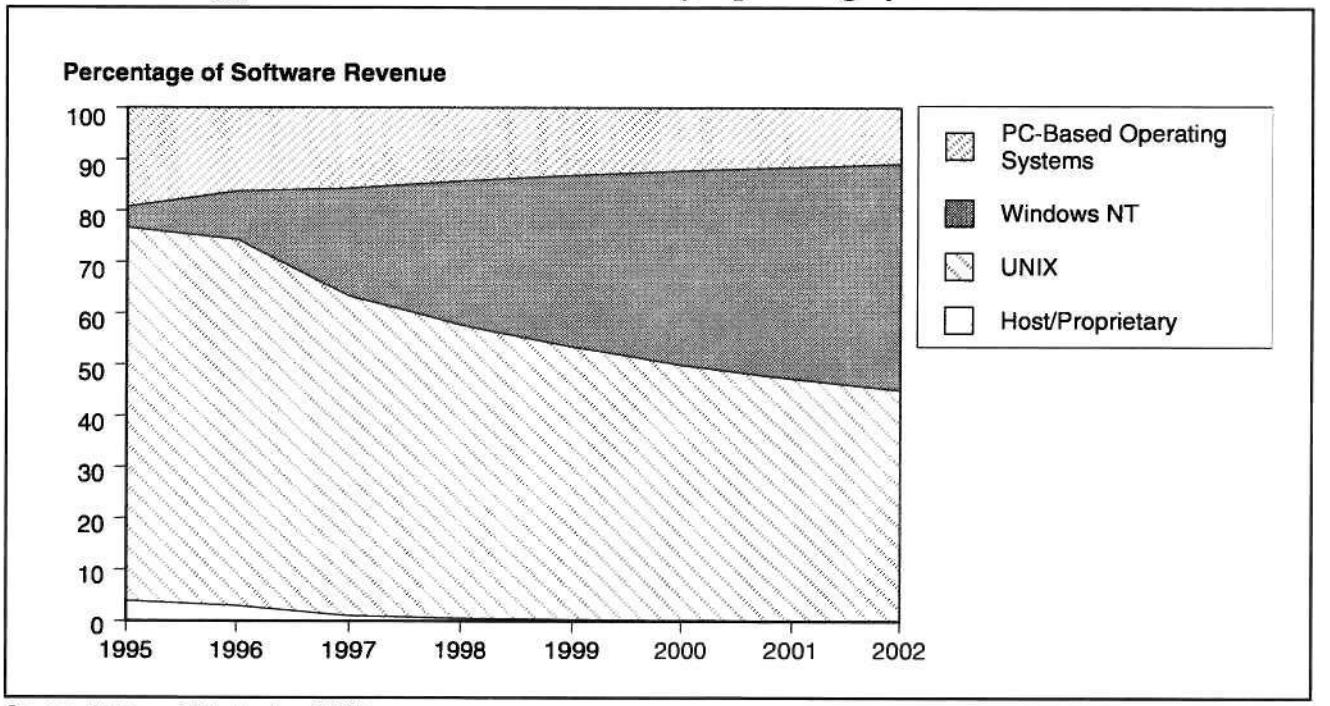
Today, CAD software is so engrained in engineering design that it is virtually impossible to develop any products without the assistance of computer-aided design tools. However, the markets that CAD caters to are quite mature, leaving little opportunity for real vendor growth. Market share is to be gained only by consolidation, niche market specialization, or a fundamental change in the way CAD technology is used.

Figure 4-1
Mechanical Applications Software Forecast by Region



Source: Dataquest (September 1998)

Figure 4-2
Mechanical Applications Software Forecast by Operating System



Source: Dataquest (September 1998)

Market consolidation is already evident. Over the past year or so, we saw PTC's purchase of Computervision and ICEM Technologies; Dassault Systemes' acquisition of SolidWorks, Deneb Robotics, and the ENOVIA PDM technology; Autodesk's acquisition of Genius; Spatial Technologies' acquisition of Three-Space Limited; and Engineering Animation's purchase of Variation Systems Analysis and Transom Technologies. In each of these cases, the acquired companies rounded out product line gaps in the parent company (with the exception of the Computervision acquisition, which we believe was more of an attempt by PTC to get a stronger foothold in the automotive and aerospace industries).

Still, other companies streamlined their operations, looking to become more niche players. Here, Concentra licensed its core ICAD technology to another company, and Adra Systems renamed itself MatrixOne and sold off its CAD business to become exclusively a PDM player.

In light of all the reshuffling, we saw higher service revenue, a definite sign of a mature market. So, where does this leave the market leaders today; who will become leaders in the future?

If CAD/CAM/CAE systems continue to be developed, marketed, and sold as they are currently done so today, we don't see any companies that are in a position to overtake one of the entrenched leaders in the market today without acquisition. The smaller, rising stars have all been absorbed by the bigger players. There are no highly innovative modeling technologies that will catapult one of the smaller players into the limelight. Nor are there any earth-shattering technology/marketing/sales partnerships that will suddenly bring a vendor into the top 10. However, if any one of these

companies earnestly focuses outside of the traditional CAD/CAM/CAE technology, embracing some of the technologies we describe at the end of this chapter, there will be new rising stars, and renewed market vigor.

Emergence of the Midrange

There is no shortage of "midrange" mechanical design packages on the market today: DesignWave, Mechanical Desktop, MicroStation Modeler, Solid Edge, the Artisan Series, and SolidWorks, to name a few. In this section, we identify the issues facing the midrange market.

Understanding the Two Tiers

What has clearly been developing in the midrange is a 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:

- Do not have budgets for more expensive UNIX-based CAD systems
- Do not have a lot of investment in historical, legacy data that would make switching CAD systems something to be avoided
- Have limited needs in analysis 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, comprises the following:

- Do not have 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 that we mentioned earlier, some fit more naturally in the first tier than in the second tier. In particular, Parametric Technology, SDRC, and Unigraphics Solutions 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, and Solid-

Works (now part of Dassault Systemes) sell midrange products today almost exclusively through the indirect channel and typically in smaller seat count deals.

One of the more interesting repricing/repackaging issues this year has been PTC's repackaging of Pro/ENGINEER, effectively offering it at a slightly lower price point, while hoping to make up the revenue difference through increased seat sales. So far, this repricing seems to be an anomaly in an otherwise price-steady market.

Indirect Channels; 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 (as 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.

One thing is clear on the channel front: vendors playing in both the UNIX-based high-end and the midrange markets will need to define clearly who can sell what. Alienating the VARs at the expense of the direct salesforce (or vice versa) is a risky proposition.

Prognosis for Europe

Over the last three years (1995 through 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 sectors will begin to slow down in 1998 and through 2000. We expect the machinery industry to pick up growth by investing in mainly NT-based solutions.

Particularly for Europe, Dataquest does not expect NT to play a significant role in the mechanical applications market until 1998 or 1999. Even then, growth for NT-based solutions will not come from the traditional users in automotive and aerospace, but instead from other industry sectors made up by small to medium-size companies. In the major industries, NT adoption will result in a mixture of NT and UNIX-based systems at these companies.

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 output. It is no surprise that Germany is among the largest buyers of mechanical applications software in Europe. Any change in the German manufacturing industry has a direct impact on mechanical CAD/CAM/CAE European market growth.

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Generally speaking, CAD investment in Europe is typically part of a global corporate strategy. This means that when orders are placed in Europe, 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 automotive and aerospace, they are five to 10 years long. Because most of the large companies in these key industries have made their CAD renewal investments, Dataquest does not expect the mechanical applications market to continue to grow at its 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.

Economic Turmoil in Asia/Pacific and Japan

Just last year, we were expecting the Asia/Pacific region to grow faster than any other region of the world over the next five years. A mixture of local government, multinational companies, and industry initiatives was driving mechanical applications software growth in this region. However, times have changed, and we have had to adjust our forecast for these regions, in light of the economic turmoil in the area. In essence, we are expecting lower growth for both Asia/Pacific and Japan over the next few years, with growth picking up toward the end of our forecast period.

This does not mean that there is a lack of opportunity in Asia/Pacific and Japan. Instead, the same fundamental needs for CAD/CAM/CAE software still exist, such as the following:

- Throughout Japan and Asia/Pacific, if CAD is used at all, designs still tend to be done in 2-D, with the paper drawing being the key. There exists a large number of 2-D users that can be migrated to 3-D design methodologies.
- Particularly in southeast Asia, mechanical designers are not as advanced in their use of CAD as are their counterparts worldwide, nor have they had as much experience with CAD systems. Training will be an important factor in these users' successes with the technology.
- 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.
- Many Asia/Pacific 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.
- For Japan, a well-integrated CAD/CAM system is key to penetrating this market. Japanese engineers have always had a very strong focus on CAM, using elaborate manufacturing systems while still doing design work in 2-D.
- The concept of design teams is very strong in Japan and Asia/Pacific, where collaboration tends to be more the norm than, say, in the United States. Products with a collaborative focus might be more accepted than products focused on individual productivity.

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System-Level Design

Since we wrote about system-level design automation (SDA) one year ago, not a lot has happened. We have been talking about system-level design for the past few years, but we are still waiting for the tools and design methodologies to come to market. Much of the SDA work today remains project oriented, though these programs are funding some new tool development. Two well-known SDA programs are the Ford C3P program (also known as the Ford 2000 program) and the European AIT consortium; a well-known "precursor" to SDA (before the term SDA was coined) 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 a mechanical systems language by 2006 (and an electrical systems language by 2002).

Much of the impetus for system-level design is coming from the automotive and aerospace manufacturers themselves—witness many automotive manufacturers' proclamations of getting automotive design time down to 18 months. This goal is not possible with today's existing CAD/CAM/CAE tools. System-level design is an attempt to bring together several processes into an environment, where a digital version of the product is created, integrated, and tested before it even reaches the manufacturing floor. In order for it to happen, users need better knowledge-based engineering tools, better data management, and system-level (not point tool) integration.

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 architecture/engineering/construction (AEC) and more slowly in mechanical CAD/CAM/CAE. The discussion that follows is largely based on a Dataquest Perspective sent to our worldwide AEC CAD clients titled "Smart Objects in CAD Software: How Far, How Fast?" (CAEC-WW-DP-9708). While the extracted text focuses on CAD in general and was published one year ago, we feel that readers of this report will find the discussion of interest, as talk of objects continues (though concrete, tangible results are nowhere to be seen).

The Confusion about Object Technology

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. For mechanical designers, this would mean that a sheet metal screw knows it shouldn't be used in wood.

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, while the amount of "object orientedness" 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. 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). In addition, there are those applications that actually allow the user to place "smart" objects within their CAD drawings. This is the "object world" that we care about. 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.

Vendor Offerings Still Not Meeting User Needs

The bottom line is that users 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 the ability 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.

Last year we said, "Objects in CAD are not quite here yet, but over the next five years we will see 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." However, we now wonder whether objects will truly ever have their place in the design world. The uptake of objects in CAD would go faster if vendors would focus more on the interoperability of objects and solutions—and interoperability has been bandied about for years, but has only been inching forward painfully slowly.

Role of Java

While we must admit we can't fully predict the impact of Java in mechanical design and manufacturing processes, it is worth noting that vendors are coming at it from different schools of thought. Most notably, Autodesk sees Java as another application programming language (much like Visual Basic or AutoLISP). On the other hand, Bentley Systems sees Java and its Java extensions (specific to engineering and CAD applications) becoming directly embedded within its flagship MicroStation products.

The reality is that some vendors have begun selling "light" applications developed in Java primarily for delivery via the Web (hence, easier access to engineering information throughout the enterprise). Good examples of these applications are product data management products with Java-based front ends, sort of acting as a lightweight client for viewing product data. But, full-blown Java-developed applications for engineering and CAD—where the Web is *not* involved—have not yet hit the market, and we don't know if they will over the next few years.

Virtual Prototyping

Although rapid prototyping and physical mockups may be a reality in engineering today, what has been deemed virtual prototyping has not yet been widely embraced. Engineers have long been building physical prototypes of their designs in order to test those ever-important qualities of fit, form, and function. But product design has become much more than just fit, form, and function—there are time-to-market issues, cost issues, and manufacturing issues, among other things. While CAD/CAM/CAE software has advanced, so too have the expectations of products designed using these tools.

While virtual prototyping can be thought of as analysis, it really takes traditional analysis techniques and combines them with other tools (like solid modeling, visualization, and animation) to answer the same questions that physical prototyping would answer, such as, can I reduce the cost of the design without affecting its performance? By how much will changing this component affect the design specifications? Which design variables can I change without affecting intended product performance? Dataquest believes that the concept of virtual prototyping is just beginning, now that all of the tools are falling into place.

Why is virtual prototyping talked about today, instead of say, five years ago? Whereas design intent used to be conveyed through drawings, it's now being conveyed through CAD models. Whereas engineers used to design parts and then pieced them together to see if the final product worked as intended, they are now designing in a more top-down fashion, starting with system-level requirements, continuing to assembly modeling, and finishing with part design. Electronic CAD models, with all of the design data and knowledge captured right there in the model, have essentially become the enabler for virtual prototyping today.

Of course, we don't believe that designers and engineers today can get away without physical prototypes—virtual prototyping is meant to enhance, not replace, current design methodologies. With real-life

prototypes, the engineer can see *exactly* how it will function in the field. However, this doesn't mean that physical prototyping is all thumbs up. In fact, the drawbacks range from the cost of creating a prototype to the fact that prototypes are like "one shot" deals—if it breaks, that's it. A simulation-gone-wrong on a real prototype can set a project back by weeks, but a simulation gone wrong on a virtual prototype might just require hitting the tweak model-reset-rerun button (of course, we realize that is a bit of a simplification).

With today's tools, both physical and virtual prototyping have their place in design and engineering. Perhaps, further down the , virtual prototyping will be able to do everything that physical mockups can do. But, it will take some time for all of the tools to be developed and for the technology to win over the confidence of the engineers and designers.

Market Evolution: Engineering Modeling for the Enterprise

What was called concurrent engineering in the 1980s evolved to collaborative engineering in the 1990s and has now evolved into EEM. The *enterprise* is key to this market—design information can no longer stay behind the engineering walls. The information can and should be leveraged throughout the organization.

The convergence of several factors we have discussed in this chapter and over the year, for example, the Internet and intranet technology, objects, and system-level design are paving the way for EEM. Over the next five years, we expect vendors and users to begin to talk about leveraging intellectual capital and corporate knowledge, rather than the fairly serial (or more ideally, concurrent) processes of design, analysis, and manufacturing. The enterprise will expand to encompass customers, suppliers, and business partners, collocated or spread out geographically, all of whom will have influence on the engineering process. Two key elements of EEM are discussed in the following section.

Central Repositories for Engineering Information

In order to evolve the fairly stagnant CAD market toward EEM, the CAD data and engineering models can no longer sit in isolation. Product data management systems have tried to get design data in front of the eyes of others in manufacturing and management, but these systems have met limited success so far. A few CAD vendors are trying to push in this direction; time will tell what tweaks need to be made to their initial visions.

One idea is to create central Web sites for engineering projects that would allow everyone involved in a worldwide project to simultaneously access up-to-date project information from a single central location. These sites may offer many types of data, including engineering files, site photographs, reports, project schedules, project specifications, and meeting minutes. Companies can begin wiring their far-flung extended enterprises together, turning a project Web site into an invaluable project design, management, communication, and marketing tool. Of course, not all engineers want 100 pairs of eyes on their work; there has to be a reasonable working scenario set up in conjunction with simply letting loose engineering information on the corporate databases.

Capturing Design Know-How and Bringing It to the Enterprise

Three years ago, we were describing knowledge-based engineering as a productivity multiplier for any CAD system, where rules are developed that can drive automated applications, capture design intent, and automate sharing of data between applications and departments. On paper, KBE looks like the perfect solution for getting products, current and future ones, out the door faster. In reality, KBE has not taken off, partly because of the fact that the technology has been costly and not well understood. For a company to implement KBE in the first place, it needs to have a good understanding of its design knowledge (in order to capture it) and design processes (in order to automate them).

Nevertheless, we still believe KBE is a useful technology that will have its place in the future engineering landscape, if it is taken in smaller chunks. Software vendors, particularly those focused on manufacturing, have incorporated KBE-related technologies into their software. A good example here is manufacturing, where tool-path generation has been tied together with in-house libraries of machines, schedules, and manufacturing knowledge.

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Chapter 5
Mechanical Market by Subapplication

In Chapter 2, we defined our mechanical subapplication structure. In this chapter, we provide a detailed look at the market by subapplication. For the convenience of our readers, we have reprinted our subapplication outline from Chapter 2 in Figure 5-1. Table 5-1 gives the 1997 market size by subapplication and forecast five year compound annual growth rate (CAGR).

There is one important distinction to be made about our subapplication database. 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).

Computer-Aided Design

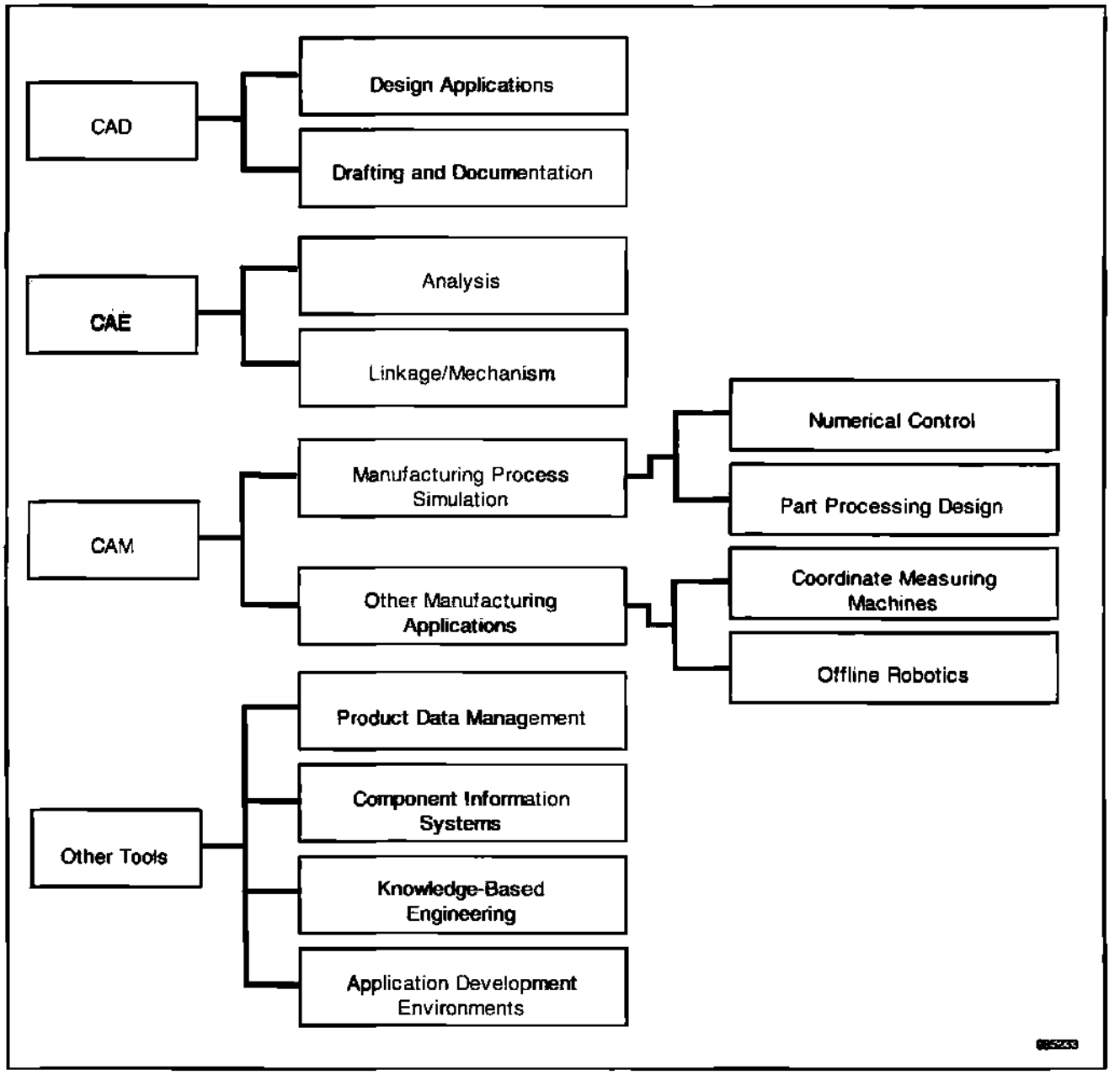
Design Applications

Design applications are the mainstay of the mechanical CAD/CAM/CAE market. Investment in basic CAD tools by end users hit a significant slowdown in 1997, after two years of high, double-digit growth. Parametric Technology and IBM continue to lead the pack in design applications software revenue. Figure 5-2 shows the 1997 software market share of the leaders in design applications. We expect that much of the slowdown in 1997 was an anomaly, caused by Computervision's downfall and Unigraphics Solutions' irregular revenue streams for 1996 and 1997.

Dataquest believes that this subapplication will continue to grow steadily over the next five years, slightly above the average market growth each year. We forecast a five-year CAGR of slightly under 11 percent through 2002 for design applications.

What will drive this steady growth? Over the next two to three years, much of the growth will come from the midrange market, where users will begin adopting the new tools, replacing some of their older 2-D tools, and in some cases, replacing their higher-end systems. Much of the investment will go to industries outside of aerospace and automotive, such as fabricated parts, industrial machinery, and consumer electronics. After that time frame, the automotive and aerospace companies will begin their CAD investment cycles, thus driving growth in 2001 and 2002, where the midrange market left off.

Figure 5-1
Mechanical Subapplications



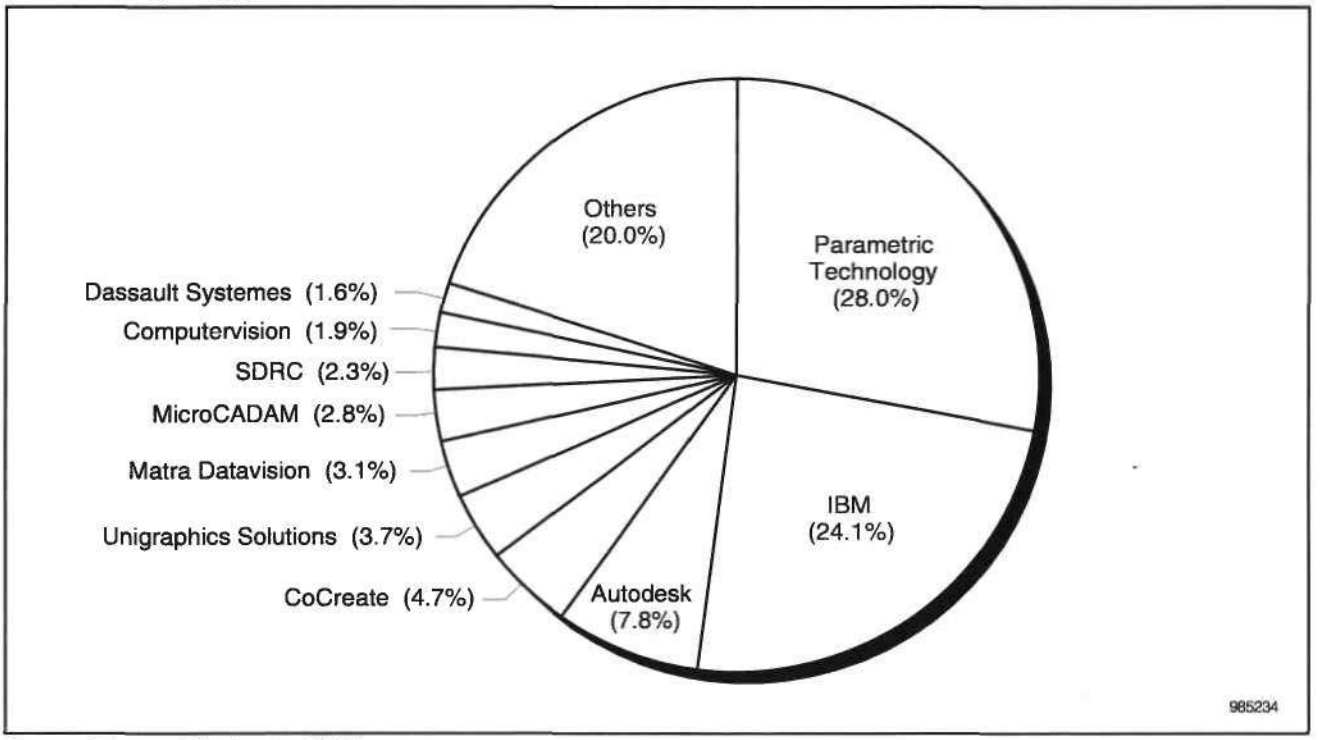
Source: Dataquest (September 1998)

Table 5-1
Mechanical Subapplications—Market Size and Forecast

	Software Revenue (Millions of Dollars) 1997	Growth (%) 1996-1997	CAGR (%) 1997-2002
Design Applications	1,494.5	7.1	10.6
Drafting and Documentation	758.6	6.3	2.9
Computer-Aided Design	2,253.1	6.8	8.2
Analysis	467.6	-0.2	8.2
Linkage/Mechanism	47.0	7.8	14.8
Computer-Aided Engineering	514.7	0.5	8.9
Manufacturing Process Simulation	379.2	3.0	10.3
Other Manufacturing Applications	50.7	22.2	16.5
Computer-Aided Manufacturing	429.9	4.9	11.1
Product Data Management	275.3	-1.1	11.9
Component Information Systems	6.7	41.9	32.1
Application Development Environments	23.1	-6.1	8.8
Knowledge-Based Engineering Tools*	7.0	-68.6	-
Other Tools	312.1	-5.4	12.2
All Subapplications	**3,510.5**	**4.4**	**9.1**

*Because of the limited number of competitors in this subapplication, we are not showing forecast information at this time.
Source: Dataquest (September 1998)

Figure 5-2
1997 Design Applications Market Share



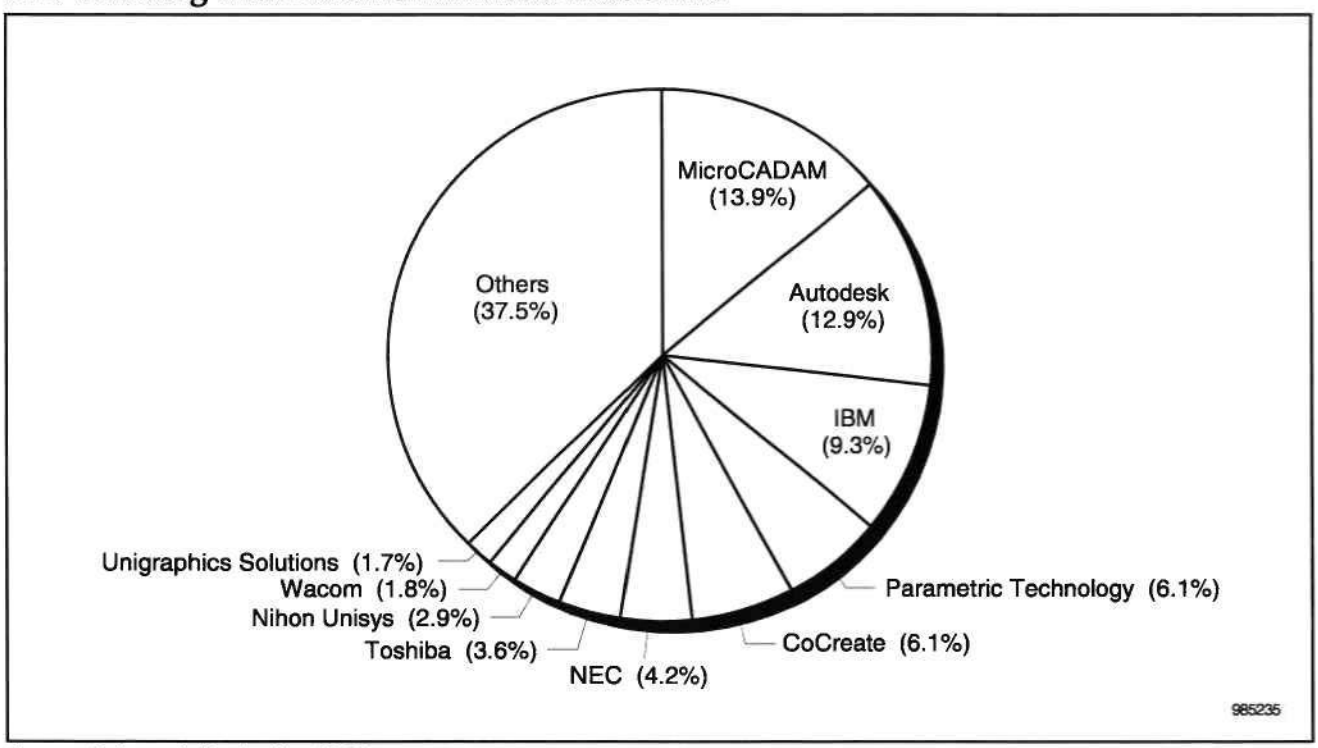
Source: Dataquest (September 1998)

Drafting and Documentation

Similar to design applications, drafting and documentation is the bread-and-butter of the mechanical CAD/CAM/CAE market; 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 over 20 percent of the 1997 mechanical CAD/CAM/CAE software revenue). In previous years, we had expected this subapplication to be stagnant in growth, but the new midrange packages on the market have revived drafting sales. In 1997, drafting and documentation grew slightly over 6 percent, which was greater than the overall market rate of growth. Figure 5-3 gives the market share of the top players in this subapplication.

We forecast that this subapplication will continue its steady growth over our forecast period. While 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, and in some regions of the world, it is the key to the design process. We wait for the day when 3-D and solid models become more common in the design process, and these models are sent directly to downstream manufacturing applications, leaving out the intermediate drafting and drawing step.

Figure 5-3
1997 Drafting and Documentation Market Share



Source: Dataquest (September 1998)

Computer-Aided Engineering

Analysis

We have been waiting for the analysis market to take off; so far, it still hasn't happened. In previous years, revenue from this subapplication has hovered around the average mechanical CAD/CAM/CAE market growth rate, performing neither well above nor well below the average growth. However, in 1997, this subapplication posted no 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 smaller niche 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 at least one vendor is already pursuing. Additionally, there are still untapped areas within this market to pursue, such as nonlinear analysis and nontraditional industries, such as in electronic packaging (though we can no longer consider this area "untapped").

Despite vendor efforts, why isn't this subapplication growing faster? In other words, how can these vendors attract new users, because the traditional users/purchasers of analysis tools are a fairly well-penetrated group? Why have we forecast this market to grow at slightly under the average market growth rate over the next five years? A little informal surveying of analysis users revealed some interesting things.

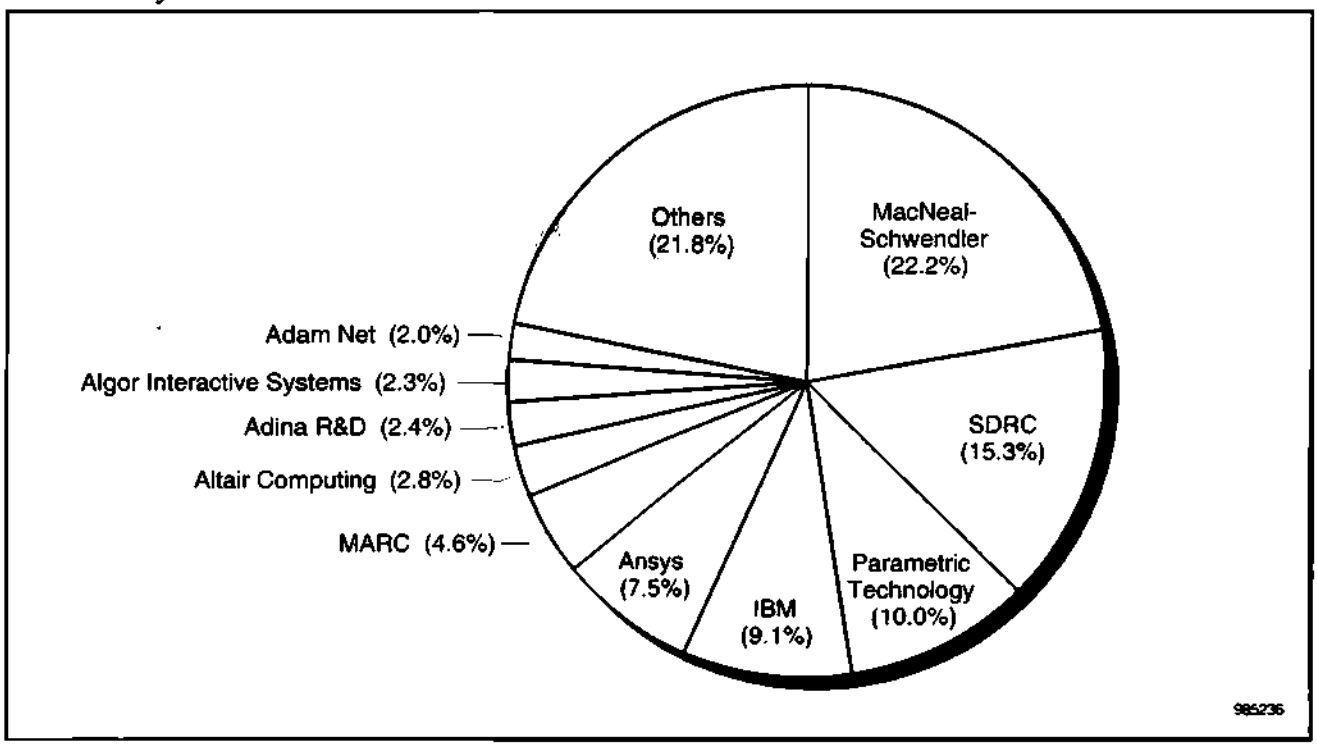
Analysis is being used mostly for exploring design possibilities and optimizing designs, rather than achieving faster time to market or reduced product development costs, which is usually the focus of marketing pitches from the analysis vendors. These engineers felt that analysis was allowing them to do more what-if simulations than they normally would do.

Tight integration with CAD is key to acceptance of CAE tools within the engineering group. Users told us that the ability to import data directly from the CAD model is a boon to analysis, as is the ability to make geometry changes from within the CAE model. Tight integration speeds up the modeling and geometry creation, which already consume much of the analysis process. While we agree that strides are being made in this direction, either users feel that tight integration is still lacking or perhaps they haven't seen the latest offerings from vendors.

The technology still isn't foolproof. There are plenty of problems, such as setting boundary conditions, that might escape the nonexpert analyst. Others want more feedback from their tools that helps them correctly set loading conditions and understand the results.

We will be able to raise our forecast for this area once *more* vendors start addressing these issues (as some are already doing so today). For now, many of them seem satisfied catering to niche areas/users, which is fine for a limited amount of time.

Figure 5-4
1997 Analysis Market Share



Source: Dataquest (September 1998)

Linkage/Mechanism

Linkage/mechanism reached $47 million in 1997, up 8 percent from the previous year. We have revised our forecast for this subapplication upward, largely as a result of the strong interest we are seeing in virtual manufacturing and visualization/simulation for product designs, and the movement of vendors in this space to integrate their products more tightly with CAD. 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.

Computer-Aided Manufacturing

Manufacturing Process Simulation

Numerical Control

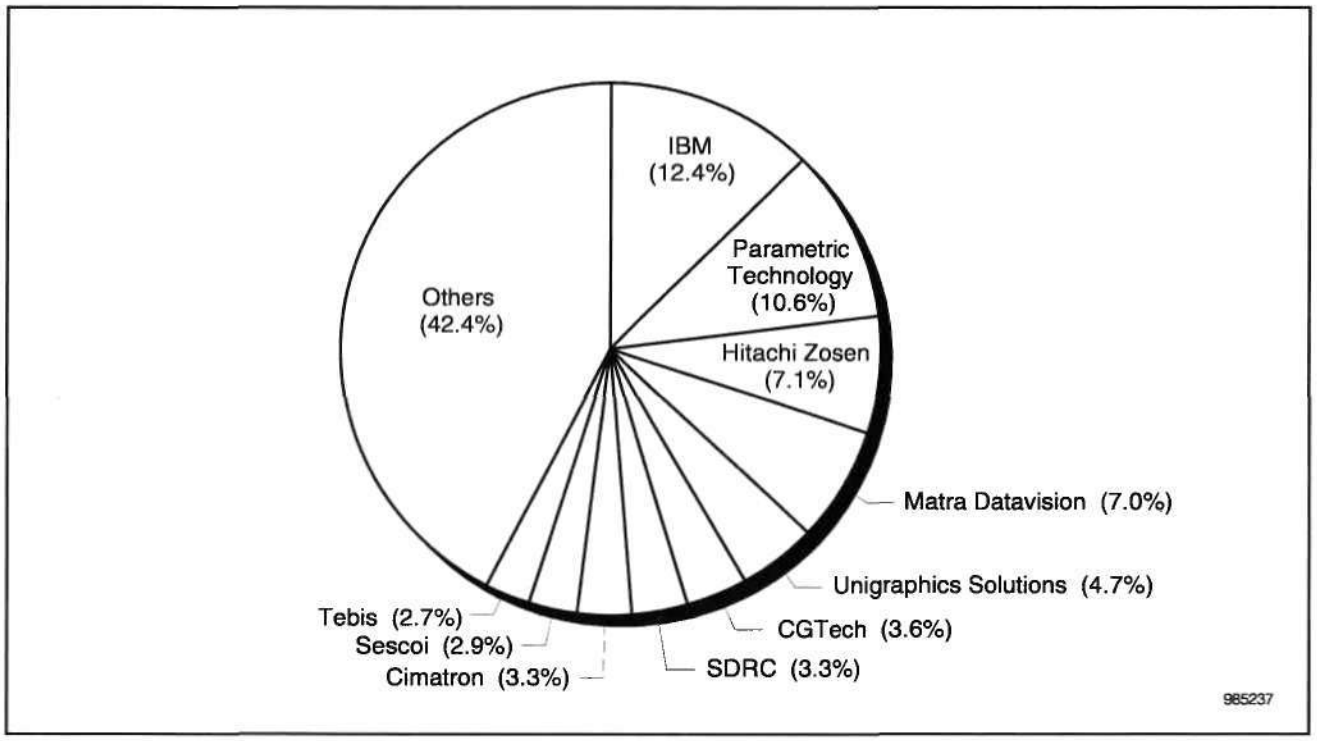
Figure 5-5 shows the 1997 software revenue market share of the leading vendors. Nearly all of the leading mechanical applications vendors play in this subapplication, including several Japanese companies (like Hitachi Zosen and Nihon Unisys) with their own in-house developed products, as well as a number of NC-only vendors (like CGTech, Pathtrace, CNC Software, and Surfware). What is readily apparent from Figure 5-5 is the highly fragmented nature of this subapplication, as represented by the "others" category, which makes up over 42 percent of the market. Despite the continuing fragmented nature of this subapplication, we do not expect a shakeout anytime soon.

It can be expected that increased sales in CAD software translate to increased sales in NC software. We have found that growth of NC software typically lags that of CAD software, but not by much. We expect NC sales to show a five-year CAGR of 10 percent, slightly under our forecast revenue growth for design applications.

There are two key growth factors for this subapplication. One factor is 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 we 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). We are already seeing steps in more tightly integrating 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, which will be discussed in the next section).

The second key factor is the uptake of midrange CAD systems into the first tier we described in Chapter 4, the tier of users moving from 2-D to 3-D design (for example, a machine shop). If this group of users begin switching CAD systems in earnest, undoubtedly CAM system updates will follow on. Further, if these users indeed do move to 3-D solids-based design methods, this movement may drive solids-based machining onto the shop floor.

Figure 5-5
1997 Numerical Control Market Share



Source: Dataquest (September 1998)

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, we are not showing market share of the part processing design players. Today's players and products include Dassault Systemes' Prismatic Machining Assistant, Matra Datavision's Euclid Machinist, SDRC's I-DEAS Generative Machining, and Tecnomatix Technologies PART.

We expect this subapplication to take shape over the next few years, morphing into a category that includes knowledge-based machining and capturing of design and manufacturing practices within a given company—"smart" CAM. The high growth that we are forecasting for this subapplication is driven by the fact that much of the CAM work today 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, where users are accustomed to a lot of manual processes.

Other Manufacturing Applications

Coordinate measuring machines and off-line robotics round out the CAM subapplications. Because of the small size of these subapplications, we have 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, off-line robotics presents some real opportunities for vendors—enough potential opportunity that Dassault Systemes purchased Deneb Robotics in late 1997. In return, Tecnomatix forged tight relationships with many of the other CAD vendors. Currently, Dassault Systemes, IBM, and Tecnomatix Technologies compete in this space. Revenue for this subapplication was at $47 million in 1997, but the real market opportunity today is slightly larger than that, as we currently do not track all players (such as SILMA). Because of the small size of this subapplication, we have chosen not to show market share information at this time.

This subapplication is just heating up. A streamlined progression from CAD to manufacturing has been a desire of many discrete manufacturing companies. Both computer-aided process engineering (CAPE) and virtual manufacturing have been targeted as solutions to the problem. To date, plant floor simulations and layouts have not been tightly linked to CAD/CAM systems; only NC programming information has that "tight" link (and some may even argue that). With the right tools and positioning (one that focuses on process, not product), we anticipate that this subapplication will post healthy growth. And, it is the big CAD spenders—those in automotive, aerospace, and industrial machinery—that will fuel growth in this subapplication.

Other Tools

Product Data Management

The influx of new players that began in 1996 and trickled over into 1997 (most notably Agile Software, ConsenSys, Right Angle, and Smart Solutions) has slowed down. The biggest PDM news in 1997 was major repositioning of products and new products offered by the major CAD vendors (for example, Dassault Systemes' ENOVIA and PTC's Windchill).

Figure 5-6 shows the 1997 market share of the leading PDM vendors. It is important to note that 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 $275 million in PDM software is smaller than what is typically quoted by other market research companies.

In a change from previous years, Computervision, which held the No. 1 spot last year, has been replaced by SDRC. The market as a whole was essentially flat in 1997. 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. 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.

Product data management has never exploded as many have hoped, and we continue to be conservative in our growth estimates. We expect PDM's software growth to remain slightly above the overall mechanical applications growth rate. We still suspect that 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 (meaning they were highly dissatisfied) of all the features. PDM systems are also fighting the same organizational/cultural barriers they have fought since the beginning. With the refocusing on PDM by the major mechanical CAD vendors in 1998, we expect the CAD/PDM integration problem to be tackled head-on over the next few years.

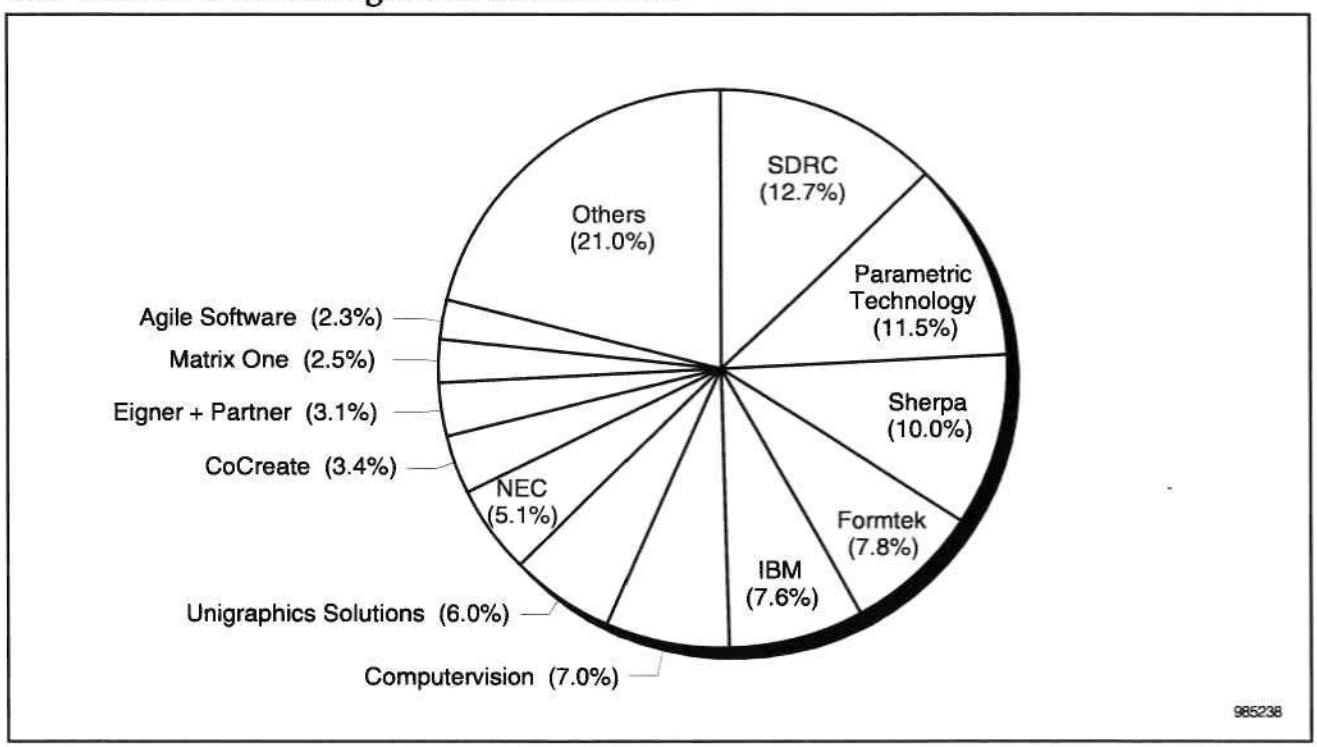
In 1996, we could have said that integration of PDM with manufacturing resource planning (MRP) solutions from companies like SAP and Baan was the "trendy" thing to do. In 1997, it has been Web enabling the PDM solution (that is, creating a Web-based interface for the PDM client). Neither "trend" will create explosive growth in the market. The PDM vision must be revisited to incorporate elements of collaborative engineering (which we discuss below) within an intranet or Internet environment. Even then, it will still be a missionary sale. On a positive note, some of the vendors understand this need and are rolling out products that are more than just Web-enabled solutions of their old PDM solutions.

Companies that are solely PDM players (that is, they don't have a CAD side of the business) are the ones looking outside of discrete mechanical-oriented manufacturing as a growth opportunity for PDM. Two targeted areas are electronic design and process plant design. While we can argue that electronic design is somewhat similar to mechanical design and PDM vendors may have an easier time making the transition to sell to this group of users, plant design/construction 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 the end-user needs and industry-specific processes are. Until that changes, PDM will largely be a solution that resides with discrete manufacturers.

Component Information Systems

Component information systems (CIS) is a unique subapplication that straddles mechanical, electrical, and architectural design/construction. Dataquest recognizes the players in this market as Aspect Development (which now owns CADIS), CenTOR Software, Information Handling Systems (IHS), newcomer InPart, and Thomas Publishing Company (which purchased Autodesk Data Publishing products PartSpec, PlantSpec, and CADBlocks). We do not include those companies that make a living at simply making electronic versions of their catalogs. Because of the small size of this subapplication the way we have defined it today, we are not reporting market share information at this time. Furthermore, our market size reflects only those vendors (or a portion of those vendors) that are positioned for discrete manufacturing CIS.

Figure 5-6
1997 Product Data Management Market Share



Source: Dataquest (September 1998)

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

Our current market size reports CIS software revenue of $7 million, though this number does not include Aspect Development and IHS (both of which are focused on electronics components). Nor does it include InPart (which did not have a shipping product until 1998). In short, the market is bigger than we show, and we will be working in 1999 to improve our coverage here.

This subapplication will be a rising star over the next five years, with growth much greater than any other mechanical subapplication we currently track. 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 prices of these lower-end CIS systems stay low. 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.

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 Unigraphics Solutions' 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 and Computervision's now-defunct Pelorus. Virtually every CAD vendor has an application development environment, largely used for application customization. Again, because of the small size of this market ($23 million in 1997) we have chosen not to show any market share information at this time.

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. When we begin to see this happen, we can raise our forecast for this subapplication.

Knowledge-Based Engineering

Generative technologies, expert systems, and KBE or rule-based engineering (RBE) can be best envisioned as technologies 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.

RBE technologies have existed for quite some time, and vendors have come and gone in this market. Today, the way we have defined KBE, 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) that are building applications on top of KBE 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.

Three years ago, we were describing KBE as a productivity multiplier for any CAD system where rules are developed that can drive automated applications, capture design intent, and automate sharing of data between applications and departments. On paper, KBE looks like the perfect solution for getting products, current and future ones, out the door faster. In reality, RBE/KBE has not taken off, partly because of the fact that the technology has been costly and not well understood. Furthermore, the systems today require 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. For a company to implement KBE in the first place, it needs to have a good understanding of its design knowledge (in order to capture it) and design processes (in order to automate them).

We expect 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.

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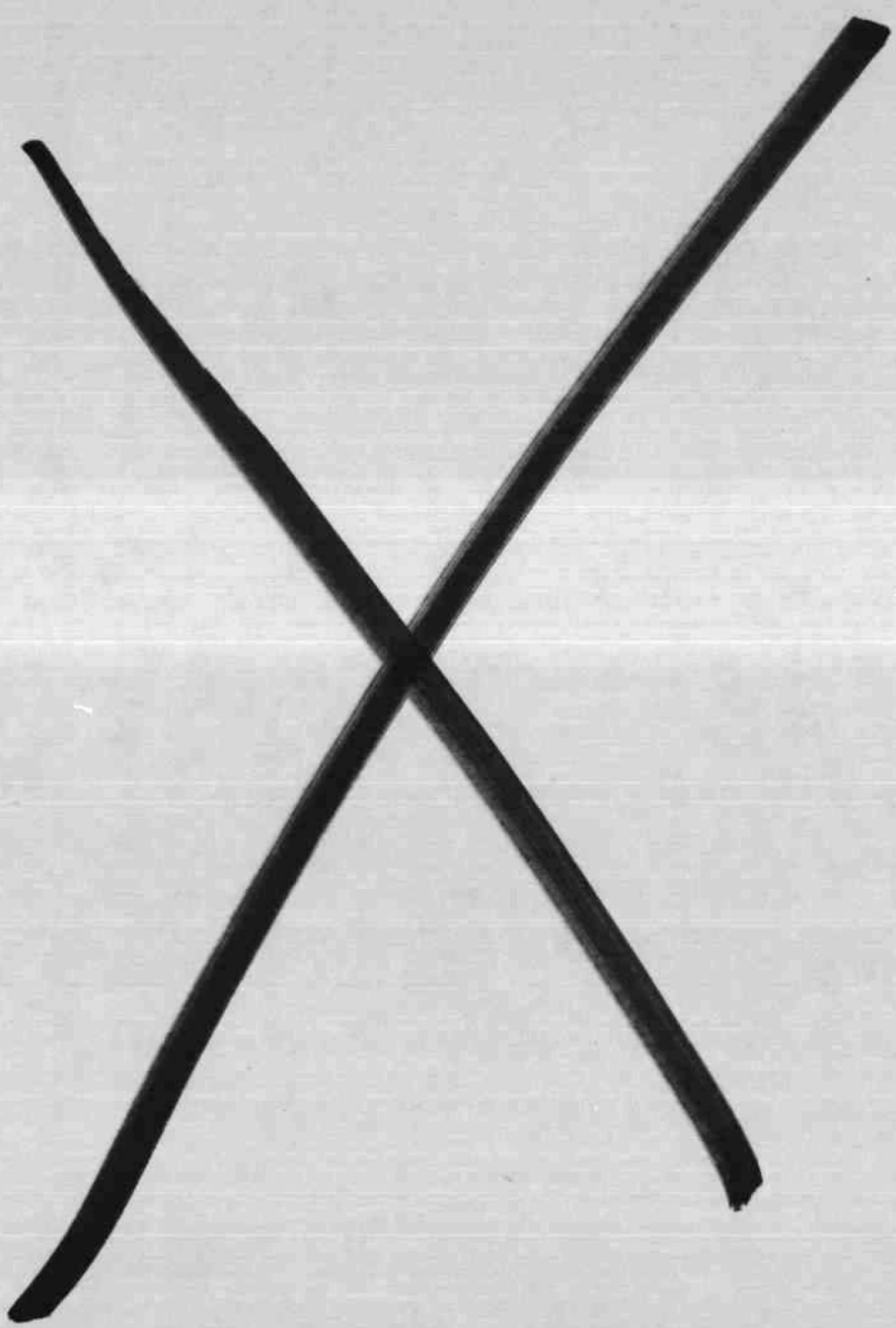
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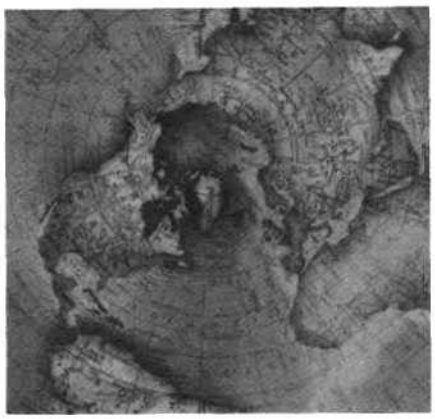
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1998 Mechanical CAD/CAM/CAE Worldwide Market Definitions

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Table of Contents

Page

1. Market Share Survey Overview 1
   Methodology 1
2. CAD/CAM/CAE, AEC and GIS, and EDA Companies 3
   The North American Companies 3
   The European Companies 7
   The Japanese Companies 10
3. Research Metrics 13
   Revenue and Channel Definitions 13
4. CAD/CAM/CAE, AEC and GIS, and EDA Software Applications Definitions 15
5. CAD/CAM/CAE Applications Segmentation 17
   Mechanical 17
      CAD—Computer-Aided Design 17
      CAE—Computer-Aided Engineering 18
      CAM—Computer-Aided Manufacturing 18
      Miscellaneous 18
   Electronic Design Automation 18
      CAE 19
      IC CAD 21
      Printed Circuit Board Design 22
   AEC and GIS 23
      AEC/Architectural, Engineering, and Construction 23
      GIS/Mapping Software 23
6. CAD/CAM/CAE, AEC and GIS, and EDA Operating Systems Group Definitions 25
7. CAD/CAM/CAE, AEC and GIS, and EDA Operating System and Industry Segmentation 27
   Operating Systems 27
   Industry Sectors 28
8. Regional Definitions 31
9. Exchange Rate Policy for Financial Reporting 33

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List of Tables

Table Page
9-1 Average 1996 and 1997 Exchange Rates against the U.S. Dollar 33

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Chapter 1
Market Share Survey Overview

Each year, Dataquest surveys CAD/CAM/CAE, AEC and GIS, and EDA vendors in order to estimate their annual revenue. The survey for 1997 covers 286 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, AEC and GIS, and EDA 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 January of the following year, and the results are summarized in a fax report that is released in February and published in a Dataquest document in March.

The second survey takes place during April. Our final CAD/CAM/CAE, AEC and GIS, and EDA market share estimates are again published in a Dataquest document by the end of June. 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, AEC and GIS, and EDA 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, AEC and GIS, and EDA market share survey program. This document comprises the 1997 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

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- 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, and credit reports
- Reseller and supplier reports and reports from vendors' 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, AEC and GIS, and EDA 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.

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Chapter 2
CAD/CAM/CAE, AEC and GIS, and EDA Companies

Dataquest will survey the following CAD/CAM/CAE, AEC and GIS, and EDA companies throughout the world for 1997 data.

The North American Companies

The following companies to be surveyed are headquartered in North America.

- 3D/Eye
- Abstract Hardware
- Accel Technologies
- Accugraph
- Adina R&D
- Agile Software
- ALDEC
- Algor Interactive Systems
- Alias Research
- Altair Computing
- AMBIT Design Systems
- Analogy
- Ansoft
- Ansys
- Applicon
- Applied Simulation Technology
- APTIX
- Artisan Components
- Ashlar
- Aspec Technology
- Aspect Development
- Auto-Trol
- Autodesk
- Autometric
- AVANT!
- B.A. Intelligence Networks
- Baystate Technologies
- Bentley Systems

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- Boothroyd Dewhurst
- Cadence
- Cadis Software
- CADSI
- CAE Plus
- Cascade Design Automation
- CGTech
- Chronology
- Chrysalis Symbolic Design
- CIMLINC
- CMstat
- CNC Software
- CoCreate
- Computervision
- Concentra
- ConsenSys
- CoreLogic
- CSAR
- DATACAD LLC
- Design Acceleration
- Diehl Graphsoft
- Digital Equipment
- DP Technology
- Drawbase Software
- DSP Group
- Dynamic Graphics
- EA Systems
- Eagle Point
- Earth Resource Mapping
- EDS Unigraphics
- Enghouse Systems Ltd.
- Engineered Software
- Engineering Mechanics
- ERDAS
- ESRI
- Fintronic

- First Cadcam
- Formtek
- Gambit Automated Design
- GDS
- Genasys II
- Geo/SQL
- GEOMAX Intl.
- Gerber Systems
- Gibbs and Assoc.
- Hewlett-Packard
- i-Logix
- IBM
- IKOS Systems
- IMSI
- Interactive Image Technology
- Intergraph
- InterHDL
- International Software Systems
- Intusoft
- Isicad
- KNIGHT
- Landmark Graphics
- Livermore Software Tech.
- Logic Vision
- Lucent Technology
- MacNeal-Schwendler
- MapInfo
- MARC
- MatrixOne
- MCS
- Mechanical Dynamics
- Mentor Graphics
- MICROCADAM
- Microsim
- Minc Software
- NOVASOFT Systems

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- OEA International
- Optem Engineering
- OrCAD EDA
- Pacific Numerix
- PADS Software
- Parametric Technology
- PCI Group
- Precedence
- Protel Technology
- Quantic Laboratories
- Quickturn Design Systems
- Radian Corporation
- Rebis
- Research Engineers—Civilsoft
- Rubicad
- Sand Micro
- Savantage
- Senté
- SES
- Sherpa
- SHL Vision Solutions
- Sigma Design
- Silicon Graphics
- Silicon Valley Research
- SILVACO
- SIMUCAD
- Simulation Technology
- Spatial Technology
- SRAC
- Structural Dynamics Research Corporation
- Summit Design
- Sun Microsystems
- Surfware
- Sweet's Electronic Publishing
- Synario Design Automation
- Synopsys

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- Synplicity
- Syntest
- Systems Science
- T D Technology
- Tactician
- Tanner Research
- Tecnomatix Technology
- Terr-Mar Resource Info Svs.
- Terra Sciences
- TMA Incorporated
- UNISYS
- Variation Systems Analysis
- Veritools
- Viagrafix
- Virtual Chips
- Workgroup Tech.
- Xynetix

The European Companies

The following companies to be surveyed are headquartered in Europe.

- ACA Ltd.
- Advanced RISC Machines
- ALS Design
- Anilam Electronics
- APIC SA
- ARKTEC
- ASCAD
- Assigraph International
- BCT GmbH
- CAD-UL
- CAD Centre
- CAD Distribution
- CAD Lab
- CADdy Spain
- Cadtronic
- Catalpa groupe Missler
- Cimatron

- CIMTEK
- Complansoft CAD
- Computational Mechanics
- Computer Services Consultants
- Concurrent Engineering
- Dansk Data Elektronik
- Dapco SA
- Dassault Systemes
- debis Systemhaus
- Delcam plc
- Eigner + Partner
- Elstree Computing
- ESI Group
- Exapt
- FHECOR
- Flomerics
- Graphisoft Group
- Ground Modeling Systems
- Han Dataport
- Hochtief
- ICEM Technologies
- ICL
- IEZ-Speedikon
- INCASES
- Investronica SA
- ISD Software
- ISDATA
- ISKA
- Just In Time Systems
- Kockums Computer Systems
- Laser-Scan
- M.O.C.
- Macon
- Matra Datavision
- mb Programme
- Modultek
- MOSS Systems Group

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- Nemetschek
- Network Management Tools
- Norlinvest Ltd.
- No. 1 Systems
- Open Mind
- PAFEC
- Pathtrace Engineering Systems
- Poppenhaeger Grips
- PROCAD GmbH & Co. KG
- Radan Computational
- RIB/Bausoftware
- RoboCAD Solutions
- Sagantec
- Sener Inginiera y Sistemaus
- Serbi
- Sescoi
- Siemens Nixdorf Info systeme
- Smallworld Systems
- Soft-Tech Software Technologies
- Softronics
- Speed
- Star Informatic
- Straessle Informationssysteme
- Superdraft
- Sysdeco Innovation
- Tebis
- Triplan
- ULTImate Technology
- VEDA
- Vero International Software
- Whessoe Computing Systems
- Wiechers Datentechnik
- Ziegler Informatics

The Japanese Companies

The following companies to be surveyed are headquartered in Japan.

- Adam Net
- Andor
- Argo Graphics
- C. Itoh Techno-Science
- CADIX
- Century Research Center
- CPU
- Design Automation
- Fujitsu
- Graphtec Engineering
- Hakuto
- Hitachi
- Hitachi Zosen Info Systems
- Info. Services International Dentsu
- Informatix
- Kanematsu Computer Systems
- Kozo Keikaku Engineering
- Kubota Computer
- Marubeni Hytech
- Mitsubishi Electric
- Mitsui Engineering
- Mutoh Industries
- NEC
- Nihon Itek
- Nihon Unisys
- Okura
- Omron
- Pasco
- Ricoh
- Seiko
- Sharp
- Sony
- Sophia Systems
- Sumisho Electronics
- Sumitomo Denko Workstation
- Technodia

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- TECHSPERT
- Tokyo Electron
- Toshiba
- Toshiba Engineering
- Toyo Information Systems
- TSSI Japan
- Uchida Yoko
- Wacom
- Yokogawa Digital Computer
- Zuken-Redac

Of the 286 companies to be surveyed, 153 are North American, 87 are European, and 46 are Japanese.

Chapter 3
Research Metrics

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

- Compound annual growth rate (CAGR): A computed, compounded growth rate used in forecasting.
- 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.
- 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.

Revenue and Channel Definitions

- Total distribution revenue: The total amount of money received by a company for all goods and services sold into the CAD/CAM/CAE/GID market. It is the sum of factory revenue, OEM revenue, and reseller revenue.
- Channels:
  - 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.
  - 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.
  - Reseller revenue: The revenue a named company in the CAD/CAM/CAE, AEC and 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.

- 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 unbundled applications software. It does not include operating systems revenue, which is part of the hardware revenue.

The following are the three types of software revenue reported in the CAD/CAM/CAE, AEC and GIS, and EDA database:

- Product software revenue: Direct and indirect software revenue combined, excluding OEM and reseller sales. This metric is used to determine market size.
- Company software revenue: The sum of revenue from the direct, indirect, OEM, and reseller channels for any given company.
- End-user software revenue: The sum of revenue from the direct, dealer, OEM, and reseller channels for any given company.

To avoid double-counting the market, market size based on company software revenue is the sum of revenue from the direct and indirect channels, and market size based on end-user spending is the sum of revenue from the direct and dealer channels.

- Service revenue: Revenue derived from the service and support of CAD/CAM/CAE, AEC and 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 for a specific customer who pays for the design and development of new customized CAD/CAM/CAE, AEC and 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 and GIS, and 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.

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Chapter 4
CAD/CAM/CAE, AEC and GIS, and EDA 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 and numerical control.
- 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 5
CAD/CAM/CAE Applications Segmentation

Additional surveys are conducted to further segment the industry with software revenue sales by application. The applications divisions are set forth in the following sections.

Mechanical

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.

CAD—Computer-Aided Design

Definitions for the CAD application segment are as follows:

- Conceptual design: Initial design process that includes industrial design, styling, conceptual modeling, rendering, and visualization.
- Functional design:
  - Component design: Design of the individual components in an assembly.
  - Assembly modeling: Integration of component designs into an assembly to test size/shape and functional characteristics.
- Manufacturing tool and fixture design: Design of custom-made tooling to facilitate a manufacturing process or structural aids to hold a component or assembly during manufacturing.
- 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. Also includes schematics and technical illustration.

CAE—Computer-Aided Engineering

Definitions for the CAE application segment are as follows:

- 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.

CAM—Computer-Aided Manufacturing

Definitions for the CAM application segment are as follows:

- 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.

Miscellaneous

Definitions for the miscellaneous application segment are as follows:

- 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.
- 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. PDM includes product structure management, workflow, and vault/document management.
- Component information systems: Software used to navigate within and manage a repository of engineering parts and associated data.

Electronic Design Automation

For the past few years, Dataquest has subdivided the electronic CAE market in an entirely new way. The subdivisions are based on design method-

ologies 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.

CAE

Definitions for the CAE application segment are as follows:

- Electronic system (ES) level:
  - Electronic system level design: Design at the conceptual level including hardware/software codesign, design partitioning, and specification; it includes no register transfer or 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).
  - ESL emulators: Dedicated hardware/software that allows a designer to observe the function of a circuit or design at the behavioral level prior to prototype.
- Register transfer (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.
    - Cycle-based simulation: Simulation that does not use time steps as the basis of measurement but uses clock cycles.
    - Mixed-signal simulation: Simulation in which both digital and analog inputs are used.

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- Accelerators: Dedicated hardware/software or optimized software used to speed up simulation, typically at the RT level.
- Emulators: Dedicated hardware/software that allows a designer to observe the function of a circuit or design at the RT level prior to prototype.
- 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 a silicon implementation. Sometimes called model generation.
- RTL analysis: Tools used for the analysis of designs at the RT level.
  - 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.
  - Signal analysis (including transmission line and cross-talk analysis): Analysis of high-speed coupling effects between signal line and reflection/degradation of high-speed signals on PCBs, MCMs, or ICs.
  - Power analysis: Analysis of the power consumption of PCBs, ICs, multichip modules (MCMs), and systems.
  - Thermal analysis: Analysis of heat distribution in PCBs, ICs, multichip modules (MCMs), and systems. Possibly not applicable at the RT level.
  - EMI: Analysis of electromagnetic generation and interference for PCBs, ICs, and cables/connectors/packaging.
  - Metal or electro migration: The unauthorized movement of metal in an IC because of excessive current density.
- Design for test tools: Tools used to determine, improve, or add to the testability of electronic circuits.
- Silicon virtual prototype: Tools that estimate silicon level performance at the RT level. This is done 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. This is the essence of the new RTL methodology. A new configuration of all six analysis tools will plug into the RTL floorplanner to bring back the verification issues into the design team.
- PCB virtual prototype: A process that uses a virtual representation of the PC board to estimate physical effects, bringing those effects back up to the CAE level of design. As is happening with silicon design, the design engineer will take on more of the responsibility of the end physical design.
- Hardware/software virtual prototype: A tool that allows the simultaneous design and simulation of both the hardware, typically in Verilog or VHDL, and the software, typically in C or C++.

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- 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 only analog inputs are used.
    - Spice simulation: Simulation using a derivative of the Berkeley Spice transistor-level simulator.
    - RF simulation: Frequency based simulation.
  - 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.
- Miscellaneous:
  - 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. Also includes 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) and the tools that automate the development of libraries.
  - FPGA tool set: Dedicated EDA software sold as a package for FPGA/CPLD design.

IC CAD

Definitions for the IC CAD application segment are as follows:

- Physical verification: The design rule and logic rule checkers used to perform final verification on an IC design prior to making masks. Previously, we called this subapplication DRC. We are now seeing the migration of the analysis tools into this category forming a physical verification tool suite.
  - Extractors: A utility that extracts information out of the laid out or completed design, typically resistance and capacitance values.

- Delay calculators: A tool that calculates the timing delays in a laid out or completed design.

- Analysis tools: Tools used for the physical analysis of designs.
  - 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.
  - Signal analysis (including transmission line and cross-talk analysis): Analysis of high-speed coupling effects between signal line and reflection/degradation of high-speed signals on PCBs, MCMs, or ICs.
  - Power analysis: Analysis of the power consumption of PCBs, ICs, multichip modules (MCMs), and systems.
  - Thermal analysis: Analysis of heat distribution in PCBs, ICs, multichip modules (MCMs), and systems.
  - EMI: Analysis of electromagnetic generation and interference for PCBs, ICs, and cables/connectors/packaging.
  - Metal or electro migration: The unauthorized movement of metal in an IC because of excessive current density.

- Floor planner: A tool that allows a designer to place elements of his design so that he may look at estimations of the effects of the final place and route.

- FPGA place and route: Tools used to implement your design into the targeted FPGA or CPLD. These are also called fitters as they fit your design into the already existing logic structure of the targeted FPGA or CPLD.

- IC place and route: Tools used to implement (lay out) your design into silicon.
  - Gate array layout: Tools used to lay out your design into a fixed base array.
  - Cell-based layout: Tools used to lay out nonfixed cell-based designs.
  - Custom IC layout: Silicon design tools that work at the transistor level. These tools can size transistors, accomplish analog design, and in general handcraft your silicon implementation. Sometimes called layout editors.

Printed Circuit Board Design

Definitions for the printed circuit board design application segment are as follows:

- PCB Design: Those tools used to design and place and route a printed circuit board.

- MCM and hybrid design: Those tools used to design and place and route a multichip module or hybrid substrate.

AEC and GIS

AEC/Architectural, Engineering, and Construction

Definitions for the AEC, or architectural, engineering, and construction, applications 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.

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- 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.

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Chapter 6
CAD/CAM/CAE, AEC and GIS, and EDA Operating Systems Group Definitions

Dataquest segments CAD/CAM/CAE, AEC and GIS, and EDA 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 7.
- 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 included are the following:
  - Mac OS: Apple's proprietary graphical user interface (GUI) operating system.
  - OS/2: IBM's GUI operating system for high-end PCs and PC servers.
  - Windows 3.1: Microsoft's GUI 16-bit operating system that runs on top of DOS. It is the dominant GUI operating system for PC and PC clones.
  - Windows 95: 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 7

CAD/CAM/CAE, AEC and GIS, and EDA 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, AEC and GIS, and EDA software market. These segments are as follows:

Operating Systems

Operating systems are broken down as follows:

- 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
- Fujitsu—host/proprietary
- Hewlett-Packard UX
- Hitachi HI-UX/G (UNIX)
- Hitachi—host/proprietary
- IBM AIX
- IBM VM/VMS
- Intergraph UNIX
- MIPS UNIX
- NEC EWS-UX (UNIX)
- OS2
- Prime PRIMOS
- Siemens—host/proprietary
- Siemens-UNIX
- Silicon Graphics UNIX

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- Solaris
- Sony NEWS-OS (UNIX)
- Sun—UNIX/OS
- Windows
- Windows NT
- XENIX/SCO UNIX
- Others—UNIX
- Others
- All Operating Systems

Industry Sectors

The CAD/CAM/CAE, AEC and GIS, and EDA database tracks the following 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
- 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)

Industries that do not correspond to an above sector are categorized as "others."

The above industry sectors can be grouped according to standard Dataquest industry sectors. CAD/CAM/CAE, AEC and GIS, and EDA industry sectors are listed below under the corresponding standard Dataquest industry sector.

- Agriculture, mining, and construction (SIC codes 01-19)
  - Agriculture, forestry, and fishing
  - Construction, contractors, and building
  - Mining
- Process manufacturing (SIC codes 20-22, 26, 28-30, 32, 33)
  - Chemical, allied, and petroleum products
- Discrete manufacturing (SIC codes 23-25, 27, 31, 34-39)
  - Aerospace, guided missiles, and space vehicles
  - Automotive, motorcycles, and bicycles
  - Computers, office equipment, and computer peripherals
  - Consumer electronics
  - Electrical/electronic equipment
  - Fabricated metal products
  - Industrial and commercial machinery
  - Industrial controls, robotics, and AGVs
  - Manufacturing not elsewhere classified (textiles, furniture, and foundries)
  - Medical manufacturing
  - Semiconductors
  - Shipbuilding, ship repairing, and developing offshore rigs
- Transportation (SIC codes 40-47)
  - Transportation
- Communications (SIC code 48)
  - Telecommunications and data communications
- Utilities (SIC code 49)
  - Utilities and pipelines
- Wholesale trade (SIC codes 50-51)

- Retail trade (SIC codes 52-59)
- Finance, banking, and real estate (SIC codes 60-62, 65-67)
  - Finance and real estate
- Insurance (SIC codes 63-64)
- Miscellaneous services (SIC codes 70-79)
- Health care (SIC code 80)
- Other services (SIC codes 81, 83-89)
  - Service companies
- Education (SIC code 82)
  - Education
- Government (SIC codes 90-97)
  - Government: environment and public health resource
  - Government: general, executive, public order, and taxation
  - Government: national security (defense)
  - Government: public works and engineering

Results from these surveys and the applications' surveys are scheduled to be published in mid-1998.

Chapter 8
Regional Definitions

The following regional hierarchy and definitions are used for all Dataquest's geographic segmentation. Not all product and service coverage have the entire segmentation. Some may have a greater level and some may have less.

- North America:
  - United States: Single-country region
  - Canada: Single-country region
- Europe:
  - Western Europe: Includes Austria, Belgium, France, Germany (including former East Germany), Italy, Luxembourg, Netherlands, Scandinavia (Denmark, Finland, Norway, Sweden), Spain, Switzerland, and the United Kingdom
  - Rest of Western Europe: Includes Andorra, Cyprus, Faroe Islands, Gibraltar, Greenland, Guernsey, Iceland, Isle of Man, Jersey, Liechtenstein, Malta, Monaco, San Marino, and Svalbard
  - Central and Eastern Europe: Includes Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, the Czech Republic, Estonia, Georgia, Hungary, Kazakstan, Kyrgyzstan, Latvia, Lithuania, Macedonia, Moldova, Poland, Romania, Russia, Slovakia, Slovenia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan, and the republics of the former Yugoslavia (Serbia and Montenegro)
- Japan: Single-country region
- Asia/Pacific:
  - **Asia/Pacific:** Includes China, Hong Kong, Korea, Singapore, and Taiwan
  - **Rest of Asia:** Includes Australia, American Samoa, Ashmore and Cartier Islands, Baker Island, Bangladesh, Bhutan, Bouvet Island, Brunei, Cambodia, Christmas Island, Cocos (Keeling) Islands, Cook Islands, Coral Sea Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Howland Island, India, Indonesia, Jarvis Island, Johnston Atoll, Kingman Reef, Kiribati, Laos, Macau, Malaysia, Maldives, Marshall Islands, Midway Islands, Mongolia, Myanmar (Burma), Nauru, Nepal, New Caledonia, New Zealand, Niue, Norfolk Island, Northern Mariana Islands, North Korea, Pakistan, Palau, Palmyra Atoll, Papua New Guinea, Paracel Islands, Philippines, Pitcairn Islands, Solomon Islands, Spratly Islands, Sri Lanka, Thailand, Tokelau, Tonga, Tuvalu, Vanuatu, Vietnam, Wake Island, Wallis and Futuna, and Western Samoa

- Rest of World:
  - **Latin America:** Includes Anguilla, Antigua and Barbuda, Argentina, Aruba, Bahamas, Barbados, Belize, Bermuda, Bolivia, Brazil, Cayman Islands, Chile, Clipperton Island, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Falkland Islands (Islas Malvinas), French Guiana, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Mexico, Montserrat, Navassa Island, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Tortola (British Virgin Islands), Trinidad and Tobago, Turks and Caicos Islands, Uruguay, Venezuela, and Virgin Islands (St. John, St. Croix and St. Thomas)
  - **Middle East/Africa:** Includes Afghanistan, Algeria, Angola, Bahrain, Bassas da India, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Cote d'Ivoire, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Europa Island, Gabon, Gambia, Ghana, Glorioso Islands, Guinea, Guinea-Bissau, Iran, Iraq, Israel, Jordan, Juan de Nova Island, Kenya, Kuwait, Lebanon, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mayotte, Morocco, Mozambique, Namibia, Niger, Nigeria, Oman, Qatar, Reunion, Rwanda, Saint Helena, Sao Tome and Principe, Saudi Arabia, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Syria, Tanzania, Togo, Tromelin Island, Tunisia, Turkey, Uganda, United Arab Emirates, Western Sahara, Yemen, Zaire, Zambia, and Zimbabwe

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Chapter 9
Exchange Rate Policy for Financial Reporting

When converting a company's local currency sales into U.S. dollars, or vice versa, it is important to use the 1997 exchange rates provided in Table 9-1. These rates will prevent inconsistencies in the conversion of off-shore sales between each company. These are the exchange rates that will be used in the final 1997 CAD/CAM/CAE and GIS market share survey. Exchange rates for historical years are available on request.

Table 9-1
Average 1996 and 1997 Exchange Rates against the U.S. Dollar

Country	1996 Rate	1997 Rate	Currency Name
Austria	10.59	12.20	Schilling
Belgium	30.96	35.79	Belgian franc
Canada	1.36	1.38	Canadian dollar
Denmark	5.81	6.61	Danish krone
European Union	0.80	0.89	ECU
Finland	4.59	5.19	Markka
France	5.12	5.84	French franc
Germany	1.50	1.73	Deutsche mark
Hong Kong	7.73	7.74	Hong Kong dollar
Italy	1,542.72	1703.02	Lira
Japan	108.81	121.10	Yen
Mexico	7.60	7.92	Peso
Netherlands	1.69	1.95	Gulden
Singapore	1.41	1.49	Singapore dollar
South Korea	805.16	954.14	Won
Spain	126.68	146.45	Peseta
Sweden	6.71	7.64	Swedish krona
Switzerland	1.24	1.45	Swiss franc
Taiwan	27.47	28.79	NT
United Kingdom	0.64	0.61	Pound

Note: The annual rate is estimated as the arithmetic mean of the 12 monthly rates.
Source: Dataquest (February 1998)

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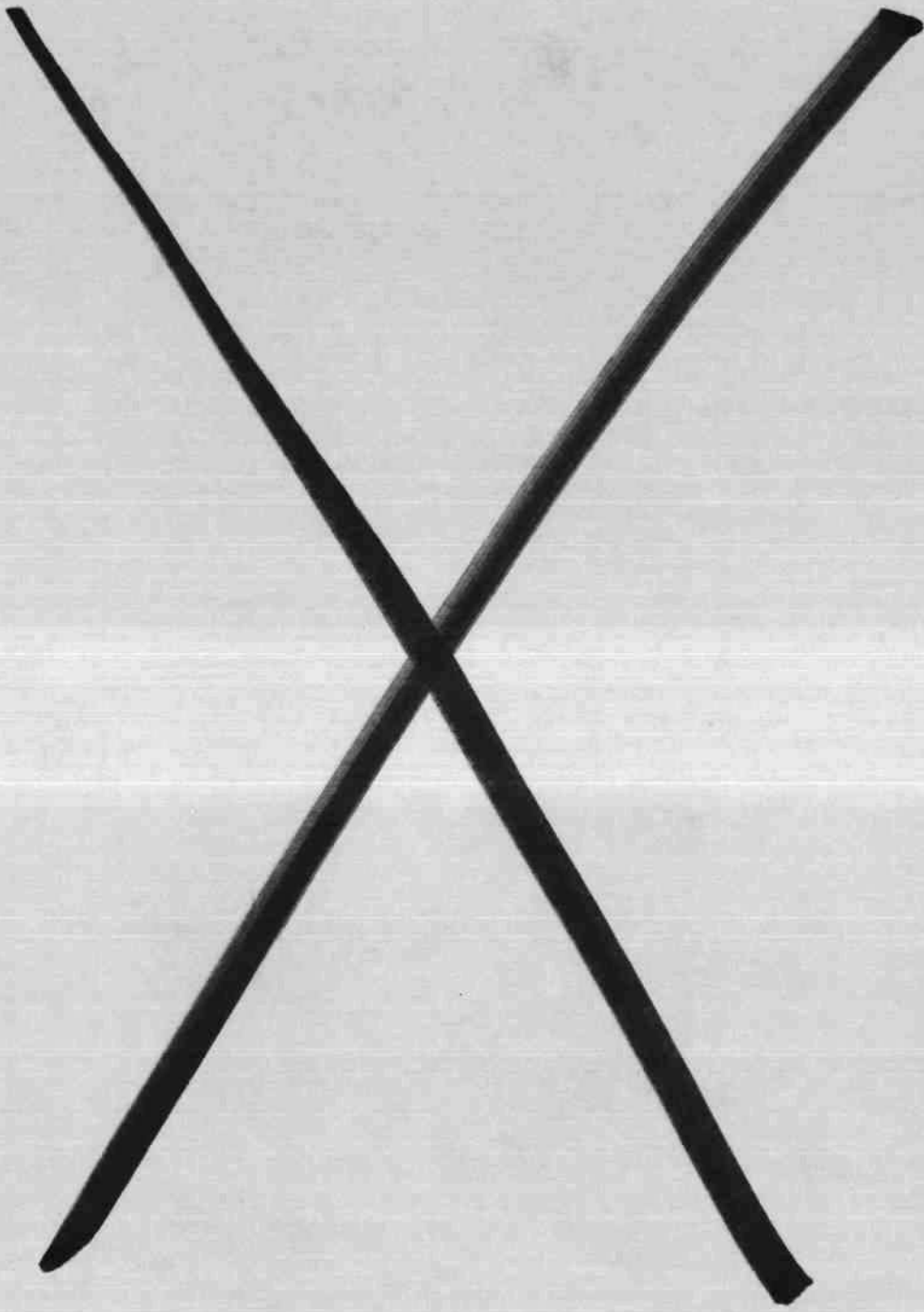
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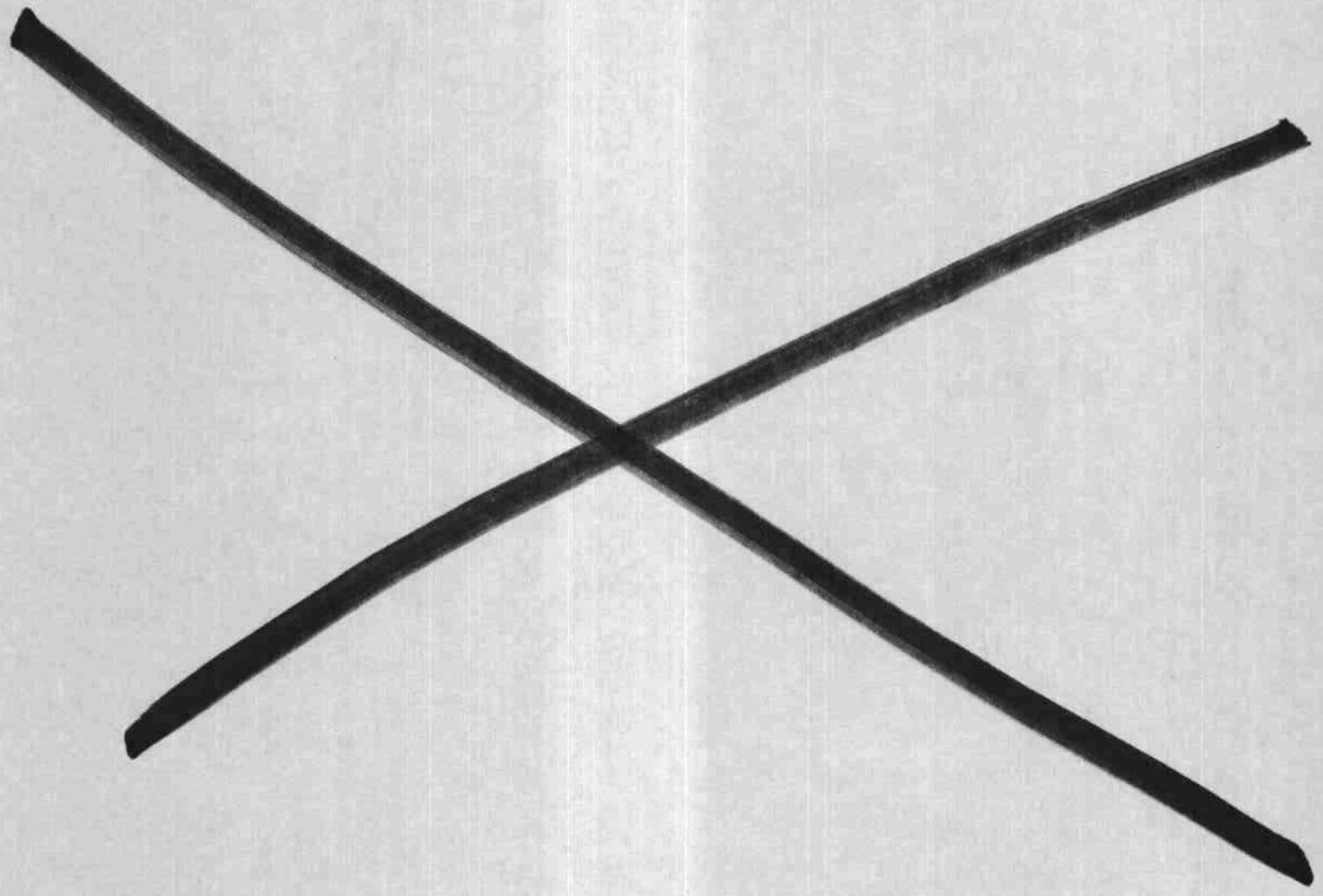
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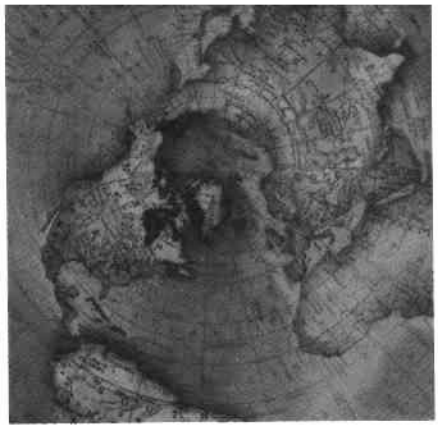
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1998 Asia/Pacific Mechanical CAD/CAM/CAE Market Forecast

Market Statistics

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Program: Mechanical CAD/CAM/CAE Asia/Pacific
Product Code: CMEC-AP-MS-9802
Publication Date: November 2, 1998
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1998 Asia/Pacific Mechanical CAD/CAM/CAE Market Forecast



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Table of Contents

Page

1. 1998 Asia/Pacific Mechanical CAD/CAM/CAE Forecast 1
   - Introduction 1
   - Worldwide Forecast Assumptions 1
     - All Applications 1
   - Mechanical Forecast Assumptions 4
     - CAD Investments Are Cyclical 4
     - Tier Two Investments 4
     - New Software, New Platforms, and New Users 4
     - Continued Economic Turmoil in Asia/Pacific 4
     - Meeting User Needs beyond Design 5
   - AEC Forecast Assumptions 5
     - CAD Is Becoming a Business Requirement 5
     - New Features in AEC CAD Products Are Achievable 5
     - A More Tailored Focus 5
     - Design Is Only Part of the Problem 5
   - GIS/Mapping Forecast Assumptions 6
     - Abundant Supply of Prospective Buyers 6
     - New Technologies 6
     - Indispensability of GIS 6
     - High Cost of Entry Remains a Barrier 6
     - Price Pressures Inhibit Growth 6
   - Electronic Design Automation Forecast Assumptions 6
     - Electronic CAE 7
     - IC Layout 7
     - PCB Design 7
   - History and Forecast for All Applications and Operating Systems 8
   - Forecast Methodology 9
   - Changes to the Forecast Database 9
   - Segmentation Definitions 10
     - Operating Systems 10
     - Line Items 10
   - Regions 11
     - Asia/Pacific 11
2. 1998 Asia/Pacific Mechanical CAD/CAM/CAE Forecast Tables 13

List of Figures

Figure Page
1-1 CAD/CAM/CAE and GIS Forecasting Model 10

List of Tables

Table		Page
1-1	CAD/CAM/CAE and GIS Revenue Growth Comparison	2
1-2	Foreign Currency Exchange Rates against the U.S. Dollar	3
1-3	CAD/CAM/CAE/GIS Software Revenue History and Forecast	8
1-4	CAD/CAM/CAE/GIS Software Revenue Growth Rate History and Forecast	8
2-1	Top-Level Mechanical Forecast, Worldwide, All Operating Systems	13
2-2	Detail Mechanical Forecast, Asia/Pacific, All Operating Systems	14
2-3	Detail Mechanical Forecast, China, All Operating Systems	15
2-4	Detail Mechanical Forecast, Hong Kong, All Operating Systems	16
2-5	Detail Mechanical Forecast, Korea, All Operating Systems	17
2-6	Detail Mechanical Forecast, Singapore, All Operating Systems	18
2-7	Detail Mechanical Forecast, Taiwan, All Operating Systems	19
2-8	Detail Mechanical Forecast, Rest of Asia, All Operating Systems	20

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Chapter 1
1998 Asia/Pacific Mechanical CAD/CAM/CAE Forecast

Introduction

This document contains Dataquest's detailed forecast information on the mechanical CAD/CAM/CAE, AEC and GIS, and EDA markets at the country level. This report is meant to supplement the worldwide forecast books for each service 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 1998 exchange rate will remain stable in the future (see Tables 1-1 and 1-2).

Additional market statistics publications for Dataquest's mechanical CAD/CAM/CAE, AEC and GIS, and EDA services for 1998 are as follows:

- Dataquest's 1997 preliminary market share documents (published as CAEC-WW-MS-9801, CEDA-WW-MS-9801, CMEC-WW-MS-9801) were sent to our clients in April.
- Dataquest's 1998 preliminary forecast documents were released in June (published as CAEC-WW-MS-9802, CEDA-WW-MS-9802, CMEC-WW-MS-9802).
- Dataquest's 1997 market share data was verified, updated, and sent to our clients in August as market share update reports (published as CAEC-WW-MS-9803, CEDA-WW-MS-9803, CMEC-WW-MS-9803). Country-level data was also made available at this time.

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 systems 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.

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

	1996	1997	Forecast 2002	Growth (%) 1996-1997	CAGR (%) 1997-2002
Europe ($M)					
Software Revenue	2,192.20	2,288.68	3,780.26	4.4	10.6
Hardware Revenue	2,736.77	2,639.54	3,491.73	-3.6	5.8
Service Revenue	1,166.77	1,160.33	1,678.11	-0.6	7.7
Total Factory Revenue	6,095.75	6,088.55	8,950.11	-0.1	8.0
ECU/U.S. Exchange Rate*	0.80	0.89	0.91	11.6	0.4
Europe (ECU Million)					
Software Revenue	1,748.45	2,036.92	3,440.04	16.5	11.0
Hardware Revenue	2,182.78	2,349.19	3,177.47	7.6	6.2
Service Revenue	930.59	1,032.70	1,527.08	11.0	8.1
Total Factory Revenue	4,861.82	5,418.81	8,144.60	11.5	8.5
Japan ($M)					
Software Revenue	1,830.17	2,022.25	3,445.40	10.5	11.2
Hardware Revenue	2,870.44	2,818.60	3,722.89	-1.8	5.7
Service Revenue	1,276.08	1,085.79	1,646.51	-14.9	8.7
Total Factory Revenue	5,976.69	5,926.64	8,814.80	-0.8	8.3
Japan/U.S. Exchange Rate*	108.81	121.10	140.79	11.3	3.1
Japan (¥M)					
Software Revenue	199,140.77	244,894.41	485,077.23	23.0	14.6
Hardware Revenue	312,332.11	341,332.56	524,146.26	9.3	9.0
Service Revenue	138,850.70	131,489.22	231,812.50	-5.3	12.0
Total Factory Revenue	650,323.58	717,716.19	1,241,035.99	10.4	11.6
North America ($M)					
Software Revenue	2,544.84	2,786.35	5,317.84	9.5	13.8
Hardware Revenue	2,963.65	3,075.77	4,822.15	3.8	9.4
Service Revenue	1,428.64	1,441.18	2,537.79	0.9	12.0
Total Factory Revenue	6,937.12	7,303.29	12,677.77	5.3	11.7
Worldwide ($M)					
Software Revenue	7,168.51	7,748.89	13,665.55	8.1	12.0
Hardware Revenue	9,332.07	9,315.86	13,098.21	-0.2	7.1
Service Revenue	4,197.99	4,031.59	6,375.98	-4.0	9.6
Total Factory Revenue	**20,698.57**	**21,096.34**	**33,139.73**	**1.9**	**9.5**

*Assuming a stable currency, the 2002 exchange rate is July 1998 monthly rate.
Source: Dataquest (October 1998)

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Table 1-2
Foreign Currency Exchange Rates against the U.S. Dollar

		Actual				Current			Year-to-Year Change (%)					
Country	Currency	1993	1994	1995	1996	1997	1998	1999	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998	1998-1999
Austria	Schilling	11.65	11.40	10.06	10.59	12.20	12.65	12.65	-2.15	-11.75	5.27	15.20	3.69	0
Belgium	Franc	34.67	33.66	29.42	30.96	35.79	37.07	37.07	-2.91	-12.60	5.23	15.60	3.58	0
Denmark	Krone	6.49	6.35	5.59	5.81	6.61	6.85	6.85	-2.16	-11.97	3.94	13.77	3.63	0
Finland	Markka	5.73	5.21	4.37	4.59	5.19	5.47	5.47	-9.08	-16.12	5.03	13.07	5.39	0
France	Franc	5.67	5.54	4.97	5.12	5.84	6.03	6.03	-2.29	-10.29	3.02	14.06	3.25	0
Germany	D-Mark	1.66	1.62	1.43	1.50	1.73	1.80	1.80	-2.41	-11.73	4.90	15.33	4.05	0
Italy	Lira	1,577.85	1,609.34	1,628.21	1,542.72	1,703.02	1,772.42	1,772.42	2.00	1.17	-5.25	10.39	4.08	0
Netherlands	Guilder	1.86	1.82	1.60	1.69	1.95	2.03	2.03	-2.15	-12.09	5.62	15.38	4.10	0
Norway	Krone	7.11	7.04	6.33	6.46	7.08	7.63	7.63	-0.98	-10.09	2.05	9.60	7.77	0
Spain	Peseta	127.87	133.48	124.40	126.68	146.45	152.58	152.58	4.39	-6.80	1.83	15.61	4.19	0
Sweden	Krona	7.82	7.70	7.14	6.71	7.64	7.99	7.99	-1.53	-7.27	-6.02	13.86	4.58	0
Switzerland	Franc	1.48	1.37	1.18	1.24	1.45	1.51	1.51	-7.43	-13.87	5.08	16.94	4.14	0
United Kingdom	Pound	0.67	0.65	0.63	0.64	0.61	0.61	0.61	-2.99	-3.08	1.59	-4.69	0	0
Europe Average	ECU	0.86	0.84	0.77	0.80	0.89	0.91	0.91	-1.52	-8.72	3.58	11.59	2.25	0
China	Renminbi	5.76	8.54	8.35	8.34	8.32	8.31	8.31	48.26	-2.22	-0.12	-0.24	-0.12	0
Hong Kong	Dollar	7.74	7.73	7.74	7.73	7.74	7.75	7.75	-0.13	0.13	-0.13	0.13	0.13	0
Japan	Yen	110.85	101.56	93.90	108.81	121.10	140.79	140.79	-8.38	-7.54	15.88	11.29	16.26	0
Korea	Won	799.42	805.80	770.57	805.16	954.14	1,295.76	1,295.76	0.80	-4.37	4.49	18.50	35.80	0
Singapore	Dollar	1.62	1.53	1.43	1.41	1.49	1.71	1.71	-5.32	-6.54	-1.40	5.67	14.77	0
Taiwan	Dollar	26.15	26.45	26.48	27.47	28.79	34.39	34.39	1.15	0.11	3.74	4.81	19.45	0

Source: Dataquest (October 1998)

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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, the won, 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 affect growth in the mechanical CAD/CAM/CAE market over our forecast period.

CAD Investments Are Cyclical

The major aerospace and automotive companies, particularly in Europe, had been significant drivers of the double-digit mechanical CAD/CAM/CAE growth in previous years. However, these companies have now completed their investment cycles in CAD technology for the next four or five years. Investment in CAD by these large companies will slow until the next investment cycle begins, bringing down the overall market growth.

Tier Two Investments

Related to the above assumption, now that these companies have completed their investment cycles, Dataquest expects to see corresponding investment by their supplier bases as a significant driver of the market.

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. 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 and who are looking to upgrade from their 2-D-based systems. Based on what we saw in 1997, we are shifting the peak of our NT-based mechanical CAD/CAM/CAE sales forecast to earlier in our five-year forecast period.

Continued Economic Turmoil in Asia/Pacific

The Asia/Pacific region will be a mixed bag of high and low growth over our forecast period, fueled by CAD investments from local and national governments and expansion by multinational companies, but also tempered by economic and political turmoil in Southeast Asia. We have lowered our forecast for Asia/Pacific in light of the economic uncertainty in some of that region.

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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. If they can come up with the "right" solution, we can significantly raise our forecast.

AEC Forecast Assumptions

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

CAD Is Becoming a Business Requirement

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

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.

A More Tailored Focus

If vendors stay focused on not selling generic CAD solutions but rather on selling more tailored solutions to fit different needs in AEC (such as architectural needs, plant design needs), then we can begin to raise our forecast upward. Over the years, AEC sales have largely been driven by vanilla sales of CAD products. Solutions that meet specific needs of users will help drive the market forward at a faster rate.

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.

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GIS/Mapping Forecast Assumptions

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

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. Advances in aerial photography, global positioning systems, and satellite imagery 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.

Indispensability of GIS

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.

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

Our final survey showed even slower growth than reported in the Preliminary Forecast. Total EDA growth was 14.6 percent. This spring Dataquest did a considerable amount of work modeling the end-user design market.

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The breakthrough happened when we broke the mainstream into upper and lower mainstream segments. With these new models we found that all our previous survey work converged. This gave us a clear picture of the actual growth by segment, explaining in greater detail the reason for the slowdown in EDA growth. The top of the pyramid, the power users, only grew 4.5 percent. This was the group that in essence had run out of tools to buy. This also explains the reason the slowdown was far more pronounced in the United States than in other geographic regions. On the other hand, the upper mainstream grew 12.8 percent and the lower mainstream a whopping 130.4 percent. These are the markets that kept EDA from falling into the 4 percent growth area of the early 1990s, another period when we ran out of tools. Just to give you a comparison picture, in 1991, 75 percent of all money spent on EDA tools was spent by the power users. This year, for the first time, the upper mainstream alone will spend more dollars on EDA tools than the power users.

It has become clear that this is not a semiconductor recession; this is a true technology inflection point. The last time we saw this was in the early 1980s when the impact of the microprocessor caused a double-dip recession. If you remember, it was the time of explosive growth in EDA. We are a much larger industry today so the growth won't be explosive but it will be significant and, as 1997 has shown, it will be driven by supply, not demand. The need is there, the money is there, now where are the needed new tools?

Electronic CAE

CAE was by far the area where the lack of new tools hit the hardest. Where is the RTL Virtual Prototype? What are we going to do about the verification crisis? Why has ES Level tool development been de-emphasized by the EDA industry? The only bright spots have been hardware and software coverification and formal verification, at least at the equivalency checking level. The best news this year has been an answer to the verification crisis. At least we think we know the answer. Until we see the new test bench, a test bench that coordinates the work of not just simulation but multiple types of simulation while also using formal verification and formal analysis, we won't know. Unfortunately, we've yet to see much progress on the RTL Virtual Prototype front. There are some new start-ups now attacking the problem, and they are showing an extremely broad level of technical expertise. We can only hope.

IC Layout

The IC CAD world is catching up with the silicon. This is obviously the most exciting news to come out of EDA in years. Announcements by Avant! and Cadence plus the progress on the Sematech CHDs, Physical Verification program have excited the industry. We're one generation behind and closing! This will keep the IC CAD market growing at about 20 percent for the foreseeable future.

PCB Design

The final PCB numbers showed a completely different picture than the preliminary PCB numbers. The Asia/Pacific region grew an extremely strong 22.2 percent. The major downfall was in Japan, followed by Europe. This is a continuation of the flow of manufacturing to Asia from these areas. North America grew at a strong 12 percent. Again the new high-speed buses will continue to drive this market.

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History and Forecast for All Applications and Operating Systems

Tables 1-3 and 1-4 show the history and forecast of all applications.

Table 1-3
CAD/CAM/CAE/GIS Software Revenue History and Forecast

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Software Revenue ($M)									
Worldwide, All Operating Systems	6,197	7,169	7,749	8,639	9,718	10,948	12,280	13,666	12.0
Worldwide									
UNIX	4,135	4,670	4,670	4,853	5,158	5,541	5,975	6,427	6.6
Windows NT	401	836	1,626	2,350	3,090	3,902	4,761	5,653	28.3
Personal Computer	1,485	1,429	1,392	1,401	1,449	1,492	1,536	1,580	2.6
Host/Proprietary	176	155	61	35	21	13	8	5	-38.2
All Operating Systems									
North America	2,098	2,545	2,786	3,190	3,677	4,206	4,748	5,318	13.8
Europe	2,000	2,192	2,289	2,501	2,787	3,074	3,402	3,780	10.6
Japan	1,613	1,830	2,022	2,239	2,480	2,786	3,112	3,445	11.2
Asia/Pacific	377	479	526	570	619	709	825	907	11.5
Rest of World	110	123	126	139	155	173	192	215	11.3

Source: Dataquest (October 1998)

Table 1-4
CAD/CAM/CAE/GIS Software Revenue Growth Rate History and Forecast

	1996	1997	1998	1999	2000	2001	2002
Year-to-Year Software Revenue Growth Rate (%)							
Worldwide, All Operating Systems	15.7	8.1	11.5	12.5	12.7	12.2	11.3
Worldwide							
UNIX	14.8	-1.7	3.9	6.3	7.4	7.8	7.6
Windows NT	108.7	94.4	44.5	31.5	26.2	22.0	18.7
Personal Computer	-3.8	-2.6	0.6	3.4	3.0	2.9	2.8
Host/Proprietary	-12.1	-60.5	-42.7	-40.3	-37.6	-35.6	-34.5
All Operating Systems							
North America	21.3	9.5	14.5	15.3	14.4	12.9	12.0
Europe	9.6	4.4	9.3	11.4	10.3	10.7	11.1
Japan	13.5	10.5	10.7	10.8	12.4	11.7	10.7
Asia/Pacific	27.0	9.9	8.4	8.6	14.6	16.3	10.0
Rest of World	11.5	2.4	11.0	11.3	11.4	11.0	12.0

Source: Dataquest (October 1998)

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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 Asia/Pacific and Europe of the events of 1997.

Figure 1-1 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:

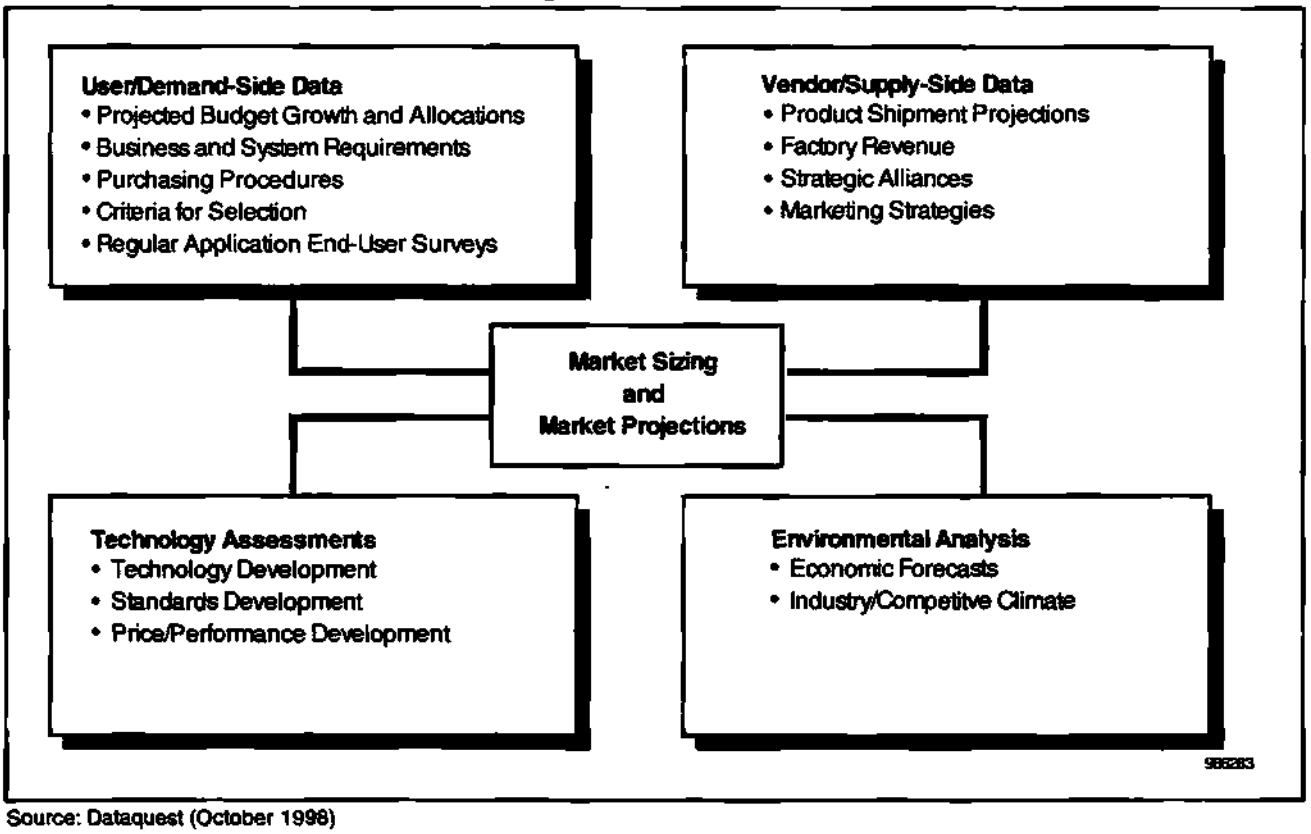
- Segment forecasting—Individual forecasts are derived for each application segment tracked by the CAD/CAM/CAE, AEC and GIS, and EDA groups. Specifically, each application, segmented by region and platform, is forecast and rolled up. In this way, each application segment incorporates its own set of unique 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.

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Figure 1-1
CAD/CAM/CAE and GIS Forecasting Model



Source: Dataquest (October 1998)

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

Line Items

Line item definitions are as follows:

- 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

- Asia/Pacific—Includes China, Hong Kong, Korea, Singapore, and Taiwan
- Rest of Asia—Includes Australia, American Samoa, Ashmore and Cartier Islands, Baker Island, Bangladesh, Bhutan, Bouvet Island, Brunei, Cambodia, Christmas Island, Cocos (Keeling) Islands, Cook Islands, Coral Sea Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Howland Island, India, Indonesia, Jarvis Island, Johnston Atoll, Kingman Reef, Kiribati, Laos, Macau, Malaysia, Maldives, Marshall Islands, Midway Islands, Mongolia, Myanmar (Burma), Nauru, Nepal, New Caledonia, New Zealand, Niue, Norfolk Island, Northern Mariana Islands, North Korea, Pakistan, Palau, Palmyra Atoll, Papua New Guinea, Paracel Islands, Philippines, Pitcairn Islands, Solomon Islands, Spratly Islands, Sri Lanka, Thailand, Tokelau, Tonga, Tuvalu, Vanuatu, Vietnam, Wake Island, Wallis and Futuna, and Western Samoa

Chapter 2
1998 Asia/Pacific Mechanical CAD/CAM/CAE Forecast Tables

Table 2-1
Top-Level Mechanical Forecast, Worldwide, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Software Revenue ($M)									
Worldwide, All Operating Systems	2,830	3,328	3,513	3,843	4,228	4,607	4,996	5,417	9.0
Worldwide									
UNIX	2,057	2,376	2,186	2,199	2,249	2,293	2,353	2,435	2.2
Windows NT	116	315	739	1,078	1,414	1,744	2,064	2,393	26.5
Personal Computer	545	539	550	546	553	562	573	585	1.2
Host/Proprietary	111	99	38	20	12	8	6	4	-35.9
All Operating Systems									
North America	788	997	1,033	1,166	1,323	1,453	1,572	1,685	10.3
Europe	987	1,084	1,106	1,188	1,295	1,391	1,515	1,686	8.8
Japan	883	1,019	1,122	1,222	1,326	1,453	1,571	1,679	8.4
Asia/Pacific	141	192	212	224	235	256	280	305	7.5
Rest of World	31	36	39	44	49	54	58	63	9.9
Year-to-Year Software Revenue Growth Rate (%)									
Worldwide, All Operating Systems		17.6	5.6	9.4	10.0	9.0	8.4	8.4	-
Worldwide									
UNIX		15.5	-8.0	0.6	2.3	2.0	2.6	3.5	-
Windows NT		170.1	134.9	45.9	31.2	23.3	18.4	15.9	-
Personal Computer		-1.1	2.1	-0.7	1.2	1.6	1.9	2.1	-
Host/Proprietary		-11.5	-61.8	-45.9	-39.8	-33.1	-30.5	-28.4	-
All Operating Systems									
North America		26.6	3.6	12.9	13.5	9.8	8.1	7.2	-
Europe		9.9	2.0	7.4	9.0	7.5	8.9	11.3	-
Japan		15.5	10.1	8.9	8.5	9.6	8.1	6.9	-
Asia/Pacific		35.9	10.9	5.3	5.0	8.9	9.5	8.8	-
Rest of World		13.0	10.0	11.7	11.7	9.7	8.8	7.5	-

Source: Dataquest (October 1998)

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Table 2-2
Detail Mechanical Forecast, Asia/Pacific, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	23,140	26,527	26,285	26,308	26,852	27,261	28,789	30,441	3
Seats	23,909	27,445	26,340	26,212	26,241	27,406	28,908	30,544	3
Year-to-Year Increase (%)	27	15	-4	0	0	4	5	6	-
Installed Base									
CPUs	52,534	65,984	74,918	80,080	83,261	85,228	87,681	91,079	4
Seats	54,884	68,746	77,143	81,495	83,509	85,267	87,795	91,280	3
Year-to-Year Increase (%)	36	25	12	6	2	2	3	4	-
Revenue Data ($M)									
Hardware Revenue	**237**	**284**	**272**	**266**	**267**	**277**	**293**	**311**	**3**
Year-to-Year Increase (%)	43	20	-4	-2	0	4	6	6	-
Software Revenue	**141**	**192**	**212**	**224**	**235**	**256**	**280**	**305**	**7**
Year-to-Year Increase (%)	42	36	11	5	5	9	10	9	-
Software Service	54	63	74	77	81	87	96	104	7
Hardware Service	42	54	55	51	51	53	56	60	2
Service Revenue	**97**	**117**	**129**	**127**	**132**	**140**	**152**	**164**	**5**
Year-to-Year Increase (%)	56	21	10	-1	3	7	8	8	-
Total Factory Revenue	**475**	**593**	**614**	**617**	**633**	**673**	**725**	**780**	**5**
Year-to-Year Increase (%)	45	25	4	1	3	6	8	8	-

Source: Dataquest (October 1998)

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Table 2-3
Detail Mechanical Forecast, China, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	1,973	2,668	3,153	3,320	3,590	3,767	4,142	4,627	8
Seats	2,002	2,665	3,153	3,296	3,474	3,787	4,158	4,643	8
Year-to-Year Increase (%)	33	33	18	5	5	9	10	12	-
Installed Base									
CPUs	4,706	6,211	7,882	9,305	10,501	11,411	12,297	13,367	11
Seats	4,914	6,351	7,970	9,331	10,389	11,312	12,241	13,351	11
Year-to-Year Increase (%)	26	29	25	17	11	9	8	9	-
Revenue Data ($M)									
Hardware Revenue	**27**	**37**	**41**	**42**	**45**	**49**	**54**	**60**	**8**
Year-to-Year Increase (%)	50	35	10	3	6	10	10	12	-
Software Revenue	**17**	**26**	**32**	**37**	**41**	**47**	**54**	**63**	**14**
Year-to-Year Increase (%)	42	54	26	13	12	16	15	15	-
Software Service	8	9	14	15	17	20	23	26	14
Hardware Service	6	8	9	9	9	10	11	12	6
Service Revenue	**14**	**18**	**23**	**24**	**26**	**30**	**34**	**39**	**11**
Year-to-Year Increase (%)	75	28	29	6	10	14	14	14	-
Total Factory Revenue	**58**	**80**	**96**	**103**	**112**	**126**	**142**	**162**	**11**
Year-to-Year Increase (%)	53	39	19	7	9	13	13	14	-

Source: Dataquest (October 1998)

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Table 2-4
Detail Mechanical Forecast, Hong Kong, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	1,883	2,662	3,323	3,250	3,174	3,092	3,198	3,246	0
Seats	1,891	2,638	3,314	3,221	3,078	3,100	3,204	3,251	0
Year-to-Year Increase (%)	25	39	26	-3	-4	1	3	1	-
Installed Base									
CPUs	4,790	6,140	7,875	9,098	9,721	9,843	9,861	9,874	5
Seats	4,911	6,197	7,892	9,069	9,593	9,730	9,785	9,831	4
Year-to-Year Increase (%)	19	26	27	15	6	1	1	0	-
Revenue Data ($M)									
Hardware Revenue	**24**	**27**	**29**	**27**	**26**	**25**	**26**	**26**	**-2**
Year-to-Year Increase (%)	65	14	8	-7	-6	-2	3	0	-
Software Revenue	**14**	**18**	**21**	**21**	**20**	**20**	**21**	**22**	**1**
Year-to-Year Increase (%)	60	29	20	-3	-2	2	5	2	-
Software Service	5	7	7	6	6	6	7	7	-1
Hardware Service	5	5	5	5	4	4	4	4	-4
Service Revenue	**10**	**12**	**12**	**11**	**11**	**11**	**11**	**11**	**-2**
Year-to-Year Increase (%)	78	24	2	-10	-4	-1	5	0	-
Total Factory Revenue	**47**	**57**	**63**	**59**	**56**	**56**	**59**	**59**	**-1**
Year-to-Year Increase (%)	66	20	10	-6	-4	0	4	1	-

Source: Dataquest (October 1998)

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Table 2-5
Detail Mechanical Forecast, Korea, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	5,281	6,036	6,700	6,646	6,748	6,810	7,173	7,612	3
Seats	5,486	6,195	6,763	6,669	6,646	6,877	7,228	7,657	3
Year-to-Year Increase (%)	27	13	9	-1	0	3	5	6	-
Installed Base									
CPUs	11,692	14,856	17,677	19,551	20,899	21,772	22,598	23,548	6
Seats	12,302	15,500	18,230	19,960	21,069	21,909	22,749	23,709	5
Year-to-Year Increase (%)	40	26	18	9	6	4	4	4	-
Revenue Data ($M)									
Hardware Revenue	**55**	**63**	**85**	**83**	**83**	**85**	**90**	**95**	**2**
Year-to-Year Increase (%)	47	14	35	-3	0	3	5	6	-
Software Revenue	**33**	**46**	**68**	**71**	**75**	**82**	**89**	**97**	**8**
Year-to-Year Increase (%)	66	39	48	6	6	8	9	9	-
Software Service	14	15	24	25	27	29	31	34	7
Hardware Service	10	12	19	17	18	18	19	21	2
Service Revenue	**23**	**27**	**43**	**42**	**44**	**47**	**51**	**55**	**5**
Year-to-Year Increase (%)	72	16	58	-1	4	7	8	8	-
Total Factory Revenue	**112**	**136**	**195**	**196**	**202**	**214**	**229**	**247**	**5**
Year-to-Year Increase (%)	57	22	44	1	3	6	7	7	-

Source: Dataquest (October 1998)

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Table 2-6
Detail Mechanical Forecast, Singapore, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	1,552	1,711	2,009	1,926	1,860	1,823	1,887	1,922	-1
Seats	1,760	2,096	2,009	1,919	1,830	1,828	1,891	1,925	-1
Year-to-Year Increase (%)	24	19	-4	-4	-5	0	3	2	-
Installed Base									
CPUs	4,014	4,697	5,440	5,887	6,042	6,002	5,961	5,956	2
Seats	4,451	5,449	6,083	6,334	6,297	6,149	6,058	6,017	0
Year-to-Year Increase (%)	27	22	12	4	-1	-2	-1	-1	-
Revenue Data ($M)									
Hardware Revenue	**23**	**29**	**19**	**18**	**17**	**16**	**17**	**17**	**-3**
Year-to-Year Increase (%)	29	25	-33	-9	-6	-3	4	1	-
Software Revenue	**12**	**15**	**17**	**16**	**16**	**16**	**18**	**18**	**2**
Year-to-Year Increase (%)	18	31	9	-2	-2	3	8	3	-
Software Service	5	6	6	5	5	5	6	6	2
Hardware Service	4	5	4	3	3	3	3	3	-5
Service Revenue	**9**	**10**	**10**	**9**	**8**	**8**	**9**	**9**	**-1**
Year-to-Year Increase (%)	40	16	-9	-9	-3	-1	8	2	-
Total Factory Revenue	**44**	**55**	**45**	**43**	**41**	**41**	**43**	**44**	**0**
Year-to-Year Increase (%)	28	25	-17	-6	-4	0	6	2	-

Source: Dataquest (October 1998)

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Table 2-7
Detail Mechanical Forecast, Taiwan, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	5,141	5,398	3,708	3,655	3,572	3,517	3,602	3,656	0
Seats	5,344	5,710	3,702	3,631	3,489	3,525	3,609	3,661	0
Year-to-Year Increase (%)	30	7	-35	-2	-4	1	2	1	-
Installed Base									
CPUs	11,436	13,981	13,815	12,989	12,168	11,568	11,350	11,369	-4
Seats	11,898	14,673	14,385	13,358	12,311	11,628	11,388	11,396	-5
Year-to-Year Increase (%)	42	23	-2	-7	-8	-6	-2	0	-
Revenue Data ($M)									
Hardware Revenue	**41**	**49**	**34**	**32**	**31**	**31**	**31**	**31**	**-1**
Year-to-Year Increase (%)	55	17	-31	-4	-4	1	1	0	-
Software Revenue	**25**	**32**	**30**	**31**	**31**	**33**	**35**	**36**	**4**
Year-to-Year Increase (%)	49	25	-6	3	1	6	5	3	-
Software Service	8	9	8	8	8	9	9	9	3
Hardware Service	7	8	7	6	6	6	6	6	-3
Service Revenue	**15**	**17**	**15**	**14**	**14**	**15**	**15**	**15**	**0**
Year-to-Year Increase (%)	49	16	-12	-5	-1	4	3	1	-
Total Factory Revenue	**82**	**97**	**78**	**77**	**76**	**78**	**81**	**82**	**1**
Year-to-Year Increase (%)	52	19	-19	-2	-2	3	3	2	-

Source: Dataquest (October 1998)

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Table 2-8
Detail Mechanical Forecast, Rest of Asia, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	7,309	8,052	7,392	7,511	7,907	8,253	8,788	9,379	5
Seats	7,426	8,142	7,399	7,476	7,723	8,288	8,819	9,408	5
Year-to-Year Increase (%)	24	10	-9	1	3	7	6	7	-
Installed Base									
CPUs	15,895	20,098	22,229	23,249	23,930	24,631	25,615	26,965	4
Seats	16,407	20,576	22,583	23,443	23,851	24,539	25,575	26,975	4
Year-to-Year Increase (%)	40	25	10	4	2	3	4	5	-
Revenue Data ($M)									
Hardware Revenue	**66**	**79**	**64**	**65**	**66**	**71**	**75**	**81**	**5**
Year-to-Year Increase (%)	30	20	-19	1	3	6	7	8	-
Software Revenue	**41**	**56**	**45**	**48**	**52**	**57**	**63**	**69**	**9**
Year-to-Year Increase (%)	26	37	-19	7	7	11	10	10	-
Software Service	14	17	16	16	17	18	20	22	7
Hardware Service	12	16	11	11	11	12	12	14	4
Service Revenue	**26**	**33**	**27**	**27**	**28**	**30**	**33**	**36**	**6**
Year-to-Year Increase (%)	40	27	-18	0	4	7	9	10	-
Total Factory Revenue	**133**	**168**	**136**	**140**	**146**	**158**	**171**	**186**	**6**
Year-to-Year Increase (%)	31	27	-19	3	4	8	8	9	-

Source: Dataquest (October 1998)

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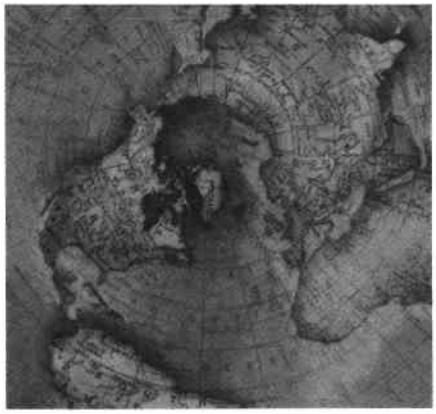
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1997 Asia/Pacific Mechanical CAD/CAM/CAE Market Share

Market Statistics

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Program: Mechanical CAD/CAM/CAE Asia/Pacific
Product Code: CMEC-AP-MS-9801
Publication Date: September 7, 1998
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Table of Contents

Page

1. Introduction 1
   - About This Document 1
   - Definitions 1
     - Asia/Pacific 1
   - Publishing Schedule 1
   - A Final Note 1
2. 1997 Asia/Pacific Mechanical CAD/CAM/CAE Market Share Tables 3

List of Tables

Table		Page
2-1	Top 30 Mechanical Software Companies, Worldwide, All Operating Systems	3
2-2	Top 30 Mechanical Software Companies, Asia/Pacific, All Operating Systems	4
2-3	Top 24 Mechanical Software Companies, China, All Operating Systems	5
2-4	Top 23 Mechanical Software Companies, Hong Kong, All Operating Systems	6
2-5	Top 30 Mechanical Software Companies, Korea, All Operating Systems	7
2-6	Top 27 Mechanical Software Companies, Singapore, All Operating Systems	8
2-7	Top 30 Mechanical Software Companies, Taiwan, All Operating Systems	9
2-8	Top 30 Mechanical Software Companies, Rest of Asia, All Operating Systems	10

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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/CAM/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 countries in the Asia/Pacific region.

Definitions

This section lists the definitions specific to this document. For other definitions, please see the worldwide Market Statistics book.

Asia/Pacific

- **Asia Pacific:** Includes China, Hong Kong, Korea, Singapore, and Taiwan
- **Rest of Asia:** Includes Australia, American Samoa, Ashmore and Cartier Islands, Baker Island, Bangladesh, Bhutan, Bouvet Island, Brunei, Cambodia, Christmas Island, Cocos (Keeling) Islands, Cook Islands, Coral Sea Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Howland Island, India, Indonesia, Jarvis Island, Johnston Atoll, Kingman Reef, Kiribati, Laos, Macau, Malaysia, Maldives, Marshall Islands, Midway Islands, Mongolia, Myanmar (Burma), Nauru, Nepal, New Caledonia, New Zealand, Niue, Norfolk Island, Northern Mariana Islands, North Korea, Pakistan, Palau, Palmyra Atoll, Papua New Guinea, Paracel Islands, Philippines, Pitcairn Islands, Solomon Islands, Spratly Islands, Sri Lanka, Thailand, Tokelau, Tonga, Tuvalu, Vanuatu, Vietnam, Wake Island, Wallis and Futuna, and Western Samoa

Publishing Schedule

Dataquest publishes market share and forecasts at the country level once each year. Our delivery schedule is as follows:

- Asia/Pacific country-level market share tables for 1997, based on data collection and analysis beginning in January 1998, are presented in this report. At this point, the market share database is frozen and will not be changed until the end of 1998.
- Forecast tables will be available electronically by mid-September, and books will be shipped in October. 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.

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Chapter 2
1997 Asia/Pacific Mechanical CAD/CAM/CAE Market Share Tables

Table 2-1
Top 30 Mechanical Software Companies, Worldwide, All Operating Systems
(Revenue in Millions of Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	IBM	449.0	563.5	641.8	13.9	18.3
2	Parametric Technology	321.2	495.0	605.8	22.4	17.3
3	Dassault Systemes	204.9	249.5	303.8	21.8	8.7
4	Autodesk	192.9	174.2	206.4	18.5	5.9
5	Structural Dynamics Research Corporation	124.7	153.1	172.1	12.4	4.9
6	MicroCADAM	129.2	152.0	150.0	-1.3	4.3
7	Info. Services Int'l. Dentsu*	85.2	117.2	125.9	7.5	3.6
8	CoCreate	107.3	113.4	125.5	10.7	3.6
9	Unigraphics Solutions	89.1	209.5	115.5	-44.9	3.3
10	MacNeal-Schwendler	114.0	106.3	104.0	-2.2	3.0
11	Fujitsu	97.0	107.3	103.5	-3.6	2.9
12	Matra Datavision	87.4	91.8	90.6	-1.2	2.6
13	NEC	72.9	62.9	70.9	12.7	2.0
14	Hitachi	70.9	63.7	68.1	6.8	1.9
15	Toshiba*	66.7	62.5	65.0	3.9	1.9
16	Computervision	149.0	174.4	61.7	-64.6	1.8
17	Nihon Unisys	52.8	54.4	54.6	0.3	1.6
18	Hitachi Zosen Info Systems	38.7	39.3	42.7	8.8	1.2
19	Ansys	32.6	37.0	35.1	-5.2	1.0
20	Tecnomatix Technology	20.1	26.3	34.2	30.0	1.0
21	C. Itoh Techno-Science*	30.8	30.8	32.5	5.5	0.9
22	Delcam Plc	16.7	22.0	30.8	40.0	0.9
23	Sherpa Corp.	20.6	26.2	27.5	5.0	0.8
24	Marubeni Hytech*	19.9	23.0	24.9	8.5	0.7
25	Sumisho Electronics*	18.8	21.6	23.4	8.4	0.7
26	MARC	18.2	19.5	21.8	11.7	0.6
27	Tokyo Electron*	17.4	20.0	21.8	8.5	0.6
28	Formtek	18.9	20.6	21.7	5.1	0.6
29	Seiko*	19.7	19.0	21.1	11.0	0.6
30	ISD Software	14.5	22.7	20.1	-11.4	0.6
	All N.A. Companies	**2,010.1**	**2,504.8**	**2,573.6**	**2.7**	**73.3**
	All European Companies	**339.5**	**345.6**	**390.9**	**13.1**	**11.1**
	All Asian Companies	**481.5**	**475.4**	**545.7**	**14.8**	**15.5**
	All Companies	**2,831.1**	**3,325.7**	**3,510.3**	**5.5**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (August 1998)

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Table 2-2
Top 30 Mechanical Software Companies, Asia/Pacific, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Parametric Technology	9.6	32.7	52.7	61.3	24.8
2	IBM	35.5	42.0	48.6	15.9	22.9
3	Dassault Systemes	16.9	17.8	28.8	61.6	13.6
4	Autodesk	21.1	22.6	23.7	4.8	11.2
5	Unigraphics Solutions	9.1	18.2	17.1	-6.3	8.0
6	Structural Dynamics Research Corporation	16.8	18.4	16.6	-9.5	7.8
7	MacNeal-Schwendler	2.4	6.4	6.6	2.7	3.1
8	Delcam Plc	2.8	3.3	4.6	40.0	2.2
9	Matra Datavision	7.0	4.6	4.6	0.6	2.2
10	MicroCADAM	3.9	4.6	4.5	-1.3	2.1
11	Computervision	10.3	10.1	4.0	-60.4	1.9
12	Formtek	0.8	2.1	2.3	10.0	1.1
13	Intergraph	0.5	1.4	2.3	64.5	1.1
14	Alias Research	1.7	1.7	2.1	20.0	1.0
15	MCS	1.8	1.8	1.8	3.7	0.9
16	Gerber Systems	1.2	1.5	1.8	18.5	0.8
17	Cimatron	1.7	1.9	1.7	-10.3	0.8
18	Sharp*	2.1	1.9	1.7	-10.1	0.8
19	Ansys	2.0	1.9	1.4	-24.1	0.7
20	Sherpa Corp.	-	1.3	1.4	5.0	0.6
21	Mechanical Dynamics	0.8	1.0	1.4	31.7	0.6
22	Tecnomatix Technology	-	1.2	1.2	0	0.6
23	Concentra	0.3	4.0	1.1	-72.9	0.5
24	Bentley Systems	0.9	0.9	1.1	17.9	0.5
25	MARC	-	0.8	1.0	30.5	0.5
26	PAFEC	-	1.0	1.0	5.2	0.5
27	Open Mind	-	0.7	0.9	19.5	0.4
28	ADRA Systems	1.1	1.3	0.9	-33.4	0.4
29	Investronica SA	3.9	0.8	0.8	2.8	0.4
30	Design Automation	1.6	1.8	0.7	-59.9	0.3
	All N.A. Companies	**120.3**	**174.3**	**192.9**	**10.7**	**90.8**
	All European Companies	**17.8**	**13.5**	**16.3**	**20.6**	**7.7**
	All Asian Companies	**4.1**	**3.8**	**3.2**	**-14.4**	**1.5**
	All Companies	**142.2**	**191.6**	**212.4**	**10.9**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (August 1998)

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Table 2-3
Top 24 Mechanical Software Companies, China, All Operating Systems
(Revenue in Millions of Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Parametric Technology	0.8	4.1	8.4	102.0	25.9
2	Unigraphics Solutions	2.5	6.9	7.8	12.5	24.1
3	IBM	4.6	5.4	5.8	6.9	17.9
4	Structural Dynamics Research Corporation	2.3	2.7	3.5	31.0	10.9
5	Dassault Systemes	2.2	2.3	3.3	47.1	10.2
6	Autodesk	0.6	0.7	1.2	78.9	3.7
7	MacNeal-Schwendler	0.8	1.1	1.1	2.7	3.4
8	MicroCADAM	0.7	0.8	0.8	-9.1	2.3
9	Matra Datavision	0.5	0.3	0.7	145.0	2.3
10	Gerber Systems	0.4	0.5	0.7	34.1	2.3
11	Computervision	1.5	1.5	0.6	-60.4	1.8
12	Delcam Plc	0.2	0.2	0.4	88.1	1.3
13	Ansys	0.5	0.6	0.4	-43.1	1.1
14	Intergraph	0	0.1	0.2	91.2	0.6
15	Mechanical Dynamics	0.1	0.1	0.2	15.2	0.5
16	Open Mind	-	0.1	0.2	19.5	0.5
17	Investronica SA	-	0.1	0.1	3.6	0.4
18	B.A. Intelligence Networks	0.1	0.1	0.1	-32.2	0.3
19	Spatial Technology	0.3	0.2	0.1	-55.5	0.2
20	Pacific Numerix	-	0	0	537.0	0.1
21	Bentley Systems	-	0	0	17.9	0.1
22	Engineered Software	-	0	0	3.6	0
23	Cimatron	0.3	0.3	-	-100.0	-
24	Applicon	0.1	0.1	-	-100.0	-
	All N.A. Companies	**14.4**	**24.0**	**29.9**	**24.5**	**92.4**
	All European Companies	**1.0**	**1.1**	**1.4**	**31.6**	**4.3**
	All Asian Companies	-	-	-	**NA**	-
	All Companies	**16.5**	**25.7**	**32.4**	**26.3**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (August 1998)

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Table 2-4
Top 23 Mechanical Software Companies, Hong Kong, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Parametric Technology	1.4	4.2	5.8	37.6	28.2
2	IBM	2.8	2.9	3.1	5.9	15.1
3	Autodesk	0.8	0.9	1.8	96.9	8.9
4	Structural Dynamics Research Corporation	2.9	2.8	1.8	-35.1	8.9
5	Dassault Systemes	1.3	1.2	1.8	45.8	8.7
6	Unigraphics Solutions	0.5	1.3	1.2	-10.8	5.6
7	MacNeal-Schwendler	0.7	-	1.1	NA	5.3
8	Matra Datavision	0.5	0.3	0.8	150.8	3.7
9	PAFEC	-	0.7	0.8	4.4	3.7
10	MicroCADAM	0.7	0.8	0.8	-9.1	3.6
11	Computervision	1.7	1.7	0.7	-60.4	3.3
12	Investronica SA	-	0.6	0.7	2.7	3.2
13	Intergraph	0.1	0.2	0.6	150.7	2.7
14	Gerber Systems	0.2	0.3	0.3	7.7	1.4
15	Ansys	-	-	0.2	NA	0.9
16	Vero International Software	0.1	0.3	0.1	-67.5	0.5
17	Just In Time Systems	-	0.1	0.1	2.7	0.5
18	CNC Software	0.1	0.1	0.1	2.7	0.5
19	CIMLINC	0.1	0.1	0.1	9.4	0.3
20	Open Mind	-	0	0.1	19.5	0.3
21	Bentley Systems	-	0	0	17.9	0.2
22	Gibbs and Assoc.	-	0	0	30.6	0.2
23	Cimatron	0.1	0.1	-	-100.0	-
	All N.A. Companies	**11.9**	**15.0**	**17.1**	**14.1**	**82.9**
	All European Companies	**0.7**	**2.2**	**2.4**	**8.9**	**11.6**
	All Asian Companies	**-**	**-**	**-**	**NA**	**-**
	All Companies	**13.4**	**17.6**	**20.6**	**17.3**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (August 1998)

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Table 2-5
Top 30 Mechanical Software Companies, Korea, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	IBM	8.2	9.3	23.2	150.1	34.3
2	Parametric Technology	2.2	8.0	15.3	91.6	22.7
3	Dassault Systemes	3.7	3.9	13.3	244.3	19.7
4	Structural Dynamics Research Corporation	4.2	5.7	6.5	13.0	9.6
5	Autodesk	5.2	5.2	5.5	4.7	8.1
6	MacNeal-Schwendler	-	3.2	3.3	2.7	4.8
7	Formtek	-	2.1	2.3	10.0	3.4
8	Delcam Plc	1.5	1.2	1.4	13.5	2.1
9	Tecnomatix Technology	-	1.2	1.2	0	1.8
10	Intergraph	0.1	0.2	1.1	401.5	1.7
11	Matra Datavision	0.9	0.6	0.8	24.4	1.1
12	MCS	0.4	0.7	0.8	3.7	1.1
13	MicroCADAM	0.7	0.8	0.8	-9.1	1.1
14	Altair Computing	-	0.6	0.7	14.0	1.0
15	Computervision	1.7	1.7	0.7	-60.4	1.0
16	ADRA Systems	0.9	1.1	0.6	-46.5	0.9
17	Unigraphics Solutions	2.0	0.5	0.5	8.5	0.8
18	Mechanical Dynamics	0.2	0.4	0.5	15.2	0.8
19	Pacific Numerix	-	0.1	0.5	537.0	0.7
20	Sherpa Corp.	-	0.4	0.5	5.0	0.7
21	Ansys	0.5	0.6	0.4	-43.1	0.5
22	Open Mind	-	0.3	0.3	19.5	0.5
23	Bentley Systems	-	0.2	0.3	17.9	0.4
24	CIMLINC	0.2	0.2	0.3	14.4	0.4
25	Gerber Systems	0.2	0.2	0.2	13.2	0.3
26	Applicon	0.1	0.1	0.2	31.3	0.3
27	PAFEC	-	0.1	0.2	6.2	0.2
28	CAD Lab	-	0.1	0.1	18.2	0.2
29	CNC Software	0.1	0.1	0.1	2.7	0.1
30	Just In Time Systems	-	0.1	0.1	2.7	0.1
	All N.A. Companies	**26.1**	**41.8**	**62.7**	**49.7**	**92.8**
	All European Companies	**3.8**	**2.7**	**2.7**	**1.0**	**4.0**
	All Asian Companies	**0.1**	**-**	**0**	**NA**	**0**
	All Companies	**33.5**	**45.6**	**67.6**	**48.2**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (August 1998)

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Table 2-6
Top 27 Mechanical Software Companies, Singapore, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Parametric Technology	1.3	3.0	4.0	30.1	23.4
2	Unigraphics Solutions	0.7	2.6	2.3	-11.4	13.5
3	Structural Dynamics Research Corporation	3.7	3.4	2.3	-32.1	13.5
4	IBM	2.3	2.4	2.0	-16.1	12.1
5	Dassault Systemes	1.1	1.0	1.2	15.5	6.9
6	Autodesk	0.7	0.7	0.8	11.4	4.8
7	MicroCADAM	0.7	0.8	0.8	-9.1	4.4
8	Matra Datavision	-	-	0.7	NA	4.4
9	Fujitsu	-	-	0.5	NA	3.1
10	Delcam Plc	0.2	0.2	0.4	67.2	2.2
11	Computervision	0.7	0.7	0.3	-60.4	1.7
12	B.A. Intelligence Networks	0.2	0.2	0.2	-15.6	1.2
13	Ansys	0.1	-	0.2	NA	1.0
14	Intergraph	0	0.1	0.1	91.2	0.8
15	Mechanical Dynamics	-	0.1	0.1	125.0	0.7
16	Just In Time Systems	-	0.1	0.1	2.7	0.6
17	CNC Software	0.1	0.1	0.1	2.7	0.6
18	Pacific Numerix	-	0	0.1	537.0	0.5
19	Concentra	0.1	0.3	0.1	-78.2	0.4
20	DP Technology	0.1	0.1	0.1	5.4	0.4
21	Open Mind	-	0	0.1	19.5	0.3
22	Vero International Software	0.1	0.2	0.1	-71.5	0.3
23	Gibbs and Assoc.	-	0	0	30.6	0.3
24	Bentley Systems	-	0	0	17.9	0.2
25	ISD Software	-	0	0	-46.7	0.1
26	Cimatron	0.1	0.1	-	-100.0	-
27	Applicon	0	0	-	-100.0	-
	All N.A. Companies	**10.4**	**14.2**	**13.1**	**-7.7**	**77.6**
	All European Companies	**0.4**	**0.6**	**1.3**	**99.8**	**7.6**
	All Asian Companies	**-**	**-**	**0.5**	**NA**	**3.1**
	All Companies	**11.4**	**15.2**	**16.9**	**11.2**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (August 1998)

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Table 2-7
Top 30 Mechanical Software Companies, Taiwan, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Parametric Technology	2.0	5.2	6.9	31.9	23.0
2	Autodesk	4.6	4.7	5.5	16.3	18.4
3	IBM	4.1	4.4	3.5	-19.8	11.8
4	Structural Dynamics Research Corporation	3.8	3.8	2.5	-33.6	8.4
5	Dassault Systemes	1.9	1.8	2.0	10.4	6.7
6	Unigraphics Solutions	0.6	1.6	1.4	-11.5	4.8
7	MacNeal-Schwendler	-	1.1	1.1	2.7	3.7
8	MCS	1.0	1.0	1.1	3.7	3.6
9	Delcam Plc	0.5	0.7	1.0	47.0	3.3
10	MicroCADAM	0.7	0.8	0.8	-9.1	2.5
11	Matra Datavision	-	-	0.7	NA	2.5
12	Gerber Systems	0.4	0.5	0.5	8.8	1.7
13	Computervision	1.2	1.2	0.5	-60.4	1.6
14	Sherpa Corp.	-	0.4	0.5	5.0	1.5
15	Hitachi Zosen Info Systems	0.4	0.4	0.4	8.8	1.4
16	Intergraph	0.1	0.2	0.3	91.2	1.1
17	Bentley Systems	-	0.2	0.2	17.9	0.8
18	DP Technology	0.2	0.2	0.2	5.5	0.8
19	Open Mind	-	0.2	0.2	19.5	0.8
20	B.A. Intelligence Networks	0.2	0.2	0.2	-16.4	0.7
21	CNC Software	0.2	0.2	0.2	2.7	0.6
22	Ansys	0.4	0.3	0.2	-43.1	0.6
23	Mechanical Dynamics	-	0.1	0.1	125.0	0.4
24	SRAC	-	-	0.1	NA	0.4
25	Livermore Software Tech.	0.1	0.1	0.1	8.8	0.2
26	Vero International Software	0	0	0.1	13.8	0.2
27	ISD Software	-	0	0	-46.3	0.1
28	Cimatron	0.9	1.0	-	-100.0	-
29	Spatial Technology	0.3	0.2	-	-100.0	-
30	Ricoh	-	0	-	-100.0	-
	All N.A. Companies	**18.9**	**25.4**	**25.2**	**-0.8**	**84.7**
	All European Companies	**1.8**	**1.8**	**1.9**	**4.2**	**6.4**
	All Asian Companies	**0.4**	**0.4**	**0.4**	**6.7**	**1.4**
	All Companies	**25.3**	**31.6**	**29.7**	**-6.0**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (August 1998)

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Table 2-8
Top 30 Mechanical Software Companies, Rest of Asia, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Parametric Technology	1.9	8.1	12.4	53.5	27.4
2	IBM	13.6	17.5	11.0	-37.3	24.3
3	Autodesk	9.3	10.4	9.0	-13.7	19.8
4	Dassault Systemes	6.6	7.3	6.3	-13.8	13.9
5	Unigraphics Solutions	2.6	5.3	3.9	-27.2	8.6
6	Delcam Plc	0.5	1.0	1.5	51.4	3.3
7	Computervision	3.4	3.3	1.3	-60.4	2.9
8	Concentra	-	3.5	1.0	-72.8	2.1
9	Matra Datavision	5.1	3.4	0.9	-74.3	1.9
10	MicroCADAM	0.4	0.4	0.8	73.1	1.7
11	Intergraph	0.2	0.6	0.6	-1.3	1.2
12	Sherpa Corp.	-	0.4	0.5	5.0	1.0
13	Bentley Systems	-	0.4	0.5	17.9	1.0
14	Mechanical Dynamics	0.5	0.3	0.4	31.9	1.0
15	ADRA Systems	0.2	0.2	0.3	30.5	0.6
16	CNC Software	0.2	0.2	0.2	1.9	0.5
17	Algor Interactive Systems	0.1	0.1	0.2	110.4	0.5
18	Ansys	0.3	0.3	0.2	-43.1	0.4
19	Research Engineers	0.1	0.1	0.2	35.0	0.3
20	IMSI	0.1	0.1	0.1	11.0	0.2
21	Gibbs and Assoc.	-	0.1	0.1	30.6	0.2
22	Just In Time Systems	-	0.1	0.1	1.9	0.2
23	PAFEC	-	0.1	0.1	11.9	0.2
24	DP Technology	0.1	0.1	0.1	5.4	0.1
25	SRAC	-	-	0.1	NA	0.1
26	Open Mind	-	0	0.1	19.5	0.1
27	RoboCAD Solutions	0	0	0	1.9	0.1
28	Diehl Graphsoft	0	0	0	23.2	0.1
29	MacNeal-Schwendler	0.8	1.1	-	-100.0	-
30	Cimatron	0.1	0.1	-	-100.0	-
	All N.A. Companies	**32.6**	**50.0**	**41.0**	**-18.0**	**90.6**
	All European Companies	**6.0**	**4.7**	**2.6**	**-45.0**	**5.7**
	All Asian Companies	**-**	**-**	**-**	**NA**	**-**
	All Companies	**42.1**	**56.0**	**45.3**	**-19.1**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (August 1998)

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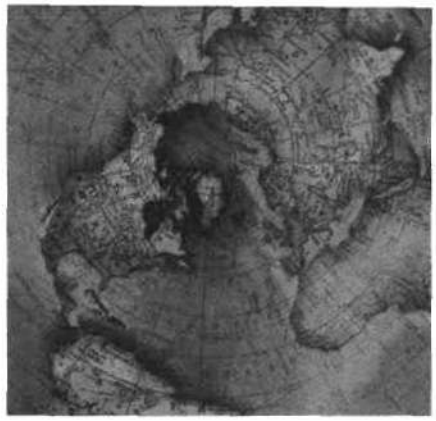
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Market Statistics

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Market Statistics

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Table of Contents

Page

1. 1998 European Mechanical CAD/CAM/CAE Forecast 1
   - Introduction 1
   - Worldwide Forecast Assumptions 1
     - All Applications 1
   - Mechanical Forecast Assumptions 4
     - CAD Investments Are Cyclical 4
     - Tier Two Investments 4
     - New Software, New Platforms, and New Users 5
     - Continued Economic Turmoil in Asia/Pacific 5
     - Meeting User Needs beyond Design 5
   - AEC Forecast Assumptions 5
     - CAD Is Becoming a Business Requirement 5
     - New Features in AEC CAD Products Are Achievable 5
     - A More Tailored Focus 6
     - Design Is Only Part of the Problem 6
   - GIS/Mapping Forecast Assumptions 6
     - Abundant Supply of Prospective Buyers 6
     - New Technologies 6
     - Indispensability of GIS 6
     - High Cost of Entry Remains a Barrier 7
     - Price Pressures Inhibit Growth 7
   - Electronic Design Automation Forecast Assumptions 7
     - Electronic CAE 8
     - IC Layout 8
     - PCB Design 8
   - History and Forecast for All Applications and Operating Systems 8
   - Forecast Methodology 9
   - Changes to the Forecast Database 11
   - Segmentation Definitions 11
     - Operating Systems 11
     - Line Items 11
   - Regions 12
     - Europe 12
2. 1998 European Mechanical CAD/CAM/CAE Forecast Tables 13

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List of Figures

Figure Page
1-1 CAD/CAM/CAE and GIS Forecasting Model 10

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List of Tables

Table		Page
1-1	CAD/CAM/CAE and GIS Revenue Growth Comparison	2
1-2	Foreign Currency Exchange Rates against the U.S. Dollar	3
1-3	CAD/CAM/CAE/GIS Software Revenue History and Forecast	8
1-4	CAD/CAM/CAE/GIS Software Revenue Growth Rate History and Forecast	9
2-1	Top-Level Mechanical Forecast, Worldwide, All Operating Systems	14
2-2	Detail Mechanical Forecast, Europe, All Operating Systems	15
2-3	Detail Mechanical Forecast, Benelux, All Operating Systems	16
2-4	Detail Mechanical Forecast, France, All Operating Systems	17
2-5	Detail Mechanical Forecast, Germany, All Operating Systems	18
2-6	Detail Mechanical Forecast, Italy, All Operating Systems	19
2-7	Detail Mechanical Forecast, Scandinavia, All Operating Systems	20
2-8	Detail Mechanical Forecast, Spain, All Operating Systems	21
2-9	Detail Mechanical Forecast, United Kingdom, All Operating Systems	22
2-10	Detail Mechanical Forecast, Austria/Switzerland, All Operating Systems	23
2-11	Detail Mechanical Forecast, Russia, All Operating Systems	24
2-12	Detail Mechanical Forecast, Central Europe, All Operating Systems	25
2-13	Detail Mechanical Forecast, Rest of Europe, All Operating Systems	26

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Chapter 1
1998 European Mechanical CAD/CAM/CAE Forecast

Introduction

This document contains Dataquest's detailed forecast information on the mechanical CAD/CAM/CAE, AEC and GIS, and EDA markets at the country level. This report is meant to supplement the worldwide forecast books for each service 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 1998 exchange rate will remain stable in the future (see Tables 1-1 and 1-2).

Additional market statistics publications for Dataquest's mechanical CAD/CAM/CAE, AEC and GIS, and EDA services for 1998 are as follows:

- Dataquest's 1997 preliminary market share documents (published as CAEC-WW-MS-9801, CEDA-WW-MS-9801, and CMEC-WW-MS-9801) were sent to our clients in April.
- Dataquest's 1998 preliminary forecast documents were released in June (published as CAEC-WW-MS-9802, CEDA-WW-MS-9802, and CMEC-WW-MS-9802).
- Dataquest's 1997 market share data was verified, updated, and sent to our clients in August as market share update reports (published as CAEC-WW-MS-9803, CEDA-WW-MS-9803, and CMEC-WW-MS-9803). Country-level data was also made available at this time.

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.

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

	1996	1997	Forecast 2002	Growth (%) 1996-1997	CAGR (%) 1997-2002
Europe ($M)					
Software Revenue	2,192.20	2,288.68	3,780.26	4.4	10.6
Hardware Revenue	2,736.77	2,639.54	3,491.73	-3.6	5.8
Service Revenue	1,166.77	1,160.33	1,678.11	-0.6	7.7
Total Factory Revenue	6,095.75	6,088.55	8,950.11	-0.1	8.0
ECU/U.S. Exchange Rate*	0.80	0.89	0.91	11.6	0.4
Europe (ECU Million)					
Software Revenue	1,748.45	2,036.92	3,440.04	16.5	11.0
Hardware Revenue	2,182.78	2,349.19	3,177.47	7.6	6.2
Service Revenue	930.59	1,032.70	1,527.08	11.0	8.1
Total Factory Revenue	4,861.82	5,418.81	8,144.60	11.5	8.5
Japan ($M)					
Software Revenue	1,830.17	2,022.25	3,445.40	10.5	11.2
Hardware Revenue	2,870.44	2,818.60	3,722.89	-1.8	5.7
Service Revenue	1,276.08	1,085.79	1,646.51	-14.9	8.7
Total Factory Revenue	5,976.69	5,926.64	8,814.80	-0.8	8.3
Japan/U.S. Exchange Rate*	108.81	121.10	140.79	11.3	3.1
Japan (¥M)					
Software Revenue	199,140.77	244,894.41	485,077.23	23.0	14.6
Hardware Revenue	312,332.11	341,332.56	524,146.26	9.3	9.0
Service Revenue	138,850.70	131,489.22	231,812.50	-5.3	12.0
Total Factory Revenue	650,323.58	717,716.19	1,241,035.99	10.4	11.6
North America ($M)					
Software Revenue	2,544.84	2,786.35	5,317.84	9.5	13.8
Hardware Revenue	2,963.65	3,075.77	4,822.15	3.8	9.4
Service Revenue	1,428.64	1,441.18	2,537.79	0.9	12.0
Total Factory Revenue	6,937.12	7,303.29	12,677.77	5.3	11.7
Worldwide ($M)					
Software Revenue	7,168.51	7,748.89	13,665.55	8.1	12.0
Hardware Revenue	9,332.07	9,315.86	13,098.21	-0.2	7.1
Service Revenue	4,197.99	4,031.59	6,375.98	-4.0	9.6
Total Factory Revenue	20,698.57	21,096.34	33,139.73	1.9	9.5

*Assuming a stable currency, the 2002 exchange rate is July 1998 monthly rate.
Source: Dataquest (October 1998)

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Table 1-2
Foreign Currency Exchange Rates against the U.S. Dollar

		Actual				Current			Year-to-Year Change (%)					
Country	Currency	1993	1994	1995	1996	1997	1998	1999	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998	1998-1999
Austria	Schilling	11.65	11.40	10.06	10.59	12.20	12.65	12.65	-2.15	-11.75	5.27	15.20	3.69	0
Belgium	Franc	34.67	33.66	29.42	30.96	35.79	37.07	37.07	-2.91	-12.60	5.23	15.60	3.58	0
Denmark	Krone	6.49	6.35	5.59	5.81	6.61	6.85	6.85	-2.16	-11.97	3.94	13.77	3.63	0
Finland	Markka	5.73	5.21	4.37	4.59	5.19	5.47	5.47	-9.08	-16.12	5.03	13.07	5.39	0
France	Franc	5.67	5.54	4.97	5.12	5.84	6.03	6.03	-2.29	-10.29	3.02	14.06	3.25	0
Germany	D-Mark	1.66	1.62	1.43	1.50	1.73	1.80	1.80	-2.41	-11.73	4.90	15.33	4.05	0
Italy	Lira	1,577.85	1,609.34	1,628.21	1,542.72	1,703.02	1,772.42	1,772.42	2.00	1.17	-5.25	10.39	4.08	0
Netherlands	Guilder	1.86	1.82	1.60	1.69	1.95	2.03	2.03	-2.15	-12.09	5.62	15.38	4.10	0
Norway	Krone	7.11	7.04	6.33	6.46	7.08	7.63	7.63	-0.98	-10.09	2.05	9.60	7.77	0
Spain	Peseta	127.87	133.48	124.40	126.68	146.45	152.58	152.58	4.39	-6.80	1.83	15.61	4.19	0
Sweden	Krona	7.82	7.70	7.14	6.71	7.64	7.99	7.99	-1.53	-7.27	-6.02	13.86	4.58	0
Switzerland	Franc	1.48	1.37	1.18	1.24	1.45	1.51	1.51	-7.43	-13.87	5.08	16.94	4.14	0
United Kingdom	Pound	0.67	0.65	0.63	0.64	0.61	0.61	0.61	-2.99	-3.08	1.59	-4.69	0	0
Europe Average	ECU	0.86	0.84	0.77	0.80	0.89	0.91	0.91	-1.52	-8.72	3.58	11.59	2.25	0
China	Renminbi	5.76	8.54	8.35	8.34	8.32	8.31	8.31	48.26	-2.22	-0.12	-0.24	-0.12	0
Hong Kong	Dollar	7.74	7.73	7.74	7.73	7.74	7.75	7.75	-0.13	0.13	-0.13	0.13	0.13	0
Japan	Yen	110.85	101.56	93.90	108.81	121.10	140.79	140.79	-8.38	-7.54	15.88	11.29	16.26	0
Korea	Won	799.42	805.80	770.57	805.16	954.14	1,295.76	1,295.76	0.80	-4.37	4.49	18.50	35.80	0
Singapore	Dollar	1.62	1.53	1.43	1.41	1.49	1.71	1.71	-5.32	-6.54	-1.40	5.67	14.77	0
Taiwan	Dollar	26.15	26.45	26.48	27.47	28.79	34.39	34.39	1.15	0.11	3.74	4.81	19.45	0

Source: Dataquest (October 1998)

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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 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.

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 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, the won, 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 affect growth in the mechanical CAD/CAM/CAE market over our forecast period.

CAD Investments Are Cyclical

The major aerospace and automotive companies, particularly in Europe, had been significant drivers of the double-digit mechanical CAD/CAM/CAE growth in previous years. However, these companies have now completed their investment cycles in CAD technology for the next four or five years. Investment in CAD by these large companies will slow until the next investment cycle begins, bringing down the overall market growth.

Tier Two Investments

Related to the above assumption, now that these companies have completed their investment cycles, Dataquest expects to see corresponding investment by their supplier bases as a significant driver of the market.

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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. 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 and who are looking to upgrade from their 2-D-based systems. Based on what we saw in 1997, we are shifting the peak of our NT-based mechanical CAD/CAM/CAE sales forecast to earlier in our five-year forecast period.

Continued Economic Turmoil in Asia/Pacific

The Asia/Pacific region will be a mixed bag of high and low growth over our forecast period, fueled by CAD investments from local and national governments and expansion by multinational companies, but also tempered by economic and political turmoil in Southeast Asia. We have lowered our forecast for Asia/Pacific in light of the economic uncertainty in some of that region.

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. If they can come up with the "right" solution, we can significantly raise our forecast.

AEC Forecast Assumptions

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

CAD Is Becoming a Business Requirement

Large design companies are growing at the expense of smaller companies and these large end users increasingly require employees and suppliers to adopt automation tools in the design and construction process. Smaller design companies must increasingly buy CAD systems or risk being dropped from consideration as a partner.

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.

A More Tailored Focus

If vendors stay focused on not selling generic CAD solutions but rather on selling more tailored solutions to fit different needs in AEC (such as architectural needs, plant design needs), then we can begin to raise our forecast upward. Over the years, AEC sales have largely been driven by vanilla sales of CAD products. Solutions that meet specific needs of users will help drive the market forward at a faster rate.

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 affect growth in the worldwide GIS market.

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. Advances in aerial photography, global positioning systems, and satellite imagery 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.

Indispensability of GIS

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.

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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

Our final survey showed even slower growth than reported in the Preliminary Forecast. Total EDA growth was 14.6 percent. This spring Dataquest did a considerable amount of work modeling the end-user design market. The breakthrough happened when we broke the mainstream into upper and lower mainstream segments. With these new models we found that all our previous survey work converged. This gave us a clear picture of the actual growth by segment, explaining in greater detail the reason for the slowdown in EDA growth. The top of the pyramid, the power users, only grew 4.5 percent. This was the group that in essence had run out of tools to buy. This also explains the reason the slowdown was far more pronounced in the United States rather than in other geographic regions. On the other hand, the upper mainstream grew 12.8 percent and the lower mainstream a whopping 130.4 percent. These are the markets that kept EDA from falling into the 4 percent growth area of the early 1990s, another period when we ran out of tools. Just to give you a comparison picture, in 1991, 75 percent of all money spent on EDA tools was spent by the power users. This year, for the first time, the upper mainstream alone will spend more dollars on EDA tools than the power users.

It has become clear that this is not a semiconductor recession; this is a true technology inflection point. The last time we saw this was in the early 1980s when the impact of the microprocessor caused a double-dip recession. If you remember, it was the time of explosive growth in EDA. We are a much larger industry today so the growth won't be explosive but it will be significant and, as 1997 has shown, it will be driven by supply, not demand. The need is there, the money is there, now where are the needed new tools?

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Electronic CAE

CAE was by far the area where the lack of new tools hit the hardest. Where is the RTL Virtual Prototype? What are we going to do about the verification crisis? Why has ES Level tool development been de-emphasized by the EDA Industry? The only bright spots have been hardware and software coverification and formal verification, at least at the equivalency checking level. The best news this year has been an answer to the verification crisis. At least we think we know the answer. Until we see the new test bench, a test bench that coordinates the work of not just simulation but multiple types of simulation while also using formal verification and formal analysis, we won't know. Unfortunately, we've yet to see much progress on the RTL Virtual Prototype front. There are some new start-ups now attacking the problem, and they are showing an extremely broad level of technical expertise. We can only hope.

IC Layout

The IC CAD world is catching up with the silicon. This is obviously the most exciting news to come out of EDA in years. Announcements by Avant! and Cadence plus the progress on the Sematech CHDs, Physical Verification program have excited the industry. We're one generation behind and closing! This will keep the IC CAD market growing at about 20 percent for the foreseeable future.

PCB Design

The final PCB numbers showed a completely different picture than the preliminary PCB numbers. The Asia/Pacific region grew an extremely strong 22.2 percent. The major downfall was in Japan, followed by Europe. This is a continuation of the flow of manufacturing to Asia from these areas. North America grew at a strong 12 percent. Again the new high-speed buses will continue to drive this market.

History and Forecast for All Applications and Operating Systems

Tables 1-3 and 1-4 show the history and forecast of all applications.

Table 1-3
CAD/CAM/CAE/GIS Software Revenue History and Forecast

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Software Revenue ($M)									
Worldwide, All Operating Systems	6,197	7,169	7,749	8,639	9,718	10,948	12,280	13,666	12.0
Worldwide									
UNIX	4,135	4,748	4,670	4,853	5,158	5,541	5,975	6,427	6.6
Windows NT	401	836	1,626	2,350	3,090	3,902	4,761	5,653	28.3
Personal Computer	1,485	1,429	1,392	1,401	1,449	1,492	1,536	1,580	2.6
Host/Proprietary	176	155	61	35	21	13	8	5	-38.2
All Operating Systems									
North America	2,098	2,545	2,786	3,190	3,677	4,206	4,748	5,318	13.8
Europe	2,000	2,192	2,289	2,501	2,787	3,074	3,402	3,780	10.6
Japan	1,613	1,830	2,022	2,239	2,480	2,786	3,112	3,445	11.2
Asia/Pacific	377	479	526	570	619	709	825	907	11.5
Rest of World	110	123	126	139	155	173	192	215	11.3

Source: Dataquest (October 1998)

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Table 1-4
CAD/CAM/CAE/GIS Software Revenue Growth Rate History and Forecast

	1996	1997	1998	1999	2000	2001	2002
Year-to-Year Software Revenue Growth Rate (%)							
Worldwide, All Operating Systems	15.7	8.1	11.5	12.5	12.7	12.2	11.3
Worldwide							
UNIX	14.8	-1.7	3.9	6.3	7.4	7.8	7.6
Windows NT	108.7	94.4	44.5	31.5	26.2	22.0	18.7
Personal Computer	-3.8	-2.6	0.6	3.4	3.0	2.9	2.8
Host/Proprietary	-12.1	-60.5	-42.7	-40.3	-37.6	-35.6	-34.5
All Operating Systems							
North America	21.3	9.5	14.5	15.3	14.4	12.9	12.0
Europe	9.6	4.4	9.3	11.4	10.3	10.7	11.1
Japan	13.5	10.5	10.7	10.8	12.4	11.7	10.7
Asia/Pacific	27.0	9.9	8.4	8.6	14.6	16.3	10.0
Rest of World	11.5	2.4	11.0	11.3	11.4	11.0	12.0

Source: Dataquest (October 1998)

Forecast Methodology

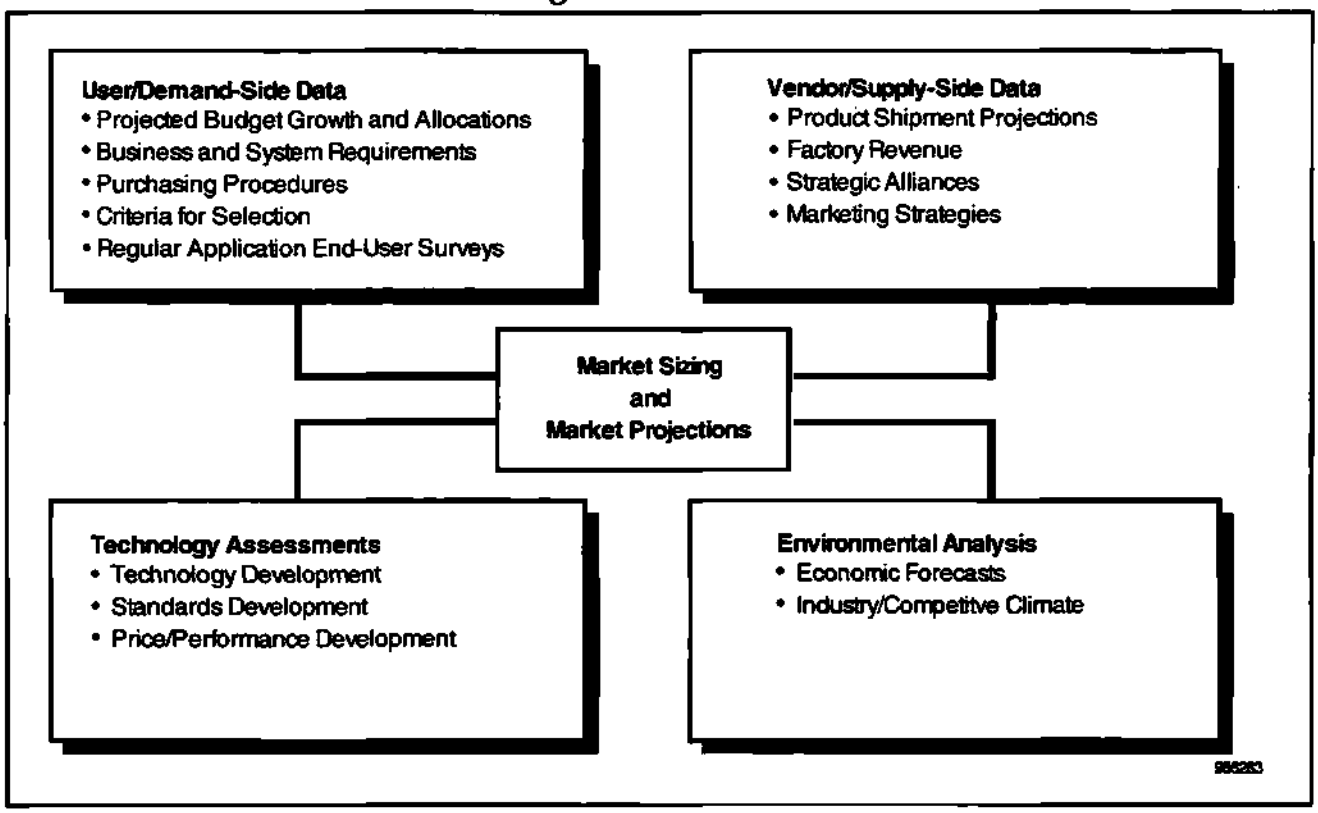
Fundamental to the way Dataquest conducts its research is the underlying philosophy that the best data and analyses come from a well-balanced program. This program includes the following: balance between primary and secondary collection techniques; balance between supply-side and demand-side analysis; 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 Asia/Pacific and Europe of the events of 1997.

Figure 1-1 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.

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Figure 1-1
CAD/CAM/CAE and GIS Forecasting Model



Source: Dataquest (October 1998)

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.

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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

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.

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- 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—Includes Austria, Belgium, France, Germany (including former East Germany), Greece, Italy, Luxembourg, Netherlands, Portugal, Scandinavia (Denmark, Finland, Norway, Sweden), Spain, Switzerland, and the United Kingdom
- Rest of Western Europe—Includes Andorra, Cyprus, Faroe Islands, Gibraltar, Greenland, Guernsey, Iceland, Isle of Man, Jersey, Liechtenstein, Malta, Monaco, San Marino, and Svalbard
- Central and Eastern Europe—Includes Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, the Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Macedonia, Moldova, Poland, Romania, Russia, Slovakia, Slovenia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan, and the republics of the former Yugoslavia (Serbia and Montenegro)

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Chapter 2
1998 European Mechanical CAD/CAM/CAE Forecast Tables

Table 2-1
Top-Level Mechanical Forecast, Worldwide, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Software Revenue ($M)									
Worldwide, All Operating Systems	2,830	3,328	3,513	3,843	4,228	4,607	4,996	5,417	9.0
Worldwide									
UNIX	2,057	2,376	2,186	2,199	2,249	2,293	2,353	2,435	2.2
Windows NT	116	315	739	1,078	1,414	1,744	2,064	2,393	26.5
Personal Computer	545	539	550	546	553	562	573	585	1.2
Host/Proprietary	111	99	38	20	12	8	6	4	-35.9
All Operating Systems									
North America	788	997	1,033	1,166	1,323	1,453	1,572	1,685	10.3
Europe	987	1,084	1,106	1,188	1,295	1,391	1,515	1,686	8.8
Japan	883	1,019	1,122	1,222	1,326	1,453	1,571	1,679	8.4
Asia/Pacific	141	192	212	224	235	256	280	305	7.5
Rest of World	31	36	39	44	49	54	58	63	9.9
Year-to-Year Software Revenue Growth Rate (%)									
Worldwide, All Operating Systems	-	17.6	5.6	9.4	10.0	9.0	8.4	8.4	-
Worldwide									
UNIX	-	15.5	-8.0	0.6	2.3	2.0	2.6	3.5	-
Windows NT	-	170.1	134.9	45.9	31.2	23.3	18.4	15.9	-
Personal Computer	-	-1.1	2.1	-0.7	1.2	1.6	1.9	2.1	-
Host/Proprietary	-	-11.5	-61.8	-45.9	-39.8	-33.1	-30.5	-28.4	-
All Operating Systems									
North America	-	26.6	3.6	12.9	13.5	9.8	8.1	7.2	-
Europe	-	9.9	2.0	7.4	9.0	7.5	8.9	11.3	-
Japan	-	15.5	10.1	8.9	8.5	9.6	8.1	6.9	-
Asia/Pacific	-	35.9	10.9	5.3	5.0	8.9	9.5	8.8	-
Rest of World	-	13.0	10.0	11.7	11.7	9.7	8.8	7.5	-

Source: Dataquest (October 1998)

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Table 2-2
Detail Mechanical Forecast, Europe, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	107,803	111,940	115,356	120,289	126,910	130,297	136,954	146,988	5
Seats	111,887	114,390	115,619	120,120	125,718	130,543	137,123	147,107	5
Year-to-Year Increase (%)	15	2	1	4	5	4	5	7	-
Installed Base									
CPUs	309,387	331,677	351,099	368,053	384,523	397,545	411,587	430,496	4
Seats	329,303	348,677	363,438	375,822	387,953	399,206	412,534	431,101	3
Year-to-Year Increase (%)	8	6	4	3	3	3	3	5	-
Revenue Data ($M)									
Hardware Revenue	1,453	1,447	1,335	1,334	1,386	1,422	1,503	1,640	4
Year-to-Year Increase (%)	10	0	-8	0	4	3	6	9	-
Software Revenue	987	1,084	1,106	1,188	1,295	1,391	1,515	1,686	9
Year-to-Year Increase (%)	20	10	2	7	9	7	9	11	-
Software Service	350	370	380	389	419	442	480	529	7
Hardware Service	275	279	267	244	252	257	272	296	2
Service Revenue	625	648	647	633	671	699	752	825	5
Year-to-Year Increase (%)	8	4	0	-2	6	4	8	10	-
Total Factory Revenue	3,065	3,179	3,089	3,155	3,352	3,513	3,771	4,152	6
Year-to-Year Increase (%)	13	4	-3	2	6	5	7	10	-

Source: Dataquest (October 1998)

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Table 2-3
Detail Mechanical Forecast, Benelux, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	4,216	5,126	5,775	5,825	5,993	6,268	6,810	7,053	4
Seats	4,366	5,160	5,756	5,810	5,945	6,271	6,813	7,055	4
Year-to-Year Increase (%)	4	18	12	1	2	5	9	4	-
Installed Base									
CPUs	12,935	14,204	15,965	17,328	18,294	19,052	19,985	20,871	6
Seats	13,756	14,823	16,358	17,538	18,352	19,058	19,979	20,863	5
Year-to-Year Increase (%)	3	8	10	7	5	4	5	4	-
Revenue Data ($M)									
Hardware Revenue	64	67	68	67	68	72	79	84	4
Year-to-Year Increase (%)	5	5	1	-2	3	5	10	6	-
Software Revenue	42	48	52	55	58	63	71	75	8
Year-to-Year Increase (%)	19	13	10	5	6	8	12	7	-
Software Service	19	15	16	17	18	19	21	23	7
Hardware Service	13	13	14	12	13	13	14	15	2
Service Revenue	32	28	30	29	31	32	36	38	5
Year-to-Year Increase (%)	38	-11	6	-3	5	6	11	6	-
Total Factory Revenue	138	143	151	151	157	167	186	197	5
Year-to-Year Increase (%)	16	4	5	0	4	6	11	6	-

Source: Dataquest (October 1998)

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Table 2-4
Detail Mechanical Forecast, France, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	17,486	17,364	17,314	18,392	20,355	20,991	21,539	22,409	5
Seats	18,352	17,909	17,384	18,359	19,993	21,099	21,606	22,463	5
Year-to-Year Increase (%)	16	-2	-3	6	9	6	2	4	-
Installed Base									
CPUs	48,318	52,730	55,492	57,874	61,158	64,005	66,296	68,410	4
Seats	51,857	55,911	57,873	59,402	61,715	64,279	66,495	68,587	3
Year-to-Year Increase (%)	13	8	4	3	4	4	3	3	-
Revenue Data ($M)									
Hardware Revenue	276	261	228	230	247	256	263	277	4
Year-to-Year Increase (%)	15	-6	-13	1	7	4	3	5	-
Software Revenue	187	195	190	208	235	256	271	291	9
Year-to-Year Increase (%)	22	4	-3	9	13	9	6	7	-
Software Service	63	70	66	69	76	81	86	91	7
Hardware Service	53	53	48	44	47	48	49	52	2
Service Revenue	117	123	114	113	122	129	135	144	5
Year-to-Year Increase (%)	5	5	-7	-1	8	5	5	6	-
Total Factory Revenue	580	579	531	550	604	641	669	712	6
Year-to-Year Increase (%)	15	0	-8	4	10	6	4	6	-

Source: Dataquest (October 1998)

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Table 2-5
Detail Mechanical Forecast, Germany, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	39,426	39,445	40,931	43,148	45,336	45,991	48,965	53,629	6
Seats	41,454	40,816	41,155	43,143	44,928	46,075	49,020	53,666	5
Year-to-Year Increase (%)	20	-2	1	5	4	3	6	9	-
Installed Base									
CPUs	110,908	118,717	125,495	131,677	137,532	141,531	146,643	154,629	4
Seats	119,040	126,182	131,173	135,437	139,447	142,571	147,255	154,997	3
Year-to-Year Increase (%)	10	6	4	3	3	2	3	5	-
Revenue Data ($M)									
Hardware Revenue	565	534	487	488	499	503	537	596	4
Year-to-Year Increase (%)	16	-5	-9	0	2	1	7	11	-
Software Revenue	369	383	385	414	445	468	515	584	9
Year-to-Year Increase (%)	25	4	0	7	8	5	10	13	-
Software Service	139	134	140	144	152	158	173	193	7
Hardware Service	105	101	96	89	91	91	97	107	2
Service Revenue	243	235	236	232	243	249	270	300	5
Year-to-Year Increase (%)	19	-3	0	-2	4	3	8	11	-
Total Factory Revenue	1,177	1,153	1,108	1,134	1,187	1,219	1,321	1,480	6
Year-to-Year Increase (%)	19	-2	-4	2	5	3	8	12	-

Source: Dataquest (October 1998)

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Table 2-6
Detail Mechanical Forecast, Italy, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	10,558	10,954	11,093	11,584	11,919	12,341	13,053	14,039	5
Seats	10,609	10,926	11,080	11,550	11,814	12,346	13,055	14,041	5
Year-to-Year Increase (%)	25	3	1	4	2	5	6	8	-
Installed Base									
CPUs	30,377	32,158	33,608	34,971	36,074	37,063	38,395	40,306	4
Seats	31,927	33,154	34,213	35,278	36,115	37,017	38,331	40,255	3
Year-to-Year Increase (%)	4	4	3	3	2	2	4	5	-
Revenue Data ($M)									
Hardware Revenue	111	118	114	115	118	123	131	144	5
Year-to-Year Increase (%)	0	6	-4	1	2	4	7	10	-
Software Revenue	79	90	93	101	107	117	129	146	9
Year-to-Year Increase (%)	14	13	4	8	7	9	11	13	-
Software Service	24	29	30	29	31	33	36	40	6
Hardware Service	20	20	20	18	19	19	21	23	2
Service Revenue	44	50	50	48	50	52	57	63	5
Year-to-Year Increase (%)	-14	12	1	-5	4	5	9	11	-
Total Factory Revenue	235	257	257	264	275	292	317	353	7
Year-to-Year Increase (%)	1	9	0	3	4	6	9	11	-

Source: Dataquest (October 1998)

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Table 2-7
Detail Mechanical Forecast, Scandinavia, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	7,415	8,006	8,159	8,445	8,810	9,569	10,011	10,780	6
Seats	7,675	8,156	8,164	8,405	8,634	9,605	10,051	10,802	6
Year-to-Year Increase (%)	30	6	0	3	3	11	5	7	-
Installed Base									
CPUs	19,040	21,660	23,778	25,365	26,601	28,037	29,447	31,130	6
Seats	20,442	22,819	24,593	25,836	26,687	28,036	29,462	31,165	5
Year-to-Year Increase (%)	12	12	8	5	3	5	5	6	-
Revenue Data ($M)									
Hardware Revenue	88	95	89	89	91	100	105	115	5
Year-to-Year Increase (%)	9	8	-6	-1	2	10	6	9	-
Software Revenue	59	70	75	80	85	99	107	120	10
Year-to-Year Increase (%)	26	17	8	6	7	16	9	12	-
Software Service	18	24	24	24	26	29	32	35	8
Hardware Service	16	18	18	16	17	18	19	21	3
Service Revenue	34	42	42	41	43	47	51	56	6
Year-to-Year Increase (%)	-6	23	0	-2	4	11	8	9	-
Total Factory Revenue	181	206	206	209	218	246	264	291	7
Year-to-Year Increase (%)	11	14	0	2	4	13	7	10	-

Source: Dataquest (October 1998)

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Table 2-8
Detail Mechanical Forecast, Spain, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	3,103	4,090	4,521	5,039	5,424	5,567	5,874	6,497	8
Seats	3,241	4,181	4,538	5,042	5,423	5,568	5,874	6,497	7
Year-to-Year Increase (%)	1	29	9	11	8	3	6	11	-
Installed Base									
CPUs	9,931	10,770	12,129	13,728	15,188	16,235	17,082	18,201	8
Seats	10,547	11,320	12,545	14,008	15,360	16,334	17,138	18,231	8
Year-to-Year Increase (%)	-3	7	11	12	10	6	5	6	-
Revenue Data ($M)									
Hardware Revenue	39	44	46	49	53	54	58	66	7
Year-to-Year Increase (%)	6	13	3	8	7	2	7	14	-
Software Revenue	27	33	36	41	47	49	54	63	12
Year-to-Year Increase (%)	9	22	11	14	13	6	10	16	-
Software Service	11	12	12	13	14	15	16	18	8
Hardware Service	7	8	8	8	9	9	10	11	5
Service Revenue	19	19	21	21	23	23	25	29	7
Year-to-Year Increase (%)	13	5	7	0	8	4	9	14	-
Total Factory Revenue	85	96	103	112	122	127	138	158	9
Year-to-Year Increase (%)	9	14	7	9	9	4	8	15	-

Source: Dataquest (October 1998)

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Table 2-9
Detail Mechanical Forecast, United Kingdom, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	16,138	18,829	18,629	18,834	20,137	20,688	21,708	23,248	5
Seats	16,666	19,088	18,600	18,790	20,062	20,697	21,710	23,248	5
Year-to-Year Increase (%)	3	15	-3	1	7	3	5	7	-
Installed Base									
CPUs	49,066	53,451	56,685	58,911	61,260	63,181	65,224	68,150	4
Seats	51,532	55,511	58,095	59,733	61,651	63,368	65,316	68,186	3
Year-to-Year Increase (%)	5	8	5	3	3	3	3	4	-
Revenue Data ($M)									
Hardware Revenue	208	233	203	197	211	217	231	253	5
Year-to-Year Increase (%)	0	12	-13	-3	7	3	6	10	-
Software Revenue	145	186	180	188	212	227	249	280	9
Year-to-Year Increase (%)	7	29	-3	5	13	7	10	12	-
Software Service	48	63	64	65	71	76	83	92	8
Hardware Service	42	47	42	38	40	41	44	48	3
Service Revenue	90	110	106	102	111	117	126	140	6
Year-to-Year Increase (%)	-11	22	-3	-4	9	5	8	11	-
Total Factory Revenue	442	528	488	487	535	561	606	672	7
Year-to-Year Increase (%)	-1	19	-8	0	10	5	8	11	-

Source: Dataquest (October 1998)

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Table 2-10
Detail Mechanical Forecast, Austria/Switzerland, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	4,947	3,696	3,500	3,583	3,602	3,658	3,741	3,888	2
Seats	4,978	3,700	3,501	3,582	3,598	3,658	3,741	3,888	2
Year-to-Year Increase (%)	92	-26	-5	2	0	2	2	4	-
Installed Base									
CPUs	8,306	10,470	11,290	11,513	11,478	11,444	11,571	11,795	1
Seats	8,475	10,593	11,375	11,568	11,506	11,457	11,575	11,796	1
Year-to-Year Increase (%)	102	25	7	2	-1	0	1	2	-
Revenue Data ($M)									
Hardware Revenue	43	42	38	37	37	37	38	40	1
Year-to-Year Increase (%)	66	-3	-10	-2	0	1	3	5	-
Software Revenue	34	38	40	45	47	51	55	60	8
Year-to-Year Increase (%)	98	14	6	11	6	8	7	9	-
Software Service	9	11	12	13	14	14	15	17	6
Hardware Service	7	8	7	7	7	7	7	7	0
Service Revenue	16	19	20	20	20	21	22	24	4
Year-to-Year Increase (%)	39	19	2	-1	4	4	6	7	-
Total Factory Revenue	93	99	98	101	105	109	115	124	5
Year-to-Year Increase (%)	70	7	-1	3	3	4	5	7	-

Source: Dataquest (October 1998)

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Table 2-11
Detail Mechanical Forecast, Russia, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	525	509	578	562	429	338	307	356	-9
Seats	525	524	583	564	429	338	307	356	-9
Year-to-Year Increase (%)	340	.0	11	-3	-24	-21	-9	16	-
Installed Base									
CPUs	655	1,090	1,456	1,677	1,665	1,503	1,328	1,250	-3
Seats	655	1,104	1,475	1,695	1,678	1,512	1,333	1,254	-3
Year-to-Year Increase (%)	361	69	34	15	-1	-10	-12	-6	-
Revenue Data ($M)									
Hardware Revenue	5	8	9	8	7	6	6	8	-3
Year-to-Year Increase (%)	116	60	12	-7	-13	-7	1	17	-
Software Revenue	4	6	8	8	7	7	7	8	2
Year-to-Year Increase (%)	148	64	27	3	-11	-3	4	19	-
Software Service	2	2	2	2	2	2	2	2	3
Hardware Service	1	1	2	2	1	1	1	2	-1
Service Revenue	3	4	4	4	3	3	3	4	1
Year-to-Year Increase (%)	94	44	6	-7	-7	-2	4	19	-
Total Factory Revenue	11	17	20	20	17	16	17	20	0
Year-to-Year Increase (%)	120	58	16	-3	-11	-5	3	18	-

Source: Dataquest (October 1998)

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Table 2-12
Detail Mechanical Forecast, Central Europe, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	1,864	1,924	2,069	2,263	2,418	2,467	2,546	2,685	5
Seats	1,898	1,938	2,075	2,262	2,410	2,469	2,547	2,688	5
Year-to-Year Increase (%)	64	2	7	9	7	2	3	6	-
Installed Base									
CPUs	4,055	5,127	5,930	6,575	7,091	7,427	7,695	7,973	6
Seats	4,146	5,210	5,997	6,622	7,111	7,437	7,700	7,979	6
Year-to-Year Increase (%)	48	26	15	10	7	5	4	4	-
Revenue Data ($M)									
Hardware Revenue	25	23	24	25	27	28	29	31	5
Year-to-Year Increase (%)	35	-9	5	5	7	2	4	8	-
Software Revenue	18	18	21	24	27	29	31	34	10
Year-to-Year Increase (%)	43	-1	18	15	12	7	7	10	-
Software Service	10	6	8	9	10	11	12	13	10
Hardware Service	5	4	5	4	5	5	5	5	2
Service Revenue	15	10	13	13	15	16	17	18	7
Year-to-Year Increase (%)	90	-34	28	5	10	5	7	9	-
Total Factory Revenue	58	51	58	63	69	72	76	83	8
Year-to-Year Increase (%)	49	-13	14	9	10	5	6	9	-

Source: Dataquest (October 1998)

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Table 2-13
Detail Mechanical Forecast, Rest of Europe, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	2,127	1,998	2,786	2,615	2,486	2,418	2,399	2,404	-3
Seats	2,124	1,991	2,784	2,613	2,483	2,418	2,399	2,404	-3
Year-to-Year Increase (%)	-59	-6	40	-6	-5	-3	-1	0	-
Installed Base									
CPUs	15,798	11,301	9,271	8,433	8,182	8,068	7,921	7,783	-3
Seats	16,926	12,052	9,740	8,706	8,333	8,138	7,949	7,788	-4
Year-to-Year Increase (%)	-25	-29	-19	-11	-4	-2	-2	-2	-
Revenue Data ($M)									
Hardware Revenue	29	22	31	28	27	26	26	26	-3
Year-to-Year Increase (%)	-40	-23	40	-8	-4	-4	-1	1	-
Software Revenue	23	18	26	25	25	25	25	26	0
Year-to-Year Increase (%)	-25	-23	45	-2	0	-1	1	3	-
Software Service	6	4	5	5	5	5	5	5	0
Hardware Service	6	4	6	6	5	5	5	5	-4
Service Revenue	12	8	12	10	10	10	10	10	-2
Year-to-Year Increase (%)	-20	-33	40	-9	-1	-2	0	3	-
Total Factory Revenue	64	48	68	64	63	61	61	62	-2
Year-to-Year Increase (%)	-32	-25	42	-6	-2	-3	0	2	-

Source: Dataquest (October 1998)

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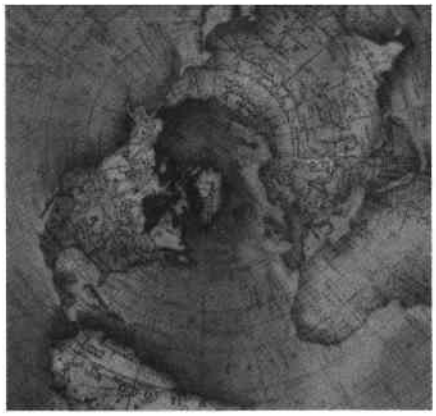
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1997 European Mechanical CAD/CAM/CAE Market Share

Market Statistics

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1997 European Mechanical CAD/CAM/CAE Market Share



Market Statistics

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Table of Contents

Page

1. Introduction 1
   - About This Document 1
   - Definitions 1
     - Europe 1
   - Publishing Schedule 1
   - A Final Note 1
2. 1997 European Mechanical CAD/CAM/CAE Market Share Tables 3

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List of Tables

Table		Page
2-1	Top 30 Mechanical Software Companies, Worldwide, All Operating Systems	3
2-2	Top 30 Mechanical Software Companies, Europe, All Operating Systems	4
2-3	Top 30 Mechanical Software Companies, France, All Operating Systems	5
2-4	Top 30 Mechanical Software Companies, Germany, All Operating Systems	6
2-5	Top 30 Mechanical Software Companies, Benelux, All Operating Systems	7
2-6	Top 30 Mechanical Software Companies, United Kingdom, All Operating Systems	8
2-7	Top 30 Mechanical Software Companies, Austria/Switzerland, All Operating Systems	9
2-8	Top 30 Mechanical Software Companies, Spain, All Operating Systems	10
2-9	Top 30 Mechanical Software Companies, Italy, All Operating Systems	11
2-10	Top 30 Mechanical Software Companies, Scandinavia, All Operating Systems	12
2-11	Top 12 Mechanical Software Companies, Russia, All Operating Systems	13
2-12	Top 22 Mechanical Software Companies, Central Europe, All Operating Systems	14
2-13	Top 30 Mechanical Software Companies, Rest of Europe, All Operating Systems	15

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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/CAM/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 countries in the Europe region.

Definitions

This section lists the definitions specific to this document. For other definitions, please see the worldwide Market Statistics book.

Europe

- **Western Europe:** Includes Austria, Belgium, France, Germany (including former East Germany), Greece, Italy, Luxembourg, Netherlands, Portugal, Scandinavia (Denmark, Finland, Norway, Sweden), Spain, Switzerland, and the United Kingdom
- **Rest of Western Europe:** Includes Andorra, Cyprus, Faroe Islands, Gibraltar, Greenland, Guernsey, Iceland, Isle of Man, Jersey, Liechtenstein, Malta, Monaco, San Marino, and Svalbard
- **Central and Eastern Europe:** Includes Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, the Czech Republic, Estonia, Georgia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Macedonia, Moldova, Poland, Romania, Russia, Slovakia, Slovenia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan, and the republics of the former Yugoslavia (Serbia and Montenegro)

Publishing Schedule

Dataquest publishes market share and forecasts at the country level once each year. Our delivery schedule is as follows:

- European country-level market share tables for 1997, based on data collection and analysis beginning in January 1998, are presented in this report. At this point, the market share database is frozen and will not be changed until the end of 1998.
- Forecast tables will be available electronically by mid-September, and books will be shipped in October. These forecast tables will contain country-level information for the European 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.

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Chapter 2
1997 European Mechanical CAD/CAM/CAE Market Share Tables

Table 2-1
Top 30 Mechanical Software Companies, Worldwide, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	IBM	449.0	563.5	641.8	13.9	18.3
2	Parametric Technology	321.2	495.0	605.8	22.4	17.3
3	Dassault Systemes	204.9	249.5	303.8	21.8	8.7
4	Autodesk	192.9	174.2	206.4	18.5	5.9
5	Structural Dynamics Research Corporation	124.7	153.1	172.1	12.4	4.9
6	MICROCADAM	129.2	152.0	150.0	-1.3	4.3
7	Info. Services Int'l. Dentsu*	85.2	117.2	125.9	7.5	3.6
8	CoCreate	107.3	113.4	125.5	10.7	3.6
9	Unigraphics Solutions	89.1	209.5	115.5	-44.9	3.3
10	MacNeal-Schwendler	114.0	106.3	104.0	-2.2	3.0
11	Fujitsu	97.0	107.3	103.5	-3.6	2.9
12	Matra Datavision	87.4	91.8	90.6	-1.2	2.6
13	NEC	72.9	62.9	70.9	12.7	2.0
14	Hitachi	70.9	63.7	68.1	6.8	1.9
15	Toshiba*	66.7	62.5	65.0	3.9	1.9
16	Computervision	149.0	174.4	61.7	-64.6	1.8
17	Nihon Unisys	52.8	54.4	54.6	0.3	1.6
18	Hitachi Zosen Info Systems	38.7	39.3	42.7	8.8	1.2
19	Ansys	32.6	37.0	35.1	-5.2	1.0
20	Tecnomatix Technology	20.1	26.3	34.2	30.0	1.0
21	C. Itoh Techno-Science*	30.8	30.8	32.5	5.5	0.9
22	Delcam Plc	16.7	22.0	30.8	40.0	0.9
23	Sherpa Corp.	20.6	26.2	27.5	5.0	0.8
24	Marubeni Hytech*	19.9	23.0	24.9	8.5	0.7
25	Sumisho Electronics*	18.8	21.6	23.4	8.4	0.7
26	MARC	18.2	19.5	21.8	11.7	0.6
27	Tokyo Electron*	17.4	20.0	21.8	8.5	0.6
28	Formtek	18.9	20.6	21.7	5.1	0.6
29	Seiko*	19.7	19.0	21.1	11.0	0.6
30	ISD Software	14.5	22.7	20.1	-11.4	0.6
	All N.A. Companies	**2,010.1**	**2,504.8**	**2,573.6**	**2.7**	**73.3**
	All European Companies	**339.5**	**345.6**	**390.9**	**13.1**	**11.1**
	All Asian Companies	**481.5**	**475.4**	**545.7**	**14.8**	**15.5**
	All Companies	**2,831.1**	**3,325.7**	**3,510.3**	**5.5**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (August 1998)

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Table 2-2
Top 30 Mechanical Software Companies, Europe, All Operating Systems
(Revenue in Millions of Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	IBM	227.3	225.5	238.1	5.6	21.5
2	Parametric Technology	109.2	171.3	203.5	18.8	18.4
3	Dassault Systemes	113.2	140.7	150.8	7.2	13.6
4	Matra Datavision	70.0	68.8	72.7	5.6	6.6
5	Autodesk	61.5	54.5	64.0	17.5	5.8
6	CoCreate	59.0	54.4	60.3	10.7	5.4
7	Structural Dynamics Research Corporation	33.2	43.1	52.5	21.8	4.7
8	Unigraphics Solutions	32.1	59.3	37.9	-36.0	3.4
9	MacNeal-Schwendler	32.0	30.8	28.3	-8.2	2.6
10	Computervision	73.6	81.1	27.1	-66.6	2.4
11	Tecnomatix Technology	11.6	15.8	20.7	31.1	1.9
12	ISD Software	14.5	22.4	19.9	-11.2	1.8
13	ASCAD	14.9	16.5	19.7	19.2	1.8
14	Delcam Plc	7.7	12.5	17.6	40.0	1.6
15	Tebis	12.5	14.0	13.1	-6.4	1.2
16	CAD Lab	13.6	10.9	12.9	18.2	1.2
17	Radan Computational	7.6	8.2	11.8	43.5	1.1
18	ICEM Technologies	10.4	11.9	11.7	-1.9	1.1
19	Applicon	12.4	12.1	10.6	-12.5	1.0
20	Ansys	10.1	11.1	10.5	-5.2	1.0
21	MICROCADAM	10.3	12.2	10.5	-13.7	0.9
22	Sherpa Corp.	7.2	9.2	9.6	5.0	0.9
23	Investronica SA	6.0	8.6	8.2	-5.0	0.7
24	BCT GmbH	4.2	7.2	8.1	12.8	0.7
25	Eigner + Partner	6.3	6.8	7.6	11.8	0.7
26	Sescoi	6.0	7.5	7.1	-5.2	0.6
27	Bentley Systems	6.2	5.9	7.0	17.9	0.6
28	PROCAD GmbH & Co KG	5.8	6.5	6.8	5.3	0.6
29	MARC	4.5	5.9	6.2	5.3	0.6
30	Mechanical Dynamics	4.9	5.7	6.1	7.0	0.6
	All N.A. Companies	**724.5**	**826.5**	**824.8**	**-0.2**	**74.6**
	All European Companies	**262.4**	**257.8**	**281.6**	**9.2**	**25.4**
	All Asian Companies	**-**	**-**	**-**	**NA**	**-**
	All Companies	**987.0**	**1,084.2**	**1,106.3**	**2.0**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (August 1998)

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Table 2-3
Top 30 Mechanical Software Companies, France, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	IBM	51.6	53.2	49.5	-7.0	26.1
2	Dassault Systemes	34.2	41.9	39.3	-6.3	20.7
3	Parametric Technology	24.9	30.0	35.7	18.8	18.8
4	Matra Datavision	38.5	33.5	34.4	2.7	18.1
5	Structural Dynamics Research Corporation	6.0	8.1	10.0	23.1	5.3
6	Autodesk	7.5	7.0	8.2	17.9	4.3
7	Computervision	17.4	17.8	5.9	-66.6	3.1
8	CoCreate	5.4	4.9	5.5	10.7	2.9
9	Serbi	5.9	5.6	5.0	-10.8	2.6
10	Unigraphics Solutions	3.5	5.7	4.5	-20.9	2.4
11	MacNeal-Schwendler	3.5	4.3	4.2	-1.4	2.2
12	Sherpa Corp.	2.3	2.9	3.0	5.0	1.6
13	MICROCADAM	2.6	3.0	2.6	-13.7	1.4
14	ESI Group	3.7	2.3	2.4	3.7	1.2
15	Ansys	1.6	2.1	2.1	1.2	1.1
16	Sescoi	1.5	1.9	1.8	-4.0	0.9
17	Catalpa groupe Missler	1.4	1.2	1.4	16.5	0.8
18	Applicon	1.3	1.4	1.2	-16.5	0.6
19	ADRA Systems	1.8	2.0	1.2	-42.9	0.6
20	Bentley Systems	-	0.9	1.0	17.9	0.5
21	CAD Lab	1.0	0.8	0.9	18.2	0.5
22	Mechanical Dynamics	0.4	0.7	0.7	8.0	0.4
23	Concentra	-	1.6	0.6	-59.1	0.3
24	Adina R&D	0.6	0.6	0.6	-2.2	0.3
25	ICEM Technologies	0.6	0.7	0.6	-16.7	0.3
26	Radan Computational	0.1	0.4	0.5	29.4	0.3
27	B.A. Intelligence Networks	0.3	0.3	0.4	39.4	0.2
28	PAFEC	-	0.4	0.4	-7.9	0.2
29	Delcam Plc	0.2	0.2	0.3	40.0	0.2
30	Gibbs and Assoc.	-	0.2	0.3	30.6	0.1
	All N.A. Companies	**126.2**	**141.5**	**133.7**	**-5.5**	**70.5**
	All European Companies	**52.3**	**47.3**	**47.9**	**1.3**	**25.2**
	All Asian Companies	**-**	**-**	**-**	**NA**	**-**
	All Companies	**187.8**	**195.1**	**189.6**	**-2.8**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (August 1998)

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Table 2-4
Top 30 Mechanical Software Companies, Germany, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	IBM	105.9	110.4	121.7	10.3	31.6
2	Dassault Systemes	39.9	55.0	60.3	9.7	15.7
3	Parametric Technology	21.4	34.8	41.4	18.8	10.7
4	CoCreate	32.2	29.7	32.9	10.7	8.5
5	ASCAD	14.1	15.7	18.7	19.2	4.9
6	Autodesk	16.4	13.7	16.5	20.5	4.3
7	Matra Datavision	14.0	16.3	15.6	-4.5	4.0
8	ISD Software	11.3	16.8	14.3	-14.8	3.7
9	Structural Dynamics Research Corporation	7.5	9.7	11.9	23.2	3.1
10	Tebis	11.0	12.3	11.5	-6.9	3.0
11	Unigraphics Solutions	8.9	19.9	9.3	-53.2	2.4
12	Applicon	7.8	8.2	7.1	-14.1	1.8
13	Eigner + Partner	4.9	5.6	6.9	23.9	1.8
14	BCT GmbH	3.5	6.0	6.8	13.2	1.8
15	ICEM Technologies	6.3	7.2	6.7	-6.3	1.7
16	PROCAD GmbH & Co KG	4.6	5.3	5.6	5.7	1.5
17	Computervision	15.2	16.5	5.5	-66.6	1.4
18	debis Systemhaus	3.0	3.5	4.7	33.0	1.2
19	MacNeal-Schwendler	8.2	10.6	4.2	-60.6	1.1
20	Wiechers Datentechnik	4.1	3.7	3.8	2.0	1.0
21	Ziegler Informatics	2.6	3.7	3.5	-4.2	0.9
22	Ansys	2.5	3.1	3.2	1.2	0.8
23	MICROCADAM	2.6	3.0	2.6	-13.7	0.7
24	ADRA Systems	3.8	4.4	2.6	-40.1	0.7
25	Mechanical Dynamics	2.2	2.4	2.6	5.8	0.7
26	Sherpa Corp.	1.7	2.2	2.3	5.0	0.6
27	Cimatron	1.3	1.5	1.9	21.9	0.5
28	Intergraph	1.6	1.4	1.9	33.8	0.5
29	Exapt	2.2	2.1	1.8	-13.3	0.5
30	Open Mind	-	1.5	1.8	19.5	0.5
	All N.A. Companies	**230.6**	**264.2**	**261.3**	**-1.1**	**67.9**
	All European Companies	**120.0**	**106.8**	**107.3**	**0.5**	**27.9**
	All Asian Companies	**-**	**-**	**-**	**NA**	**-**
	All Companies	**368.9**	**383.3**	**384.9**	**0.4**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (August 1998)

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Table 2-5
Top 30 Mechanical Software Companies, Benelux, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Parametric Technology	11.4	17.7	21.1	18.8	40.2
2	IBM	8.7	7.9	8.4	6.2	16.0
3	Unigraphics Solutions	6.4	6.6	6.8	3.7	13.0
4	Dassault Systemes	3.8	4.2	4.4	2.5	8.3
5	Autodesk	4.4	4.1	4.3	4.2	8.1
6	Structural Dynamics Research Corporation	1.2	1.3	1.6	20.9	3.1
7	ISD Software	0.6	1.1	1.2	6.5	2.3
8	MacNeal-Schwendler	1.4	1.1	1.0	-1.4	2.0
9	Matra Datavision	1.7	0.9	0.9	4.6	1.8
10	Bentley Systems	-	0.5	0.6	17.9	1.1
11	Radan Computational	0.2	0.4	0.5	26.5	0.9
12	Cimatron	0.1	0.2	0.5	204.8	0.9
13	ASCAD	0.3	0.3	0.4	19.2	0.8
14	Computervision	1.0	1.2	0.4	-66.6	0.7
15	PAFEC	-	0.4	0.4	-10.0	0.7
16	Ansys	0.6	0.7	0.4	-49.4	0.7
17	Delcam Plc	0.3	0.2	0.3	40.0	0.6
18	Intergraph	0.3	0.2	0.3	24.9	0.5
19	Investronica SA	-	0.3	0.2	-12.8	0.5
20	RoboCAD Solutions	0.3	0.3	0.2	-12.8	0.4
21	MCS	0.2	0.2	0.2	13.3	0.4
22	Vero International Software	0.1	0.2	0.2	26.0	0.4
23	ICEM Technologies	0.2	0.2	0.2	13.3	0.4
24	Applicon	0.2	0.2	0.2	-16.5	0.4
25	Sherpa Corp.	0.1	0.2	0.2	5.0	0.3
26	Han Dataport	0.4	0.5	0.2	-62.0	0.3
27	Gerber Systems	0.2	0.2	0.2	-4.4	0.3
28	Open Mind	-	0.1	0.2	19.5	0.3
29	Modultek Oy	-	-	0.1	NA	0.3
30	Wiechers Datentechnik	0.1	0.1	0.1	2.5	0.3
	All N.A. Companies	**35.1**	**41.0**	**44.7**	**8.9**	**85.4**
	All European Companies	**4.8**	**5.0**	**5.5**	**9.3**	**10.5**
	All Asian Companies	**-**	**-**	**-**	**NA**	**-**
	All Companies	**42.0**	**47.6**	**52.4**	**10.0**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (August 1998)

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Table 2-6
Top 30 Mechanical Software Companies, United Kingdom, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Parametric Technology	22.3	36.8	43.7	18.8	24.3
2	IBM	21.0	15.8	18.1	14.6	10.1
3	Dassault Systemes	11.4	10.9	12.1	10.2	6.7
4	Structural Dynamics Research Corporation	6.2	8.4	10.7	27.0	6.0
5	Radan Computational	6.8	7.3	10.6	45.4	5.9
6	Computervision	24.7	29.2	9.7	-66.6	5.4
7	Autodesk	8.6	7.5	8.5	12.8	4.7
8	Delcam Plc	2.2	5.7	8.0	40.0	4.5
9	Unigraphics Solutions	6.8	18.1	8.0	-56.0	4.4
10	MacNeal-Schwendler	7.0	7.4	7.3	-1.4	4.1
11	Matra Datavision	2.6	3.4	6.5	89.2	3.6
12	CoCreate	5.4	4.9	5.5	10.7	3.1
13	Whessoe Computing Systems	4.5	4.5	4.6	0.7	2.5
14	PAFEC	-	4.0	4.1	3.4	2.3
15	Pathtrace Engineering Systems	1.3	1.7	3.6	109.1	2.0
16	MICROCADAM	2.6	3.0	2.6	-13.7	1.5
17	Anilam Electronics	2.2	2.3	2.3	0.2	1.3
18	Sherpa Corp.	1.3	1.7	1.8	5.0	1.0
19	Sescoi	1.2	1.5	1.6	7.9	0.9
20	Applicon	1.5	1.5	1.4	-10.1	0.8
21	MCS	1.0	1.1	1.3	13.3	0.7
22	Bentley Systems	-	1.0	1.2	17.9	0.7
23	CGTech	0.9	1.0	1.2	19.5	0.7
24	CIMLINC	1.0	1.0	1.1	9.9	0.6
25	Ansys	1.3	1.4	1.1	-24.4	0.6
26	Concentra	-	3.5	1.0	-72.8	0.5
27	RoboCAD Solutions	0.9	0.9	0.9	0.2	0.5
28	Mechanical Dynamics	0.6	0.8	0.9	8.0	0.5
29	Formtek	0.7	0.8	0.9	6.9	0.5
30	ICEM Technologies	0.5	0.5	0.8	51.1	0.4
	All N.A. Companies	**113.4**	**146.2**	**126.9**	**-13.2**	**70.7**
	All European Companies	**23.6**	**33.8**	**45.1**	**33.2**	**25.1**
	All Asian Companies	**-**	**-**	**-**	**NA**	**-**
	All Companies	**144.3**	**186.1**	**179.6**	**-3.5**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (August 1998)

Table 2-7
Top 30 Mechanical Software Companies, Austria/Switzerland, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Parametric Technology	-	5.6	6.6	18.8	16.5
2	CoCreate	5.4	4.9	5.5	10.7	13.6
3	CAD Distribution	5.1	4.4	4.7	6.1	11.6
4	IBM	4.3	4.1	4.3	6.7	10.8
5	Structural Dynamics Research Corporation	2.2	3.1	3.8	22.6	9.4
6	Autodesk	4.2	2.3	2.5	11.3	6.3
7	Dassault Systemes	1.9	2.0	2.1	2.8	5.2
8	ISD Software	0.6	1.4	1.6	18.4	4.0
9	BCT GmbH	0.7	1.2	1.3	10.7	3.2
10	PROCAD GmbH & Co KG	1.2	1.2	1.2	3.4	3.1
11	MacNeal-Schwendler	-	-	1.0	NA	2.6
12	Han Dataport	1.8	2.6	1.0	-63.0	2.4
13	Matra Datavision	2.2	0.9	0.9	4.7	2.4
14	Unigraphics Solutions	-	0.9	0.9	6.6	2.4
15	Ansys	0.6	0.7	0.7	1.2	1.7
16	ICEM Technologies	0.6	0.7	0.6	-15.0	1.5
17	ASCAD	0.4	0.5	0.6	19.2	1.5
18	Tebis	0.4	0.4	0.4	-9.0	1.0
19	Just In Time Systems	0.4	0.4	0.3	-12.1	0.8
20	Computervision	0.6	0.6	0.2	-66.6	0.5
21	Intergraph	0.1	0.1	0.2	35.3	0.5
22	Bentley Systems	-	0.2	0.2	17.9	0.5
23	B.A. Intelligence Networks	0.1	0.1	0.2	44.9	0.5
24	Mechanical Dynamics	-	0.2	0.2	8.0	0.4
25	Open Mind	-	0.1	0.2	19.5	0.4
26	Wiechers Datentechnik	-	0.1	0.1	2.5	0.4
27	Ziegler Informatics	0.1	0.1	0.1	-2.9	0.3
28	Gibbs and Assoc.	-	0.1	0.1	30.6	0.2
29	Spatial Technology	0.1	0.1	0.1	-11.1	0.2
30	Vero International Software	0	-	0.1	NA	0.1
	All N.A. Companies	**17.1**	**22.4**	**26.1**	**16.5**	**64.8**
	All European Companies	**14.9**	**14.5**	**12.4**	**-14.6**	**30.9**
	All Asian Companies	**-**	**-**	**-**	**NA**	**-**
	All Companies	**33.6**	**38.1**	**40.2**	**5.4**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (August 1998)

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Table 2-8
Top 30 Mechanical Software Companies, Spain, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Parametric Technology	3.5	6.6	7.8	18.8	21.5
2	IBM	7.3	6.5	7.0	7.4	19.3
3	Dassault Systemes	3.8	4.2	4.4	4.1	12.0
4	Autodesk	2.6	3.3	4.1	26.3	11.4
5	Investronica SA	-	1.9	2.0	2.7	5.4
6	CIMTEK	1.2	1.6	1.8	13.9	5.0
7	Matra Datavision	0.9	0.9	1.8	99.4	5.0
8	CADdy Spain	1.4	1.4	1.7	17.2	4.6
9	Structural Dynamics Research Corporation	1.2	1.3	1.6	22.1	4.5
10	ICEM Technologies	1.1	1.2	1.6	29.5	4.4
11	Unigraphics Solutions	1.2	1.4	1.5	11.2	4.2
12	Delcam Plc	0.8	0.9	1.2	40.0	3.4
13	Computervision	2.7	3.2	1.1	-66.6	2.9
14	MacNeal-Schwendler	1.3	1.1	1.0	-1.4	2.9
15	Softronics	1.0	1.0	1.0	2.7	2.9
16	ISD Software	0.3	0.7	0.6	-11.2	1.7
17	FHECOR	0.6	0.6	0.6	2.7	1.6
18	Cimatron	0.3	0.3	0.5	52.4	1.3
19	Tebis	0.4	0.4	0.5	6.4	1.2
20	Sescoi	0.3	0.4	0.4	10.6	1.1
21	Bentley Systems	-	0.3	0.4	17.9	1.1
22	Ansys	0.3	0.3	0.4	1.2	1.0
23	Applicon	0.1	0.1	0.2	67.0	0.5
24	Intergraph	0.2	0.2	0.2	18.2	0.5
25	Open Mind	-	0.1	0.2	19.5	0.5
26	ADRA Systems	0.3	0.3	0.1	-50.0	0.4
27	Gerber Systems	0.1	0.1	0.1	12.6	0.3
28	Ziegler Informatics	0.1	0.1	0.1	-3.8	0.2
29	Vero International Software	0	-	0.1	NA	0.1
30	MCS	0	0	0	13.3	0.1
	All N.A. Companies	**20.1**	**23.9**	**24.9**	**4.1**	**68.5**
	All European Companies	**5.4**	**7.8**	**9.9**	**27.0**	**27.3**
	All Asian Companies	**-**	**-**	**-**	**NA**	**-**
	All Companies	**26.8**	**32.7**	**36.3**	**11.0**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (August 1998)

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Table 2-9
Top 30 Mechanical Software Companies, Italy, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Parametric Technology	9.2	15.4	18.3	18.8	19.5
2	CAD Lab	12.2	9.8	11.6	18.2	12.3
3	IBM	9.9	10.3	10.9	5.8	11.6
4	Autodesk	6.9	6.9	8.2	19.8	8.8
5	Dassault Systemes	5.7	7.7	7.9	1.7	8.4
6	Matra Datavision	6.1	8.1	5.9	-28.1	6.3
7	CoCreate	5.4	4.9	5.5	10.7	5.8
8	Structural Dynamics Research Corporation	2.7	3.3	3.9	17.3	4.1
9	Investronica SA	-	4.0	3.7	-6.9	3.9
10	Computervision	7.1	7.2	2.4	-66.6	2.6
11	Cimatron	1.8	2.9	2.2	-25.1	2.3
12	Delcam Plc	1.2	1.5	2.2	40.0	2.3
13	Vero International Software	1.1	1.2	2.1	73.8	2.2
14	Unigraphics Solutions	-	1.4	1.5	6.6	1.6
15	Formtek	1.2	1.4	1.4	-0.7	1.5
16	Mechanical Dynamics	0.4	1.2	1.2	8.0	1.3
17	Sherpa Corp.	0.9	1.1	1.2	5.0	1.2
18	Ansys	1.0	1.0	1.1	1.2	1.1
19	MacNeal-Schwendler	3.8	-	1.0	NA	1.1
20	Bentley Systems	-	0.9	1.0	17.9	1.1
21	Adina R&D	0.6	0.8	0.8	2.0	0.8
22	Tebis	0.6	0.7	0.7	-3.6	0.7
23	CGTech	0.5	0.5	0.7	19.5	0.7
24	ICEM Technologies	0.3	0.4	0.6	70.0	0.6
25	ADRA Systems	0.5	0.6	0.4	-25.0	0.5
26	ISD Software	0.3	0.5	0.4	-11.2	0.4
27	Applicon	0.3	0.4	0.4	11.3	0.4
28	Sescoi	0.3	0.4	0.4	0.2	0.4
29	MCS	0.2	0.2	0.3	13.3	0.3
30	Open Mind	-	0.2	0.3	19.5	0.3
	All N.A. Companies	**62.3**	**66.7**	**71.2**	**6.9**	**76.0**
	All European Companies	**13.0**	**20.2**	**18.5**	**-8.3**	**19.8**
	All Asian Companies	**-**	**-**	**-**	**NA**	**-**
	All Companies	**79.3**	**89.8**	**93.7**	**4.4**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (August 1998)

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Table 2-10
Top 30 Mechanical Software Companies, Scandinavia, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Parametric Technology	9.6	17.0	20.2	18.8	26.9
2	IBM	14.7	15.6	16.5	5.9	21.9
3	Dassault Systemes	5.7	8.4	8.6	2.0	11.4
4	Autodesk	7.6	6.9	8.3	20.7	11.0
5	CoCreate	5.4	4.9	5.5	10.7	7.3
6	Structural Dynamics Research Corporation	3.0	3.6	4.4	21.0	5.8
7	MICROCADAM	2.6	3.0	2.6	-13.7	3.5
8	Modultek Oy	-	-	2.2	NA	2.9
9	MacNeal-Schwendler	2.7	2.1	2.1	-1.4	2.8
10	Computervision	4.0	4.4	1.5	-66.6	1.9
11	Ansys	1.3	1.4	1.4	1.2	1.9
12	Formtek	0.9	1.0	1.0	-4.4	1.3
13	Delcam Plc	0.3	0.7	0.9	40.0	1.2
14	Matra Datavision	2.2	2.9	0.8	-71.3	1.1
15	Sherpa Corp.	0.5	0.7	0.7	5.0	0.9
16	ISD Software	0.3	0.7	0.6	-11.2	0.8
17	Mechanical Dynamics	0.2	0.5	0.5	8.0	0.7
18	Bentley Systems	-	0.4	0.5	17.9	0.6
19	ICEM Technologies	0.2	0.2	0.4	126.7	0.5
20	Investronica SA	-	0.4	0.4	-10.4	0.5
21	Intergraph	0.5	0.3	0.4	10.7	0.5
22	PAFEC	-	0.4	0.4	-7.5	0.5
23	Pathtrace Engineering Systems	0.1	0.2	0.4	109.1	0.5
24	Gibbs and Assoc.	-	0.2	0.3	52.3	0.4
25	Whessoe Computing Systems	0.3	0.3	0.3	-10.7	0.4
26	Auto-Trol	-	0.3	0.2	-4.5	0.3
27	Anilam Electronics	0.2	0.2	0.2	-10.4	0.3
28	Applicon	0.2	0.2	0.2	-16.5	0.3
29	Ziegler Informatics	0.1	0.2	0.2	-14.5	0.2
30	Exapt	0.2	0.2	0.2	-10.7	0.2
	All N.A. Companies	**51.7**	**61.0**	**64.8**	**6.3**	**86.2**
	All European Companies	**4.7**	**6.7**	**7.2**	**7.6**	**9.6**
	All Asian Companies	**-**	**-**	**-**	**NA**	**-**
	All Companies	**59.4**	**70.0**	**75.2**	**7.5**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (August 1998)

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Table 2-11
Top 12 Mechanical Software Companies, Russia, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Delcam Plc	1.7	1.3	1.8	40.0	24.3
2	IBM	-	1.8	1.7	-7.6	22.0
3	Dassault Systemes	1.9	2.0	1.4	-31.5	18.5
4	MacNeal-Schwendler	-	-	1.0	NA	13.8
5	Parametric Technology	-	0.9	1.0	18.8	13.5
6	Matra Datavision	0.9	0.9	0.9	4.7	12.5
7	Autodesk	0.7	0.6	0.6	6.8	8.4
8	Computervision	0.1	0.5	0.2	-66.6	2.0
9	Ziegler Informatics	0.1	0.1	0.1	-2.9	1.2
10	Intergraph	-	0.1	0.1	23.0	0.8
11	Diehl Graphsoft	0	0	0	57.4	0.3
12	IMSI	0	0	0	10.9	0.2
	All N.A. Companies	**0.9**	**3.5**	**4.4**	**25.3**	**58.5**
	All European Companies	**2.6**	**2.2**	**2.8**	**25.6**	**37.2**
	All Asian Companies	**-**	**-**	**-**	**NA**	**-**
	All Companies	**3.7**	**6.0**	**7.6**	**26.8**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (August 1998)

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Table 2-12
Top 22 Mechanical Software Companies, Central Europe, All Operating Systems
(Revenue in Millions of Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Unigraphics Solutions	5.1	5.0	5.0	-0.3	23.9
2	IBM	3.9	3.6	3.8	5.6	18.1
3	Structural Dynamics Research Corporation	2.0	2.9	3.3	13.1	15.7
4	Autodesk	1.8	1.8	2.2	24.2	10.8
5	Matra Datavision	0.9	0.9	1.8	99.4	8.7
6	MacNeal-Schwendler	-	-	1.0	NA	5.0
7	CNC Software	0.6	0.6	0.6	-1.9	2.9
8	Investronica SA	-	0.4	0.4	-1.9	2.0
9	ISD Software	0.6	0.7	0.4	-40.8	1.9
10	Bentley Systems	-	0.3	0.4	17.9	1.9
11	Gerber Systems	0.3	0.3	0.4	7.5	1.8
12	Ansys	0.3	0.3	0.4	1.2	1.7
13	Delcam Plc	0.5	0.2	0.3	40.0	1.5
14	Spatial Technology	0.1	0.1	0.2	166.8	1.1
15	ICEM Technologies	0.2	0.2	0.2	13.3	1.0
16	ADRA Systems	0.3	0.3	0.1	-50.0	0.7
17	Vero International Software	0.1	0.1	0.1	26.0	0.5
18	Intergraph	0.1	0.1	0.1	19.4	0.3
19	Computervision	0.4	0.1	0	-66.6	0.1
20	Diehl Graphsoft	0	0	0	57.4	0.1
21	ESI Group	-	-	0	NA	0.1
22	IMSI	0	0	0	10.9	0.1
	All N.A. Companies	**14.2**	**14.7**	**16.7**	**13.5**	**80.5**
	All European Companies	**2.8**	**2.3**	**3.2**	**35.6**	**15.3**
	All Asian Companies	**-**	**-**	**-**	**NA**	**-**
	All Companies	**17.9**	**17.6**	**20.7**	**17.7**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (August 1998)

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Table 2-13
Top 30 Mechanical Software Companies, Rest of Europe, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Parametric Technology	7.0	6.5	7.8	18.8	29.9
2	MacNeal-Schwendler	4.1	4.3	4.2	-1.4	16.1
3	Matra Datavision	-	-	3.9	NA	14.9
4	Sescoi	1.5	1.9	1.4	-22.9	5.6
5	Structural Dynamics Research Corporation	1.1	1.3	1.4	2.0	5.2
6	Delcam Plc	-	0.6	0.9	40.0	3.4
7	Eigner + Partner	0.8	-	0.7	NA	2.7
8	Cimatron	-	-	0.6	NA	2.4
9	Camcentre	-	-	0.6	NA	2.1
10	Sherpa Corp.	0.4	0.5	0.5	5.0	1.9
11	Autodesk	0.6	0.5	0.5	-8.4	1.9
12	Wiechers Datentechnik	0.6	0.5	0.4	-15.2	1.7
13	ADRA Systems	-	-	0.4	NA	1.7
14	Vero International Software	-	-	0.4	NA	1.6
15	Unigraphics Solutions	0.2	0.3	0.3	2.3	1.2
16	Spatial Technology	0.1	0.1	0.2	166.8	0.8
17	SRAC	-	-	0.2	NA	0.7
18	MCS	0.1	0.2	0.2	13.3	0.7
19	Ziegler Informatics	0.1	0.1	0.2	30.4	0.7
20	Computervision	0.4	0.4	0.1	-66.6	0.6
21	B.A. Intelligence Networks	0.1	-	0.1	NA	0.4
22	Intergraph	0.1	0.1	0.1	12.7	0.2
23	CIMLINC	0.1	0.1	0	-21.4	0.2
24	Research Engineers	0	0	0	28.3	0.1
25	Investronica SA	-	0	0	-28.4	0
26	ESI Group	0.1	0.1	0	-99.7	0
27	debis Systemhaus	0.4	-	0	NA	0
28	Ansys	0.5	-	-	NA	-
29	ISD Software	0.1	-	-	NA	-
30	Applicon	-	-	-	NA	-
	All N.A. Companies	**15.9**	**14.1**	**15.8**	**11.7**	**60.8**
	All European Companies	**6.2**	**3.2**	**9.1**	**182.1**	**34.9**
	All Asian Companies	**-**	**-**	**-**	**NA**	**-**
	All Companies	**23.2**	**17.9**	**26.0**	**44.8**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
Source: Dataquest (August 1998)

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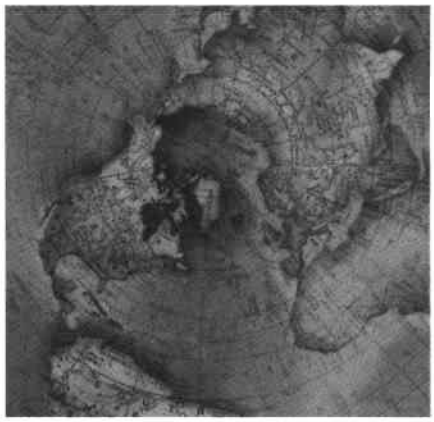
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1998 Mechanical CAD/CAM/CAE Worldwide Forecast Update

Market Statistics

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Table of Contents

Page

1. 1998 Mechanical CAD/CAM/CAE Worldwide Forecast Update 1
   - Introduction 1
   - Worldwide Forecast Assumptions 1
     - All Applications 1
   - Mechanical Forecast Assumptions 4
     - CAD Investments Are Cyclical 4
     - Tier Two Investments 4
     - New Software, New Platforms, and New Users 4
     - Continued Economic Turmoil in Asia/Pacific 4
     - Meeting User Needs beyond Design 5
   - AEC Forecast Assumptions 5
     - CAD Is Becoming a Business Requirement 5
     - New Features in AEC CAD Products Are Achievable 5
     - A More Tailored Focus 5
     - Design Is Only Part of the Problem 5
   - GIS/Mapping Forecast Assumptions 5
     - Abundant Supply of Prospective Buyers 6
     - New Technologies 6
     - Indispensability of GIS 6
     - High Cost of Entry Remains a Barrier 6
     - Price Pressures Inhibit Growth 6
   - Electronic Design Automation Forecast Assumptions 6
     - Electronic CAE 7
     - IC Layout 7
     - PCB Design 7
   - History and Forecast for All Applications and Operating Systems 7
   - Forecast Methodology 9
   - Changes to the Forecast Database 10
   - Segmentation Definitions 11
     - Operating Systems 11
     - Line Items 11
   - Regional Definitions 12
2. 1998 Mechanical CAD/CAM/CAE Worldwide Forecast Update Tables 15

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List of Figures

Figure Page

1-1 Mechanical CAD/CAM/CAE, AEC and GIS, and EDA Forecasting Model 10

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List of Tables

Table		Page
1-1	CAD/CAM/CAE and GIS Revenue Growth Comparison	2
1-2	Foreign Currency per U.S. Dollar	3
1-3	CAD/CAM/CAE/GIS Software Revenue History and Forecast	8
1-4	CAD/CAM/CAE/GIS Software Revenue Growth Rate History and Forecast	9
2-1	Top-Level Mechanical Forecast, Worldwide, All Operating Systems	16
2-2	Detail Mechanical Forecast, Worldwide, All Operating Systems	17
2-3	Detail Mechanical Forecast, Worldwide, UNIX	18
2-4	Detail Mechanical Forecast, Worldwide, Windows NT	19
2-5	Detail Mechanical Forecast, Worldwide, Personal Computer	20
2-6	Detail Mechanical Forecast, Worldwide, Host/Proprietary	21
2-7	Detail Mechanical Forecast, North America, All Operating Systems	22
2-8	Detail Mechanical Forecast, Europe, All Operating Systems	23
2-9	Detail Mechanical Forecast, Japan, All Operating Systems	24
2-10	Detail Mechanical Forecast, Asia/Pacific, All Operating Systems	25
2-11	Detail Mechanical Forecast, Rest of World, All Operating Systems	26

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Chapter 1
1998 Mechanical CAD/CAM/CAE Worldwide Forecast Update

Introduction

Dataquest's CAD/CAM/CAE, AEC and GIS, and EDA forecasts are based on market share software revenue gathered primarily during the first quarter of 1998. Dataquest's software forecast for all applications include the following:

- 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 1998 exchange rate will remain stable in the future (see Tables 1-1 and 1-2).

Dataquest's 1997 market share documents for these markets (published as CAEC-WW-MS-9803, CEDA-WW-MS-9803, and CMEC-WW-MS-9803) 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 systems 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 1-1
CAD/CAM/CAE and GIS Revenue Growth Comparison
(U.S. Dollars versus Local Currency for Both Europe and Japan)

	1996	1997	Forecast 2002	Growth (%) 1996-1997	CAGR (%) 1997-2002
Europe (Millions of U.S. Dollars)					
Software Revenue	2,192.20	2,288.68	3,780.26	4.4	10.6
Hardware Revenue	2,736.77	2,639.54	3,491.73	-3.6	5.8
Service Revenue	1,166.77	1,160.33	1,678.11	-0.6	7.7
Total Factory Revenue	**6,095.75**	**6,088.55**	**8,950.11**	**-0.1**	**8.0**
ECU/U.S. Dollar Exchange Rate*	0.80	0.89	0.91	11.6	0.4
Europe (ECU Million)					
Software Revenue	1,748.45	2,036.92	3,440.04	16.5	11.0
Hardware Revenue	2,182.78	2,349.19	3,177.47	7.6	6.2
Service Revenue	930.59	1,032.70	1,527.08	11.0	8.1
Total Factory Revenue	**4,861.82**	**5,418.81**	**8,144.60**	**11.5**	**8.5**
Japan (Millions of U.S. Dollars)					
Software Revenue	1,830.17	2,022.25	3,445.40	10.5	11.2
Hardware Revenue	2,870.44	2,818.60	3,722.89	-1.8	5.7
Service Revenue	1,276.08	1,085.79	1,646.51	-14.9	8.7
Total Factory Revenue	**5,976.69**	**5,926.64**	**8,814.80**	**-0.8**	**8.3**
Japan/U.S. Dollar Exchange Rate*	108.81	121.10	140.79	11.3	3.1
Japan (Yen Million)					
Software Revenue	199,140.77	244,894.41	485,077.23	23.0	14.6
Hardware Revenue	312,332.11	341,332.56	524,146.26	9.3	9.0
Service Revenue	138,850.70	131,489.22	231,812.50	-5.3	12.0
Total Factory Revenue	650,323.58	717,716.19	1,241,035.99	10.4	11.6
North America (Millions of U.S. Dollars)					
Software Revenue	2,544.84	2,786.35	5,317.84	9.5	13.8
Hardware Revenue	2,963.65	3,075.77	4,822.15	3.8	9.4
Service Revenue	1,428.64	1,441.18	2,537.79	0.9	12.0
Total Factory Revenue	6,937.12	7,303.29	12,677.77	5.3	11.7
Worldwide (Millions of U.S. Dollars)					
Software Revenue	7,168.51	7,748.89	13,665.55	8.1	12.0
Hardware Revenue	9,332.07	9,315.86	13,098.21	-0.2	7.1
Service Revenue	4,197.99	4,031.59	6,375.98	-4.0	9.6
Total Factory Revenue	**20,698.57**	**21,096.34**	**33,139.73**	**1.9**	**9.5**

*Assuming a stable currency, the 2002 exchange rate is the July 1998 monthly rate.
Source: Dataquest (September 1998)

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Table 1-2
Foreign Currency per U.S. Dollar

Country	Currency	Actual					Current		Year-to-Year Change (%)					
		1993	1994	1995	1996	1997	1998	1999	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998	1998-1999
Austria	Schilling	11.65	11.40	10.06	10.59	12.20	12.65	12.65	-2.15	-11.75	5.27	15.20	3.69	0
Belgium	Franc	34.67	33.66	29.42	30.96	35.79	37.07	37.07	-2.91	-12.60	5.23	15.60	3.58	0
Denmark	Krone	6.49	6.35	5.59	5.81	6.61	6.85	6.85	-2.16	-11.97	3.94	13.77	3.63	0
Finland	Markka	5.73	5.21	4.37	4.59	5.19	5.47	5.47	-9.08	-16.12	5.03	13.07	5.39	0
France	Franc	5.67	5.54	4.97	5.12	5.84	6.03	6.03	-2.29	-10.29	3.02	14.06	3.25	0
Germany	D-Mark	1.66	1.62	1.43	1.50	1.73	1.80	1.80	-2.41	-11.73	4.90	15.33	4.05	0
Italy	Lira	1,577.85	1,609.34	1,628.21	1,542.72	1,703.02	1,772.42	1,772.42	2.00	1.17	-5.25	10.39	4.08	0
Netherlands	Guilder	1.86	1.82	1.60	1.69	1.95	2.03	2.03	-2.15	-12.09	5.62	15.38	4.10	0
Norway	Krone	7.11	7.04	6.33	6.46	7.08	7.63	7.63	-0.98	-10.09	2.05	9.60	7.77	0
Spain	Peseta	127.87	133.48	124.40	126.68	146.45	152.58	152.58	4.39	-6.80	1.83	15.61	4.19	0
Sweden	Krona	7.82	7.70	7.14	6.71	7.64	7.99	7.99	-1.53	-7.27	-6.02	13.86	4.58	0
Switzerland	Franc	1.48	1.37	1.18	1.24	1.45	1.51	1.51	-7.43	-13.87	5.08	16.94	4.14	0
United Kingdom	Pound	0.67	0.65	0.63	0.64	0.61	0.61	0.61	-2.99	-3.08	1.59	-4.69	0.00	0
Europe Average	ECU	0.86	0.84	0.77	0.80	0.89	0.91	0.91	-1.52	-8.72	3.58	11.59	2.25	0
China	Renminbi	5.76	8.54	8.35	8.34	8.32	8.31	8.31	48.26	-2.22	-0.12	-0.24	-0.12	0
Hong Kong	Dollar	7.74	7.73	7.74	7.73	7.74	7.75	7.75	-0.13	0.13	-0.13	0.13	0.13	0
Japan	Yen	110.85	101.56	93.90	108.81	121.10	140.79	140.79	-8.38	-7.54	15.88	11.29	16.26	0
Korea	Won	799.42	805.80	770.57	805.16	954.14	1,295.76	1,295.76	0.80	-4.37	4.49	18.50	35.80	0
Singapore	Dollar	1.62	1.53	1.43	1.41	1.49	1.71	1.71	-5.32	-6.54	-1.40	5.67	14.77	0
Taiwan	Dollar	26.15	26.45	26.48	27.47	28.79	34.39	34.39	1.15	0.11	3.74	4.81	19.45	0

Source: Dataquest (September 1998)

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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.

Also 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, the won, 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 affect growth in the mechanical CAD/CAM/CAE market over our forecast period.

CAD Investments Are Cyclical

The major aerospace and automotive companies, particularly in Europe, had been significant drivers of the double-digit mechanical CAD/CAM/CAE growth in previous years. However, these companies have now completed their investment cycles in CAD technology for the next four or five years. Investment in CAD by these large companies will slow until the next investment cycle begins, bringing down the overall market growth.

Tier Two Investments

Related to the above assumption, now that these companies have completed their investment cycles, Dataquest expects to see corresponding investment by their supplier bases as a significant driver of the market.

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. 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 and who are looking to upgrade from their 2-D-based systems. Based on what we saw in 1997, we are shifting the peak of our NT-based mechanical CAD/CAM/CAE sales forecast to earlier in our five-year forecast period.

Continued Economic Turmoil in Asia/Pacific

The Asia/Pacific region will be a mixed bag of high and low growth over our forecast period, fueled by CAD investments from local and national governments and expansion by multinational companies, but also tempered by economic and political turmoil in Southeast Asia. We have lowered our forecast for Asia/Pacific in light of the economic uncertainty in some of that region.

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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. If they can come up with the right solution, we can significantly raise our forecast.

AEC Forecast Assumptions

The following factors will affect 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.

New Features in AEC CAD Products Are Achievable

Better, lower-cost visualization tools will be in increasing demand in addition to sales and communication tools. Data and database functions are growing in importance in AEC design, creating opportunities to sell to users a 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.

A More Tailored Focus

If vendors stay focused on not selling generic CAD solutions but rather on selling more tailored solutions to fit different needs in AEC (such as architectural needs, plant design needs), then we can begin to raise our forecast upwards. Over the years, AEC sales have largely been driven by vanilla sales of CAD products. Solutions that meet specific needs of users will help drive the market forward at a faster rate.

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 affect growth in the worldwide GIS market.

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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. Advances in aerial photography, global positioning systems, and satellite imagery 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.

Indispensability of GIS

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.

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

Our final survey showed even slower growth than reported in the preliminary forecast total EDA growth, which was 14.6 percent. This spring we did a considerable amount of work modeling the end-user design market. The breakthrough happened when we broke the mainstream into upper and lower mainstream segments. With these new models we found that all our previous survey work converged. This gave us a clear picture of the actual growth by segment, explaining in greater detail the reason for the slowdown in EDA growth. The top of the pyramid, the power users, only grew 4.5 percent. This was the group that in essence had run out of tools to

buy. This also explains the reason the slowdown was far more pronounced in the United States than in other geographic regions. On the other hand, the upper mainstream grew 12.8 percent and the lower mainstream a whopping 130.4 percent. These then are the markets that kept EDA from falling into the 4 percent growth area of the early 1990s, another period where we ran out of tools. Just to give you a comparison picture, in 1991, 75 percent of all money spent on EDA tools was spent by the power users. This year, for the first time, the upper mainstream alone will spend more dollars on EDA tools than the power users.

The other thing that has become clear is that this is not a semiconductor recession, this is a true technology inflection point. The last time we saw this was in the early 1980s when the impact of the microprocessor caused a double-dip recession. If you remember back then, it was the time of explosive growth in EDA. We are a much larger industry today so the growth won't be explosive, but it will be significant and, as 1997 has shown, it will be driven by supply not demand. The need is there, the money is there, now where are the needed new tools?

Electronic CAE

CAE was by far the area where the lack of new tools hit the hardest. Where is the RTL virtual prototype? What are we going to do about the verification crisis? Why has ES-level tool development been de-emphasized by the EDA industry? The only bright spots have been hardware/software coverification and formal verification, at least at the equivalency checking level. The best news this year has been an answer to the verification crisis. At least we think we know the answer. Until we see the new test bench, a test bench that coordinates the work of not just simulation but multiple types of simulation while also using formal verification and formal analysis, we won't know. Unfortunately, we've yet to see much progress on the RTL virtual prototype front. There are some new start-ups now attacking the problem, and they are showing an extremely broad level of technical expertise. We can only hope.

IC Layout

The IC CAD world is catching up with the silicon. This is obviously the most exciting news to come out of EDA in years. Announcements by Avant! and Cadence plus the progress on the Sematech CHDs, physical verification program have excited the industry. We're one generation behind and closing! This will keep the IC CAD market growing at around 20 percent for the foreseeable future.

PCB Design

The final PCB numbers showed a completely different picture than the preliminary PCB numbers. The Asia/Pacific region grew an extremely strong 22.2 percent. The major downfall was in Japan, followed by Europe. This is a continuation of the flow of manufacturing to Asia from these areas. North America grew at a strong 12 percent. Again the new high-speed buses will continue to drive this market.

History and Forecast for All Applications and Operating Systems

Tables 1-3 and 1-4 show the history and forecast of all applications.

Table 1-3
CAD/CAM/CAE/GIS Software Revenue History and Forecast

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Software Revenue ($M)									
Worldwide, All Operating Systems	6,197	7,169	7,749	8,639	9,718	10,948	12,280	13,666	12.0
Worldwide									
UNIX	4,135	4,748	4,670	4,853	5,158	5,541	5,975	6,427	6.6
Windows NT	401	836	1,626	2,350	3,090	3,902	4,761	5,653	28.3
Personal Computer	1,485	1,429	1,392	1,401	1,449	1,492	1,536	1,580	2.6
Host/Proprietary	176	155	61	35	21	13	8	5	-38.2
All Operating Systems									
North America	2,098	2,545	2,786	3,190	3,677	4,206	4,748	5,318	13.8
Europe	2,000	2,192	2,289	2,501	2,787	3,074	3,402	3,780	10.6
Japan	1,613	1,830	2,022	2,239	2,480	2,786	3,112	3,445	11.2
Asia/Pacific	377	479	526	570	619	709	825	907	11.5
Rest of World	110	123	126	139	155	173	192	215	11.3

Source: Dataquest (September 1998)

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Table 1-4
CAD/CAM/CAE/GIS Software Revenue Growth Rate History and Forecast

	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Year-to-Year Software Revenue Growth Rate (%)								
Worldwide, All Operating Systems	15.7	8.1	11.5	12.5	12.7	12.2	11.3	-
Worldwide								
UNIX	14.8	-1.7	3.9	6.3	7.4	7.8	7.6	-
Windows NT	108.7	94.4	44.5	31.5	26.2	22.0	18.7	-
Personal Computer	-3.8	-2.6	0.6	3.4	3.0	2.9	2.8	-
Host/Proprietary	-12.1	-60.5	-42.7	-40.3	-37.6	-35.6	-34.5	-
All Operating Systems								
North America	21.3	9.5	14.5	15.3	14.4	12.9	12.0	-
Europe	9.6	4.4	9.3	11.4	10.3	10.7	11.1	-
Japan	13.5	10.5	10.7	10.8	12.4	11.7	10.7	-
Asia/Pacific	27.0	9.9	8.4	8.6	14.6	16.3	10.0	-
Rest of World	11.5	2.4	11.0	11.3	11.4	11.0	12.0	-

Source: Dataquest (September 1998)

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 Asia and Europe of the events of 1997.

Figure 1-1 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.

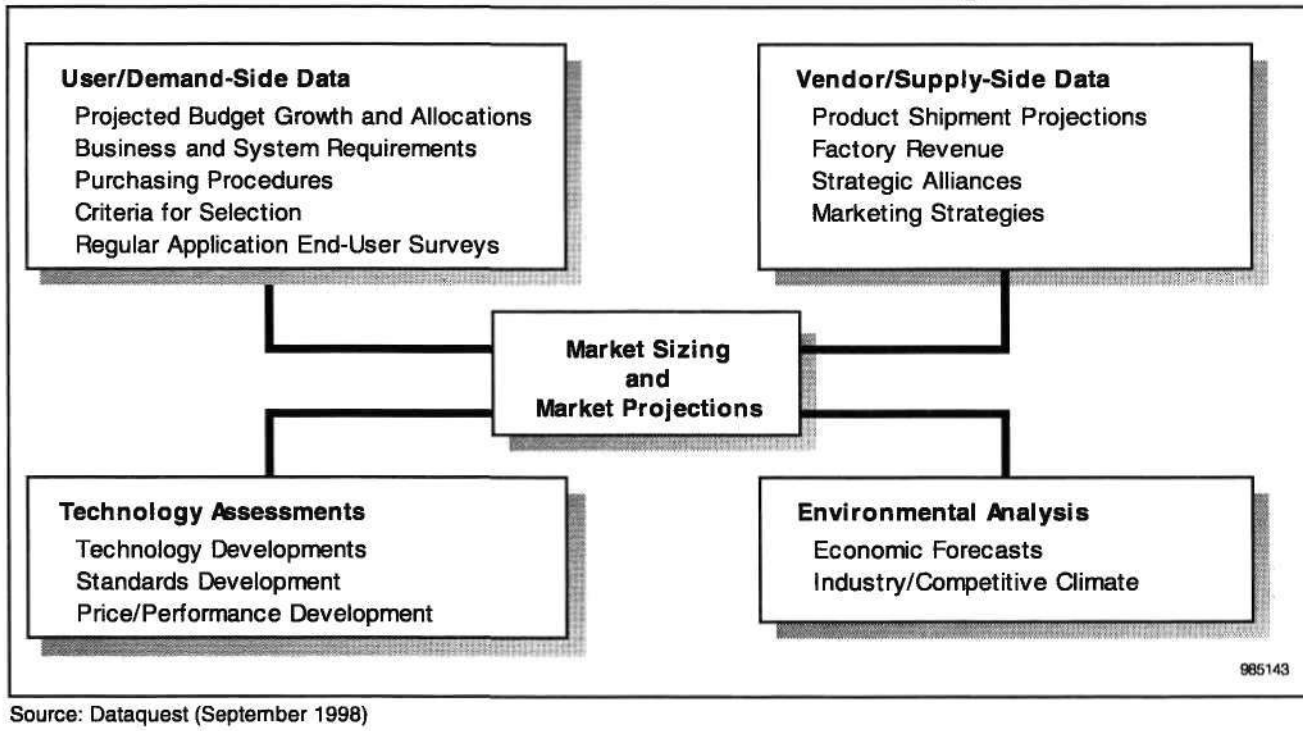
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- Demand-based analysis—Market growth is tracked and forecast in terms of the present and anticipated demand of current and future users. This requires the development of a total available market model and a satisfied available market figure to assess 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.

Figure 1-1
Mechanical CAD/CAM/CAE, AEC and GIS, and EDA Forecasting Model



Source: Dataquest (September 1998)

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

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.

Regional Definitions

The following regional hierarchy and definitions are used for all Dataquest's geographic segmentation. Not all product categories and Dataquest services have the entire segmentation. Some may have a greater level and some may have less. In particular, the Latin America region is included in the Rest of World region for all mechanical CAD/CAM/CAE, AEC and GIS, and EDA market statistics.

- North America region
  - United States: Includes the 48 contiguous states, Washington, D.C., Alaska, Hawaii, and Puerto Rico
  - Canada: Single-country region
- Latin America region: Countries covered include Argentina, Brazil, Chile, Colombia, Mexico, Peru, and Venezuela
  - Rest of Latin America: Anguilla, Antigua and Barbuda, Aruba, Bahamas, Barbados, Belize, Bermuda, Bolivia, Cayman Islands, Clipperton Island, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Falkland Islands (Islas Malvinas), French Guiana, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Montserrat, Navassa Island, Netherlands Antilles, Nicaragua, Panama, Paraguay, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Tortola (British Virgin Islands), Trinidad and Tobago, Turks and Caicos Islands, Uruguay, and Virgin Islands (St. John, St. Croix, and St. Thomas)
- Europe region
  - Western Europe: Countries covered include Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and United Kingdom
  - Rest of Western Europe: Andorra, Cyprus, Faroe Islands, Gibraltar, Greenland, Guernsey, Iceland, Isle of Man, Jersey, Liechtenstein, Luxembourg, Malta, Monaco, San Marino, and Svalbard
  - Central and Eastern Europe: Belarus, Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Russia, Slovakia, and Ukraine
  - Rest of Eastern Europe: Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Croatia, Georgia, Kazakhstan, Kyrgyzstan, Macedonia, Moldova, Romania, Slovenia, Tajikistan, Turkmenistan, Uzbekistan, and Yugoslavia (Serbia and Montenegro)
- Japan: Single-country region

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- Asia/Pacific: Countries covered include Australia, China, Hong Kong, India, Indonesia, South Korea, Malaysia, Singapore, Taiwan, and Thailand
  - Rest of Asia/Pacific: American Samoa, Ashmore and Cartier Islands, Baker Island, Bangladesh, Bhutan, Bouvet Island, Brunei, Cambodia, Christmas Island, Cocos (Keeling) Islands, Cook Islands, Coral Sea Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Howland Island, Jarvis Island, Johnston Atoll, Kingman Reef, Kiribati, Laos, Macau, Maldives, Marshall Islands, Midway Islands, Mongolia, Myanmar (Burma), Nauru, Nepal, New Caledonia, New Zealand, Niue, Norfolk Island, Northern Mariana Islands, North Korea, Pakistan, Palau, Palmyra Atoll, Papua New Guinea, Paracel Islands, Philippines, Pitcairn Islands, Solomon Islands, Spratly Islands, Sri Lanka, Tokelau, Tonga, Tuvalu, Vanuatu, Vietnam, Wake Island, Wallis and Futuna, and Western Samoa
- Rest of World: Afghanistan, Algeria, Angola, Bahrain, Bassas da India, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Cote d'Ivoire, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Europa Island, Gabon, Gambia, Ghana, Glorioso Islands, Guinea, Guinea-Bissau, Iran, Iraq, Israel, Jordan, Juan de Nova Island, Kenya, Kuwait, Lebanon, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mayotte, Morocco, Mozambique, Namibia, Niger, Nigeria, Oman, Qatar, Reunion, Rwanda, Saint Helena, Sao Tome and Principe, Saudi Arabia, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Syria, Tanzania, Togo, Tromelin Island, Tunisia, Turkey, Uganda, United Arab Emirates, Western Sahara, Yemen, Zaire, Zambia, and Zimbabwe

Chapter 2
1998 Mechanical CAD/CAM/CAE Worldwide Forecast Update Tables

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Table 2-1
Top-Level Mechanical Forecast, Worldwide, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Software Revenue ($M)									
Worldwide, All Operating Systems	2,830	3,328	3,513	3,843	4,228	4,607	4,996	5,417	9.0
Worldwide									
UNIX	2,057	2,376	2,186	2,199	2,249	2,293	2,353	2,435	2.2
Windows NT	116	315	739	1,078	1,414	1,744	2,064	2,393	26.5
Personal Computer	545	539	550	546	553	562	573	585	1.2
Host/Proprietary	111	99	38	20	12	8	6	4	-35.9
All Operating Systems									
North America	788	997	1,033	1,166	1,323	1,453	1,572	1,685	10.3
Europe	987	1,084	1,106	1,188	1,295	1,391	1,515	1,686	8.8
Japan	883	1,019	1,122	1,222	1,326	1,453	1,571	1,679	8.4
Asia/Pacific	141	192	212	224	235	256	280	305	7.5
Rest of World	31	36	39	44	49	54	58	63	9.9
Year-to-Year Software Revenue Growth Rate (%)									
Worldwide, All Operating Systems		17.6	5.6	9.4	10.0	9.0	8.4	8.4	-
Worldwide									
UNIX		15.5	-8.0	0.6	2.3	2.0	2.6	3.5	-
Windows NT		170.1	134.9	45.9	31.2	23.3	18.4	15.9	-
Personal Computer		-1.1	2.1	-0.7	1.2	1.6	1.9	2.1	-
Host/Proprietary		-11.5	-61.8	-45.9	-39.8	-33.1	-30.5	-28.4	-
All Operating Systems									
North America		26.6	3.6	12.9	13.5	9.8	8.1	7.2	-
Europe		9.9	2.0	7.4	9.0	7.5	8.9	11.3	-
Japan		15.5	10.1	8.9	8.5	9.6	8.1	6.9	-
Asia/Pacific		35.9	10.9	5.3	5.0	8.9	9.5	8.8	-
Rest of World		13.0	10.0	11.7	11.7	9.7	8.8	7.5	-

Source: Dataquest (September 1998)

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Table 2-2
Detail Mechanical Forecast, Worldwide, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	333,268	367,577	412,540	441,688	472,077	492,527	518,084	547,480	6
Seats	343,129	375,239	413,313	440,994	468,635	493,164	518,542	547,836	6
Year-to-Year Increase (%)	15	9	10	7	6	5	5	6	-
Installed Base									
CPUs	918,419	1,027,962	1,150,362	1,264,795	1,368,407	1,450,759	1,523,402	1,596,836	7
Seats	971,201	1,073,576	1,183,553	1,285,530	1,377,215	1,454,802	1,525,646	1,598,297	6
Year-to-Year Increase (%)	12	11	10	9	7	6	5	5	-
Revenue Data ($M)									
CPU Revenue	3,861	4,167	4,026	4,115	4,330	4,526	4,769	5,077	5
Terminal Revenue	154	135	14	9	5	3	2	1	-37
Peripheral Revenue	350	345	355	320	301	287	276	267	-6
Hardware Revenue	4,365	4,647	4,394	4,444	4,636	4,817	5,047	5,345	4
Year-to-Year Increase (%)	11	6	-5	1	4	4	5	6	-
Software Revenue	2,830	3,328	3,513	3,843	4,228	4,607	4,996	5,417	9
Year-to-Year Increase (%)	18	18	6	9	10	9	8	8	-
Software Service	1,008	1,133	1,067	1,117	1,211	1,304	1,412	1,520	7
Hardware Service	808	879	853	790	818	846	888	940	2
Service Revenue	1,816	2,012	1,920	1,907	2,029	2,151	2,300	2,461	5
Year-to-Year Increase (%)	13	11	-5	-1	6	6	7	7	-
Total Factory Revenue	**9,011**	**9,987**	**9,827**	**10,194**	**10,893**	**11,574**	**12,343**	**13,222**	**6**
Year-to-Year Increase (%)	14	11	-2	4	7	6	7	7	-

Source: Dataquest (September 1998)

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Table 2-3
Detail Mechanical Forecast, Worldwide, UNIX

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	121,676	130,837	126,544	115,977	114,324	112,983	113,558	115,160	-2
Seats	121,676	130,837	126,544	115,977	114,324	112,983	113,558	115,160	-2
Year-to-Year Increase (%)	12	8	-3	-8	-1	-1	1	1	-
Installed Base									
CPUs	371,573	418,318	447,560	453,676	449,794	440,807	433,269	430,294	-1
Seats	371,573	418,318	447,560	453,676	449,794	440,807	433,269	430,294	-1
Year-to-Year Increase (%)	16	13	7	1	-1	-2	-2	-1	-
Revenue Data ($M)									
CPU Revenue	2,814	2,886	2,634	2,419	2,396	2,380	2,397	2,423	-2
Terminal Revenue	-	-	-	-	-	-	-	-	NA
Peripheral Revenue	267	254	267	225	206	190	177	164	-9
Hardware Revenue	3,081	3,140	2,901	2,644	2,602	2,570	2,574	2,587	-2
Year-to-Year Increase (%)	16	2	-8	-9	-2	-1	0	0	-
Software Revenue	2,057	2,376	2,186	2,199	2,249	2,293	2,353	2,435	2
Year-to-Year Increase (%)	16	15	-8	1	2	2	3	3	-
Software Service	819	892	822	834	853	873	897	929	2
Hardware Service	673	726	704	610	613	617	630	645	-2
Service Revenue	1,491	1,618	1,526	1,444	1,466	1,490	1,527	1,575	1
Year-to-Year Increase (%)	16	9	-6	-5	2	2	2	3	-
Total Factory Revenue	**6,630**	**7,134**	**6,614**	**6,287**	**6,317**	**6,354**	**6,454**	**6,597**	**0**
Year-to-Year Increase (%)	16	8	-7	-5	0	1	2	2	-

NA = Not applicable
Source: Dataquest (September 1998)

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Table 2-4
Detail Mechanical Forecast, Worldwide, Windows NT

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	6,011	33,112	77,577	102,546	125,401	143,074	158,697	176,278	18
Seats	6,011	33,112	77,577	102,546	125,401	143,074	158,697	176,278	18
Year-to-Year Increase (%)	165	451	134	32	22	14	11	11	-
Installed Base									
CPUs	8,097	39,905	111,673	194,263	274,773	344,046	401,225	452,824	32
Seats	8,097	39,905	111,673	194,263	274,773	344,046	401,225	452,824	32
Year-to-Year Increase (%)	247	393	180	74	41	25	17	13	-
Revenue Data ($M)									
CPU Revenue	70	365	697	971	1,221	1,428	1,650	1,930	23
Terminal Revenue	-	-	-	-	-	-	-	-	NA
Peripheral Revenue	6	10	18	24	27	30	32	36	15
Hardware Revenue	75	376	715	995	1,248	1,458	1,683	1,965	22
Year-to-Year Increase (%)	130	401	90	39	25	17	15	17	
Software Revenue	116	315	739	1,078	1,414	1,744	2,064	2,393	26
Year-to-Year Increase (%)	179	170	135	46	31	23	18	16	-
Software Service	30	76	162	236	316	390	476	553	28
Hardware Service	9	61	86	114	146	173	202	240	23
Service Revenue	39	137	247	350	462	563	679	793	26
Year-to-Year Increase (%)	47	253	80	42	32	22	20	17	-
Total Factory Revenue	**230**	**827**	**1,701**	**2,423**	**3,124**	**3,765**	**4,425**	**5,152**	**25**
Year-to-Year Increase (%)	128	259	106	42	29	21	18	16	-

NA = Not applicable
Source: Dataquest (September 1998)

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Table 2-5
Detail Mechanical Forecast, Worldwide, Personal Computer

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	202,758	199,389	206,585	221,015	228,002	236,470	245,829	256,043	4
Seats	202,941	199,689	206,688	221,015	228,002	236,470	245,829	256,043	4
Year-to-Year Increase (%)	18	-2	4	7	3	4	4	4	-
Installed Base									
CPUs	522,272	553,593	577,250	604,972	631,129	656,256	682,427	709,673	4
Seats	522,272	553,593	577,250	604,972	631,129	656,256	682,427	709,673	4
Year-to-Year Increase (%)	11	6	4	5	4	4	4	4	-
Revenue Data ($M)									
CPU Revenue	694	692	615	682	689	704	712	718	3
Terminal Revenue	-	-	-	-	-	-	-	-	NA
Peripheral Revenue	48	44	54	60	61	63	64	65	4
Hardware Revenue	741	736	669	742	750	766	775	783	3
Year-to-Year Increase (%)	16	-1	-9	11	1	2	1	1	-
Software Revenue	545	539	550	546	553	562	573	585	1
Year-to-Year Increase (%)	19	-1	2	-1	1	2	2	2	
Software Service	77	82	53	32	32	32	32	32	-10
Hardware Service	31	27	39	53	52	52	52	53	6
Service Revenue	107	109	92	85	83	83	84	84	-2
Year-to-Year Increase (%)	9	2	-16	-7	-2	0	1	1	-
Total Factory Revenue	**1,393**	**1,384**	**1,311**	**1,373**	**1,386**	**1,411**	**1,432**	**1,452**	**2**
Year-to-Year Increase (%)	16	-1	-5	5	1	2	1	1	-

NA = Not applicable
Source: Dataquest (September 1998)

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Table 2-6
Detail Mechanical Forecast, Worldwide, Host/Proprietary

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	2,824	4,239	1,834	2,150	4,351	-	-	-	NA
Seats	12,501	11,601	2,503	1,457	908	637	458	356	-32
Year-to-Year Increase (%)	-15	-7	-78	-42	-38	-30	-28	-22	-
Installed Base									
CPUs	16,477	16,146	13,878	11,884	12,710	9,650	6,481	4,045	-22
Seats	69,259	61,760	47,070	32,619	21,519	13,693	8,725	5,506	-35
Year-to-Year Increase (%)	-10	-11	-24	-31	-34	-36	-36	-37	-
Revenue Data ($M)									
CPU Revenue	283	224	79	44	24	15	10	6	-40
Terminal Revenue	154	135	14	9	5	3	2	1	-37
Peripheral Revenue	30	37	17	11	6	5	3	2	-32
Hardware Revenue	467	396	109	64	36	23	15	10	-38
Year-to-Year Increase (%)	-24	-15	-72	-42	-44	-36	-34	-34	-
Software Revenue	111	99	38	20	12	8	6	4	-36
Year-to-Year Increase (%)	-15	-11	-62	-46	-40	-33	-30	-28	-
Software Service	83	83	30	15	11	9	8	6	-27
Hardware Service	96	65	24	13	7	4	3	2	-40
Service Revenue	**179**	**147**	**54**	**28**	**18**	**14**	**10**	**8**	**-32**
Year-to-Year Increase (%)	-6	-18	-63	-48	-37	-23	-23	-24	-
Total Factory **Revenue**	**757**	**642**	**201**	**112**	**66**	**45**	**31**	**22**	**-36**
Year-to-Year Increase (%)	-19	-15	-69	-44	-41	-32	-30	-30	-

NA = Not applicable
Source: Dataquest (September 1998)

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Table 2-7
Detail Mechanical Forecast, North America, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	116,892	126,249	129,562	138,137	150,019	156,367	162,176	168,173	5
Seats	118,607	127,199	129,500	137,797	149,027	156,473	162,258	168,239	5
Year-to-Year Increase (%)	10	7	2	6	8	5	4	4	-
Installed Base									
CPUs	332,090	361,768	385,772	410,112	438,144	463,095	484,526	503,792	5
Seats	347,944	373,748	393,757	414,617	439,563	463,399	484,517	503,742	5
Year-to-Year Increase (%)	8	7	5	5	6	5	5	4	-
Revenue Data ($M)									
CPU Revenue	992	1,155	1,123	1,183	1,285	1,356	1,428	1,507	6
Terminal Revenue	33	25	3	2	1	1	0	0	-37
Peripheral Revenue	35	34	41	37	36	35	34	32	-4
Hardware Revenue	1,060	1,215	1,166	1,222	1,322	1,391	1,462	1,539	6
Year-to-Year Increase (%)	6	15	-4	5	8	5	5	5	-
Software Revenue	788	997	1,033	1,166	1,323	1,453	1,572	1,685	10
Year-to-Year Increase (%)	12	27	4	13	13	10	8	7	-
Software Service	277	314	320	353	396	434	473	506	10
Hardware Service	205	247	236	227	243	257	272	289	4
Service Revenue	**482**	**561**	**556**	**580**	**640**	**691**	**745**	**794**	**7**
Year-to-Year Increase (%)	12	16	-1	4	10	8	8	7	-
Total Factory Revenue	**2,329**	**2,773**	**2,756**	**2,967**	**3,285**	**3,535**	**3,779**	**4,018**	**8**
Year-to-Year Increase (%)	9	19	-1	8	11	8	7	6	-

NA = Not applicable
Source: Dataquest (September 1998)

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Table 2-8
Detail Mechanical Forecast, Europe, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	107,803	111,940	115,356	120,289	126,910	130,297	136,954	146,988	5
Seats	111,887	114,390	115,619	120,120	125,718	130,543	137,123	147,107	5
Year-to-Year Increase (%)	15	2	1	4	5	4	5	7	-
Installed Base									
CPUs	309,387	331,677	351,099	368,053	384,523	397,545	411,587	430,496	4
Seats	329,303	348,677	363,438	375,822	387,953	399,206	412,534	431,101	3
Year-to-Year Increase (%)	8	6	4	3	3	3	3	5	-
Revenue Data ($M)									
CPU Revenue	1,300	1,313	1,245	1,253	1,311	1,354	1,438	1,576	5
Terminal Revenue	58	44	5	4	2	1	1	0	-37
Peripheral Revenue	94	90	85	77	72	67	65	64	-6
Hardware Revenue	1,453	1,447	1,335	1,334	1,386	1,422	1,503	1,640	4
Year-to-Year Increase (%)	10	0	-8	0	4	3	6	9	-
Software Revenue	987	1,084	1,106	1,188	1,295	1,391	1,515	1,686	9
Year-to-Year Increase (%)	20	10	2	7	9	7	9	11	-
Software Service	350	370	380	389	419	442	480	529	7
Hardware Service	275	279	267	244	252	257	272	296	2
Service Revenue	**625**	**648**	**647**	**633**	**671**	**699**	**752**	**825**	**5**
Year-to-Year Increase (%)	8	4	0	-2	6	4	8	10	-
Total Factory Revenue	3,065	3,179	3,089	3,155	3,352	3,513	3,771	4,152	6
Year-to-Year Increase (%)	**13**	**4**	**-3**	**2**	**6**	**5**	**7**	**10**	-

Source: Dataquest (September 1998)

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Table 2-9
Detail Mechanical Forecast, Japan, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	77,839	94,875	133,651	148,517	159,281	169,197	180,253	191,421	7
Seats	81,003	98,152	134,176	148,456	158,733	169,327	180,334	191,482	7
Year-to-Year Increase (%)	20	21	37	11	7	7	7	6	-
Installed Base									
CPUs	205,536	246,966	315,707	382,463	437,023	478,108	511,437	541,843	11
Seats	219,115	260,014	325,801	389,206	440,679	480,163	512,654	542,563	11
Year-to-Year Increase (%)	18	19	25	19	13	9	7	6	-
Revenue Data ($M)									
CPU Revenue	1,320	1,404	1,357	1,379	1,428	1,497	1,564	1,633	4
Terminal Revenue	48	46	5	2	1	1	0	0	-46
Peripheral Revenue	201	206	210	187	176	169	162	155	-6
Hardware Revenue	1,569	1,656	1,571	1,568	1,605	1,667	1,726	1,789	3
Year-to-Year Increase (%)	11	6	-5	0	2	4	4	4	-
Software Revenue	883	1,019	1,122	1,222	1,326	1,453	1,571	1,679	8
Year-to-Year Increase (%)	19	15	10	9	9	10	8	7	-
Software Service	320	377	284	288	305	329	351	368	5
Hardware Service	278	292	286	261	262	270	277	285	0
Service Revenue	**599**	**670**	**569**	**549**	**567**	**599**	**628**	**653**	**3**
Year-to-Year Increase (%)	17	12	-15	-4	3	6	5	4	-
Total Factory Revenue	3,050	3,345	3,263	3,339	3,498	3,719	3,925	4,120	5
Year-to-Year Increase (%)	**14**	**10**	**-2**	**2**	**5**	**6**	**6**	**5**	-

Source: Dataquest (September 1998)

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Table 2-10
Detail Mechanical Forecast, Asia/Pacific, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	23,140	26,527	26,285	26,308	26,852	27,261	28,789	30,441	3
Seats	23,909	27,445	26,340	26,212	26,241	27,406	28,908	30,544	3
Year-to-Year Increase (%)	27	15	-4	0	0	4	5	6	-
Installed Base									
CPUs	52,534	65,984	74,918	80,080	83,261	85,228	87,681	91,079	4
Seats	54,884	68,746	77,143	81,495	83,509	85,267	87,795	91,280	3
Year-to-Year Increase (%)	36	25	12	6	2	2	3	4	-
Revenue Data ($M)									
CPU Revenue	208	253	256	252	253	265	281	299	3
Terminal Revenue	14	18	1	1	1	1	1	0	-19
Peripheral Revenue	16	13	15	13	12	12	11	11	-5
Hardware Revenue	237	284	272	266	267	277	293	311	3
Year-to-Year Increase (%)	43	20	-4	-2	0	4	6	6	-
Software Revenue	141	192	212	224	235	256	280	305	7
Year-to-Year Increase (%)	42	36	11	5	5	9	10	9	-
Software Service	54	63	74	77	81	87	96	104	7
Hardware Service	42	54	55	51	51	53	56	60	2
Service Revenue	97	117	129	127	132	140	152	164	5
Year-to-Year Increase (%)	56	21	10	-1	3	7	8	8	-
Total Factory Revenue	**475**	**593**	**614**	**617**	**633**	**673**	**725**	**780**	**5**
Year-to-Year Increase (%)	45	25	4	1	3	6	8	8	-

Source: Dataquest (September 1998)

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Table 2-11
Detail Mechanical Forecast, Rest of World, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	7,595	7,986	7,687	8,438	9,016	9,406	9,911	10,457	6
Seats	7,723	8,054	7,679	8,409	8,915	9,414	9,919	10,463	6
Year-to-Year Increase (%)	22	4	-5	10	6	6	5	5	-
Installed Base									
CPUs	18,870	21,567	22,865	24,087	25,456	26,783	28,171	29,626	5
Seats	19,955	22,392	23,414	24,390	25,512	26,766	28,145	29,610	5
Year-to-Year Increase (%)	19	12	5	4	5	5	5	5	-
Revenue Data ($M)									
CPU Revenue	41	42	45	49	52	55	58	62	6
Terminal Revenue	1	1	0	0	0	0	0	0	-17
Peripheral Revenue	4	3	4	4	5	5	5	5	1
Hardware Revenue	46	45	50	53	57	60	63	66	6
Year-to-Year Increase (%)	8	-2	9	7	7	5	5	5	-
Software Revenue	31	36	39	44	49	54	58	63	10
Year-to-Year Increase (%)	12	13	10	12	12	10	9	8	-
Software Service	7	9	9	10	11	12	13	13	8
Hardware Service	7	8	8	8	9	9	10	11	5
Service Revenue	**14**	**16**	**18**	**18**	**20**	**21**	**23**	**24**	**6**
Year-to-Year Increase (%)	-18	19	9	3	9	7	7	6	-
Total Factory Revenue	**91**	**97**	**106**	**115**	**125**	**134**	**144**	**153**	**8**
Year-to-Year Increase (%)	4	6	9	8	9	7	7	6	-

Source: Dataquest (September 1998)

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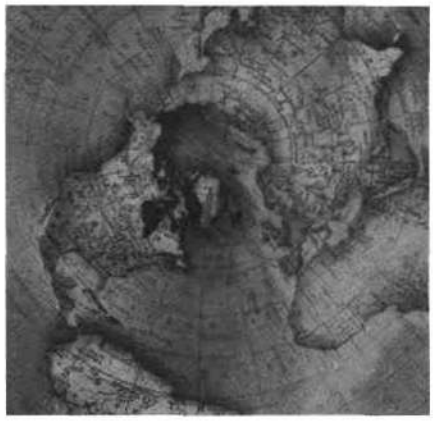
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1997 Mechanical CAD/CAM/CAE Worldwide Market Share Update

Market Statistics

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Table of Contents

Page

1. Introduction 1
   - About This Document 3
   - Segmentation Definitions 5
     - Applications 5
   - Regions 6
   - Operating Systems 8
   - Metrics 8
   - Market Share Methodology 12
   - The Audit Process 13
   - Reporting Changes 14
   - A Final Note 14
   - Publishing Schedule 14
2. 1997 Worldwide Mechancial CAD/CAM/CAE Market Share Tables 17

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List of Figures

Figure Page
1-1 CAD/CAM/CAE, AEC and GIS, and EDA Database 1

List of Tables

Table		Page
1-1	Market Summary for All CAD Applications, 1996 to 1997	2
1-2	Average 1995, 1996, and 1997 Exchange Rates against the U.S. Dollar	3
1-3	Companies Renamed in 1997	4
1-4	Companies (or CAD Portions of Companies) Sold/Merged in 1997	4
1-5	Top 25 Product Software Revenue, Software Companies, Worldwide, All Operating Systems	10
1-6	Top 25 Company Software Revenue, Software Companies, Worldwide, All Operating Systems	11
2-1	1997 Top 30 Mechanical Software Companies, Worldwide, All Operating Systems	17
2-2	1997 Top 30 Mechanical Software Companies, Worldwide, UNIX	18
2-3	1997 Top 30 Mechanical Software Companies, Worldwide, Windows NT	19
2-4	1997 Top 30 Mechanical Software Companies, Worldwide, Personal Computer	20
2-5	1997 Top 24 Mechanical Software Companies, Worldwide, Host/Proprietary	21
2-6	1997 Top 30 Mechanical Software Companies, North America, All Operating Systems	22
2-7	1997 Top 30 Mechanical Software Companies, North America, UNIX	23
2-8	1997 Top 30 Mechanical Software Companies, North America, Windows NT	24
2-9	1997 Top 30 Mechanical Software Companies, North America, Personal Computer	25
2-10	1997 Top 14 Mechanical Software Companies, North America, Host/Proprietary	26
2-11	1997 Top 30 Mechanical Software Companies, Europe, All Operating Systems	27
2-12	1997 Top 30 Mechanical Software Companies, Europe, UNIX	28
2-13	1997 Top 30 Mechanical Software Companies, Europe, Windows NT	29
2-14	1997 Top 30 Mechanical Software Companies, Europe, Personal Computer	30
2-15	1997 Top 14 Mechanical Software Companies, Europe, Host/Proprietary	31
2-16	1997 Top 30 Mechanical Software Companies, Japan, All Operating Systems	32
2-17	1997 Top 30 Mechanical Software Companies, Japan, UNIX	33
2-18	1997 Top 30 Mechanical Software Companies, Japan, Windows NT	34

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List of Tables (Continued)

Table		Page
2-19	1997 Top 30 Mechanical Software Companies, Japan, Personal Computer	35
2-20	1997 Top 20 Mechanical Software Companies, Japan, Host/Proprietary	36
2-21	1997 Top 30 Mechanical Software Companies, Asia/Pacific, All Operating Systems	37
2-22	1997 Top 30 Mechanical Software Companies, Asia/Pacific, UNIX	38
2-23	1997 Top 30 Mechanical Software Companies, Asia/Pacific, Windows NT	39
2-24	1997 Top 30 Mechanical Software Companies, Asia/Pacific, Personal Computer	40
2-25	1997 Top 10 Mechanical Software Companies, Asia/Pacific, Host/Proprietary	41
2-26	1997 Top 30 Mechanical Software Companies, Rest of World, All Operating Systems	42
2-27	1997 Top 29 Mechanical Software Companies, Rest of World, UNIX	43
2-28	1997 Top 22 Mechanical Software Companies, Rest of World, Windows NT	44
2-29	1997 Top 30 Mechanical Software Companies, Rest of World, Personal Computer	45
2-30	1997 Top Seven Mechanical Software Companies, Rest of World, Host/Proprietary	46
2-31	All Mechanical Software Companies, Worldwide, All Operating Systems	47
2-32	1997 Top 30 Mechanical Software Companies, Worldwide, All Operating Systems	51
2-33	1997 Top 30 Mechanical Software Companies, Worldwide, UNIX	52
2-34	1997 Top 30 Mechanical Software Companies, Worldwide, Windows NT	53
2-35	1997 Top 30 Mechanical Software Companies, Worldwide, Personal Computer	54
2-36	1997 Top 23 Mechanical Software Companies, Worldwide, Host/Proprietary	55

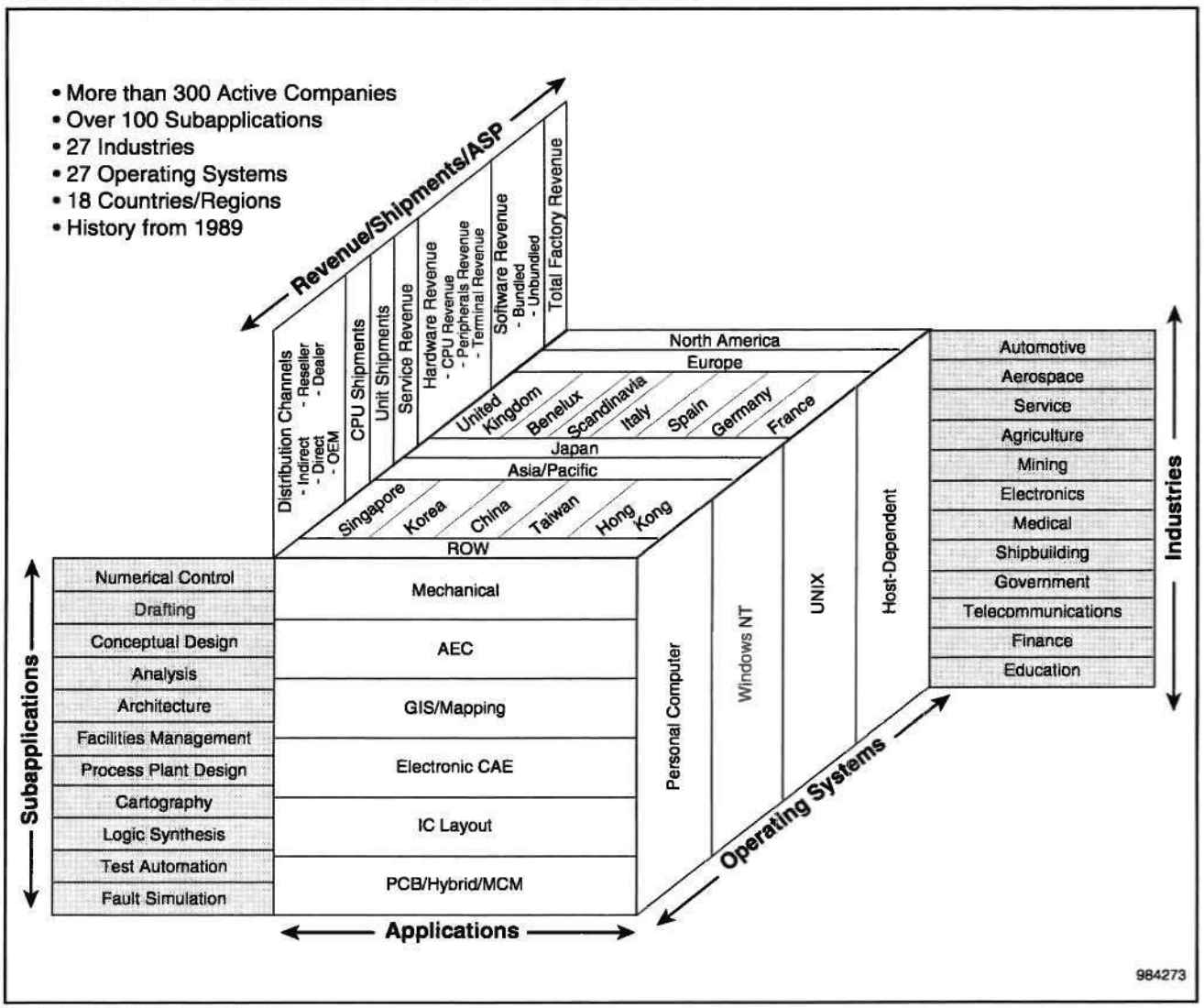
Chapter 1
Introduction

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 1-1.

Table 1-1 summarizes the performance in various segments of the CAD/CAM/CAE/GIS markets in 1997 versus 1996. Table 1-2 shows the exchange rates used to convert a company's local currency sales into U.S. dollars for consistent reporting.

Figure 1-1
CAD/CAM/CAE, AEC and GIS, and EDA Database



Source: Dataquest (July 1998)

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Table 1-1
Market Summary for All CAD Applications, 1996 to 1997 (Millions of Dollars)

	Software Revenue			Hardware Revenue			Total Factory Revenue			Seat Shipments		
	1996	1997	Growth (%) 1996-1997	1996	1997	Growth (%) 1996-1997	1996	1997	Growth (%) 1996-1997	1996	1997	Growth (%) 1996-1997
Applications—For All Operating Systems and Regions												
Mechanical	3,325.74	3,510.31	5.55	5,024.63	4,814.02	-4.19	10,519.05	10,679.00	1.52	381,025.14	432,555.13	13.52
AEC	958.24	961.01	0.29	1,277.91	1,196.89	-6.34	2,644.38	2,544.87	-3.76	222,239.95	199,109.75	-10.41
GIS/Mapping	933.09	1,039.47	11.40	1,096.02	1,126.98	2.82	2,626.20	2,839.61	8.13	129,798.19	142,640.45	9.89
Electronic CAE	1,216.84	1,403.27	15.32	1,188.64	1,377.31	15.87	3,344.71	3,800.06	13.61	96,232.56	105,362.43	9.49
IC Layout	423.03	509.11	20.35	338.71	408.25	20.53	1,113.49	1,328.66	19.32	17,383.68	21,704.88	24.86
PCB/MCM/Hybrid	309.65	321.74	3.90	384.53	386.74	0.58	919.79	963.27	4.73	35,796.64	37,678.09	5.26
Electronic Design Automation	1,949.51	2,234.12	14.60	1,911.88	2,172.30	13.62	5,377.99	6,091.99	13.28	149,412.87	164,745.40	10.26
All Applications	7,166.58	7,744.91	8.07	9,310.44	9,310.19	0	21,167.61	22,155.48	4.67	882,476.16	939,050.73	6.41
Region—For All Applications All Operating Systems												
North America	2,544.84	2,786.26	9.49	2,995.30	3,198.53	6.78	7,312.28	7,910.20	8.18	341,202.15	352,820.60	3.41
Europe	2,192.20	2,288.63	4.40	2,992.48	2,858.52	-4.48	6,560.14	6,618.67	0.89	291,434.76	287,829.33	-1.24
Japan	1,830.17	2,022.30	10.50	2,734.23	2,694.54	-1.45	5,767.15	6,039.14	4.72	166,871.90	220,623.65	32.21
Asia/Pacific	479.99	526.09	9.60	461.05	427.15	-7.35	1,212.60	1,257.50	3.70	61,195.41	57,332.93	-6.31
Rest of World	122.64	125.50	2.34	132.05	137.17	3.88	321.70	335.08	4.16	21,837.98	20,534.70	-5.97
Worldwide	7,166.58	7,744.91	8.07	9,310.44	9,310.19	0	21,167.61	22,155.48	4.67	882,476.16	939,050.73	6.41
Operating System—For All Applications and Regions												
UNIX	4,746.79	4,669.38	-1.63	6,261.97	6,146.17	-1.85	14,766.86	14,689.70	-0.52	264,584.09	272,395.33	2.95
Host/Proprietary	154.82	61.08	-60.55	530.15	177.12	-66.59	914.42	313.79	-65.68	8,987.28	3,874.95	-56.88
Windows NT	834.45	1,622.94	94.49	780.45	1,412.49	80.98	2,019.40	3,838.16	90.06	68,176.28	144,697.92	112.24
Personal Computer	1,430.52	1,391.51	-2.73	1,737.87	1,574.41	-9.41	3,466.93	3,313.83	-4.42	540,728.50	518,082.52	-4.19
All Operating Systems	7,166.58	7,744.91	8.07	9,310.44	9,310.19	0	21,167.61	22,155.48	4.67	882,476.16	939,050.73	6.41

Source: Dataquest (July 1998)

Table 1-2
Average 1995, 1996, and 1997 Exchange Rates against the U.S. Dollar

Country	1995 Rate	1996 Rate	1997 Rate	Currency Name
Austria	10.06	10.59	12.20	Schilling
Belgium	29.42	30.96	35.79	Belgian franc
Canada	1.37	1.36	1.38	Canadian dollar
Denmark	5.59	5.81	6.61	Danish krone
European Union	0.77	0.80	0.89	ECU
Finland	4.37	4.59	5.19	Markka
France	4.97	5.12	5.84	French franc
Germany	1.43	1.50	1.73	Deutsche mark
Hong Kong	7.74	7.73	7.74	Hong Kong dollar
Italy	1,628.21	1,542.72	1703.02	Lira
Japan	93.90	108.81	121.10	Yen
Mexico	6.41	7.60	7.92	Peso
Netherlands	1.60	1.69	1.95	Gulden
Singapore	1.43	1.41	1.49	Singapore dollar
South Korea	770.57	805.16	954.14	Won
Spain	124.40	126.68	146.45	Peseta
Sweden	7.14	6.71	7.64	Swedish krona
Switzerland	1.18	1.24	1.45	Swiss franc
Taiwan	26.48	27.47	28.79	NT
United Kingdom	0.63	0.64	0.61	Pound

Notes: The annual rate is estimated as the arithmetic mean of the 12 monthly rates.
Source: Dataquest (July 1998)

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). See Tables 1-3 and 1-4 for changes in the companies tracked from our 1996 report. Companies deleted or added to our database are also listed later in this chapter. The following is a list containing descriptions of the companies included in the Market Share books:

- 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 1997 shipments and revenue.

Table 1-3
Companies Renamed in 1997

Original Company Name	New Company Name
EDS Unigraphics	Unigraphics Solutions
Harris EDA	Xynetix
Virtual Chips	Phoenix Technology Limited
VLSI Libraries	Artisan Components

Source: Dataquest (July 1998)

Table 1-4
Companies (or CAD Portions of Companies) Sold/Merged in 1997

Original Company Name	Acquired by/Merged with
Cimtel Ltd.	Concurrent Engineering
Clemessy Geocity	Network Management Tools
Compact Software	Ansoft
Compass Design Automation	Avant!
Cooper & Chyan Technology	Cadence
Deneb Robotics	Dassault Systemes
Eagle Design Automation	Synopsys
EPIC Design Technology	Synopsys
Framasoft	ESI Group
Simulation Technology	Summit Design
Softdesk	Autodesk
SolidWorks	Dassault Systemes
SpeedSim	Quickturn Systems Design
Viewlogic Systems	Synopsys

Source: Dataquest (July 1998)

Companies deleted from our database in 1997 are as follows:

- Actel
- Altera
- Precedence
- Straessle Informationssysteme
- Xilinx

Companies added to our database in 1997 are as follows:

- AMBIT Design Systems
- Argonaut RISC Cores
- CAD Corporation
- Camcentre
- CoreLogic
- DSP Group
- Flomerics
- Gambit Automated Design
- Innovative Semiconductors
- Modultek Oy
- Open Mind
- Simplex Solutions
- Tekla Oy
- Western Design Center

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 defines 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 electro-mechanical 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.

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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 regional hierarchy and definitions are used for all Dataquest's geographic segmentation. Not all product categories and Dataquest services have the entire segmentation. Some may have a greater level and some may have less.

- North America Region
  - United States: Includes the 48 contiguous states, Washington, D.C., Alaska, Hawaii, and Puerto Rico
  - Canada: Single-country region
- Latin America Region: Countries covered include Argentina, Brazil, Chile, Colombia, Mexico, Peru, and Venezuela
  - Rest of Latin America: Anguilla, Antigua and Barbuda, Aruba, Bahamas, Barbados, Belize, Bermuda, Bolivia, Cayman Islands, Clipperton Island, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Falkland Islands (Islas Malvinas), French Guiana, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Montserrat, Navassa Island, Netherlands Antilles, Nicaragua, Panama, Paraguay, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Tortola (British Virgin Islands), Trinidad and Tobago, Turks and Caicos Islands, Uruguay, and Virgin Islands (St. John, St. Croix, and St. Thomas)

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- Europe Region
  - Western Europe: Countries covered include Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and United Kingdom
  - Rest of Western Europe: Andorra, Cyprus, Faroe Islands, Gibraltar, Greenland, Guernsey, Iceland, Isle of Man, Jersey, Liechtenstein, Luxembourg, Malta, Monaco, San Marino, and Svalbard
  - Central and Eastern Europe: Belarus, Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Russia, Slovakia, and Ukraine
  - Rest of Eastern Europe: Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Croatia, Georgia, Kazakhstan, Kyrgyzstan, Macedonia, Moldova, Romania, Slovenia, Tajikistan, Turkmenistan, Uzbekistan, and Yugoslavia (Serbia and Montenegro)
- Japan: Single-country region
- Asia/Pacific: Countries covered include Australia, China, Hong Kong, India, Indonesia, South Korea, Malaysia, Singapore, Taiwan, and Thailand
  - Rest of Asia/Pacific: American Samoa, Ashmore and Cartier Islands, Baker Island, Bangladesh, Bhutan, Bouvet Island, Brunei, Cambodia, Christmas Island, Cocos (Keeling) Islands, Cook Islands, Coral Sea Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Howland Island, Jarvis Island, Johnston Atoll, Kingman Reef, Kiribati, Laos, Macau, Maldives, Marshall Islands, Midway Islands, Mongolia, Myanmar (Burma), Nauru, Nepal, New Caledonia, New Zealand, Niue, Norfolk Island, Northern Mariana Islands, North Korea, Pakistan, Palau, Palmyra Atoll, Papua New Guinea, Paracel Islands, Philippines, Pitcairn Islands, Solomon Islands, Spratly Islands, Sri Lanka, Tokelau, Tonga, Tuvalu, Vanuatu, Vietnam, Wake Island, Wallis and Futuna, and Western Samoa
- Rest of World: Afghanistan, Algeria, Angola, Bahrain, Bassas da India, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Cote d'Ivoire, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Europa Island, Gabon, Gambia, Ghana, Glorioso Islands, Guinea, Guinea-Bissau, Iran, Iraq, Israel, Jordan, Juan de Nova Island, Kenya, Kuwait, Lebanon, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mayotte, Morocco, Mozambique, Namibia, Niger, Nigeria, Oman, Qatar, Reunion, Rwanda, Saint Helena, Sao Tome and Principe, Saudi Arabia, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Syria, Tanzania, Togo, Tromelin Island, Tunisia, Turkey, Uganda, United Arab Emirates, Western Sahara, Yemen, Zaire, Zambia, and Zimbabwe

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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 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 for a specific customer who pays for the 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

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  - 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 as follows:

- 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 1-5 and Table 1-6 provide views of the market, including market share by product software revenue and company software revenue for the entire CAD market. Statistics on end-user spending are available by inquiry.

Table 1-5
Top 25 Product Software Revenue, Software Companies, Worldwide, All Operating Systems (Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%)
1	Parametric Technology	321.2	495.0	605.8	22.4	7.8
2	IBM	464.0	522.2	602.7	15.4	7.8
3	Autodesk	558.1	498.9	567.9	13.8	7.3
4	Cadence	283.0	411.5	524.0	27.4	6.8
5	Synopsys	283.6	361.0	442.1	22.5	5.7
6	Intergraph	333.8	373.4	402.1	7.7	5.2
7	Mentor Graphics	183.3	205.7	217.6	5.8	2.8
8	Fujitsu	151.4	160.5	197.0	22.8	2.5
9	ESRI	122.1	160.0	190.1	18.8	2.5
10	Structural Dynamics Research Corporation	124.8	153.1	172.1	12.4	2.2
11	MicroCADAM	129.2	152.0	150.0	-1.3	1.9
12	Bentley Systems	89.4	100.8	140.6	39.4	1.8
13	Avant!	103.1	124.6	132.5	6.3	1.7
14	CoCreate	107.3	113.4	125.5	10.7	1.6
15	Unigraphics Solutions	89.1	209.5	115.5	-44.9	1.5
16	Quickturn Design Systems	72.0	88.6	104.6	18.0	1.4
17	NEC	110.0	94.9	104.4	10.0	1.3
18	MacNeal-Schwendler	117.6	106.3	104.0	-2.2	1.3
19	Landmark Graphics	89.9	98.3	102.8	4.5	1.3
20	Matra Datavision	87.4	91.8	90.6	-1.2	1.2
21	Hitachi	94.5	85.0	85.1	0.2	1.1
22	Siemens Nixdorf Infosysteme	93.2	75.2	83.5	10.9	1.1
23	Toshiba*	88.5	78.0	82.8	6.3	1.1
24	Nihon Unisys	77.1	79.3	78.3	-1.3	1.0
25	Computervision	163.7	191.7	67.8	-64.6	0.9
	All N.A. Companies	**4,590.5**	**5,464.0**	**5,923.7**	**8.4**	**76.5**
	All European Companies	**764.4**	**829.6**	**877.3**	**5.7**	**11.3**
	All Asian Companies	**879.5**	**873.0**	**944.0**	**8.1**	**12.2**
	All Companies	**6,234.3**	**7,166.6**	**7,744.9**	**8.1**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 1-6
Top 25 Company Software Revenue, Software Companies, Worldwide, All Operating Systems (Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%)
1	IBM	530.6	602.7	682.2	13.2	8.8
2	Parametric Technology	321.2	495.0	605.8	22.4	7.8
3	Autodesk	563.3	503.6	573.3	13.8	7.4
4	Cadence	293.9	421.7	531.4	26.0	6.9
5	Synopsys	295.3	367.2	450.4	22.7	5.8
6	Intergraph	395.5	417.3	426.8	2.3	5.5
7	Dassault Systemes	208.8	254.1	309.1	21.6	4.0
8	Mentor Graphics	185.0	207.9	219.3	5.5	2.8
9	Fujitsu	210.8	225.0	197.0	-12.4	2.5
10	ESRI	122.1	160.0	190.1	18.8	2.5
11	Structural Dynamics Research Corporation	124.7	153.1	172.1	12.4	2.2
12	MicroCADAM	129.2	152.0	150.0	-1.3	1.9
13	Bentley Systems	89.4	100.8	140.6	39.4	1.8
14	Avant!	106.0	127.4	134.3	5.4	1.7
15	Information Services International Dentsu*	85.2	117.2	125.9	7.5	1.6
16	CoCreate	107.3	113.4	125.5	10.7	1.6
17	Unigraphics Solutions	89.1	209.5	115.5	-44.9	1.5
18	Quickturn Design Systems	72.0	88.6	104.6	18.0	1.4
19	NEC	110.0	94.9	104.4	10.0	1.3
20	MacNeal-Schwendler	117.6	106.3	104.0	-2.2	1.3
21	Landmark Graphics	89.9	98.3	102.8	4.5	1.3
22	Matra Datavision	87.4	91.8	90.6	-1.2	1.2
23	Toshiba*	97.3	85.7	87.1	1.6	1.1
24	Hitachi	94.5	85.0	85.1	0.2	1.1
25	Siemens Nixdorf Info systeme	93.2	75.2	83.5	11.0	1.1
	All North American Companies	**4,590.5**	**5,464.0**	**5,923.7**	**8.4**	**76.5**
	All European Companies	**764.4**	**829.6**	**877.3**	**5.7**	**11.3**
	All Asian Companies	**879.5**	**873.0**	**944.0**	**8.1**	**12.2**
	All Companies	**6,234.3**	**7,166.6**	**7,744.9**	**8.1**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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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 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 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

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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.

The company statistics published by Dataquest are estimated based on the data supplied by vendors along with the numerous sources listed above. 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.

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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.

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 data for 1997 was published and distributed to clients on April 13.
- A five-year forecast for CAD/CAM/CAE/GIS was shipped to clients on June 8.
- Final updated market share tables, based on additional data collection and analysis, are presented in this report. At this point, the market share database is frozen and will not be changed until the end of the year.

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We have finalized our 1997 market share data, including country-level data, end-user spending, industry-level data, and subapplication information. 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.

Chapter 2
1997 Worldwide Mechancial CAD/CAM/CAE Market Share Tables

Table 2-1
1997 Top 30 Mechanical Software Companies, Worldwide, All Operating Systems (Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	IBM	494.5	563.5	641.8	13.9	18.3
2	Parametric Technology	321.2	495.0	605.8	22.4	17.3
3	Dassault Systemes	204.9	249.5	303.8	21.8	8.7
4	Autodesk	192.9	174.2	206.4	18.5	5.9
5	Structural Dynamics Research Corporation	124.7	153.1	172.1	12.4	4.9
6	MicroCADAM	129.2	152.0	150.0	-1.3	4.3
7	Info. Services Int'l. Dentsu*	85.2	117.2	125.9	7.5	3.6
8	CoCreate	107.3	113.4	125.5	10.7	3.6
9	Unigraphics Solutions	89.1	209.5	115.5	-44.9	3.3
10	MacNeal-Schwendler	114.0	106.3	104.0	-2.2	3.0
11	Fujitsu	97.0	107.3	103.5	-3.6	2.9
12	Matra Datavision	87.4	91.8	90.6	-1.2	2.6
13	NEC	72.9	62.9	70.9	12.7	2.0
14	Hitachi	70.9	63.7	68.1	6.8	1.9
15	Toshiba*	66.7	62.5	65.0	3.9	1.9
16	Computervision	149.0	174.4	61.7	-64.6	1.8
17	Nihon Unisys	52.8	54.4	54.6	0.3	1.6
18	Hitachi Zosen Info Systems	38.7	39.3	42.7	8.8	1.2
19	Ansys	32.6	37.0	35.1	-5.2	1.0
20	Tecnomatix Technology	20.1	26.3	34.2	30.0	1.0
21	C. Itoh Techno-Science*	30.8	30.8	32.5	5.5	0.9
22	Delcam plc	16.7	22.0	30.8	40.0	0.9
23	Sherpa Corp.	20.6	26.2	27.5	5.0	0.8
24	Marubeni Hytech*	19.9	23.0	24.9	8.5	0.7
25	Sumisho Electronics*	18.8	21.6	23.4	8.4	0.7
26	MARC	18.2	19.5	21.8	11.7	0.6
27	Tokyo Electron*	17.4	20.0	21.8	8.5	0.6
28	Formtek	18.9	20.6	21.7	5.1	0.6
29	Seiko*	19.7	19.0	21.1	11.0	0.6
30	ISD Software	14.5	22.7	20.1	-11.4	0.6
	All North American Companies	**2,049.9**	**2,504.8**	**2,573.6**	**2.7**	**73.3**
	All European Companies	**339.5**	**345.6**	**390.9**	**13.1**	**11.1**
	All Asian Companies	**481.5**	**475.4**	**545.7**	**14.8**	**15.5**
	All Companies	**2,870.9**	**3,325.7**	**3,510.3**	**5.5**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

Table 2-2
1997 Top 30 Mechanical Software Companies, Worldwide, UNIX
(Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	IBM	405.2	493.3	613.5	24.4	28.1
2	Parametric Technology	269.8	386.1	454.3	17.7	20.8
3	Dassault Systemes	160.6	215.1	261.4	21.5	12.0
4	Info. Services Int'l. Dentsu*	80.9	111.3	119.6	7.5	5.5
5	Structural Dynamics Research Corporation	116.5	136.5	119.5	-12.5	5.5
6	MacNeal-Schwendler	86.6	78.1	93.1	19.2	4.3
7	Unigraphics Solutions	89.1	188.5	80.8	-57.1	3.7
8	Matra Datavision	75.5	79.2	65.8	-16.9	3.0
9	Computervision	142.4	166.7	59.0	-64.6	2.7
10	Nihon Unisys	51.8	53.6	53.6	0.1	2.5
11	CoCreate	80.5	76.1	53.1	-30.2	2.4
12	NEC	43.7	37.7	40.9	8.5	1.9
13	Hitachi Zosen Info Systems	38.7	39.3	38.5	-2.0	1.8
14	Tecnomatix Technology	20.1	26.3	34.2	30.0	1.6
15	C. Itoh Techno-Science*	28.4	28.4	30.8	8.5	1.4
16	Toshiba*	50.0	42.5	29.2	-31.2	1.3
17	Sherpa Corp.	20.4	26.0	25.9	-0.4	1.2
18	Marubeni Hytech*	19.9	23.0	24.9	8.5	1.1
19	Delcam plc	16.0	17.8	24.9	39.8	1.1
20	MicroCADAM	51.7	45.6	22.5	-50.7	1.0
21	Ansys	24.5	27.8	21.8	-21.6	1.0
22	Tokyo Electron*	17.4	20.0	21.8	8.5	1.0
23	Fujitsu	65.0	72.7	19.7	-73.0	0.9
24	MARC	18.2	17.7	18.9	6.7	0.9
25	Alias Research	17.3	17.3	18.6	7.9	0.9
26	ICEM Technologies	17.6	19.6	18.5	-5.9	0.8
27	Sumisho Electronics*	14.2	16.4	17.8	8.5	0.8
28	Mitsui Engineering	13.5	15.5	16.9	8.5	0.8
29	Gerber Systems	13.1	14.9	16.2	8.8	0.7
30	Formtek	13.3	14.4	15.4	7.1	0.7
	All North American Companies	**1,474.0**	**1,811.0**	**1,707.5**	**-5.7**	**78.1**
	All European Companies	**243.0**	**208.8**	**201.3**	**-3.6**	**9.2**
	All Asian Companies	**374.5**	**356.0**	**277.2**	**-22.1**	**12.7**
	All Companies	**2,091.4**	**2,375.7**	**2,186.0**	**-8.0**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-3
1997 Top 30 Mechanical Software Companies, Worldwide, Windows NT
(Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Parametric Technology	51.4	108.9	151.4	39.1	20.6
2	Autodesk	-	28.7	103.2	259.1	14.0
3	Fujitsu	-	-	55.9	NA	7.6
4	Structural Dynamics Research Corporation	4.8	15.3	51.2	234.7	7.0
5	CoCreate	4.4	9.8	49.3	406.1	6.7
6	MicroCADAM	6.4	18.2	45.0	146.8	6.1
7	Unigraphics Solutions	-	20.9	34.6	65.4	4.7
8	Dassault Systemes	-	6.5	24.3	273.6	3.3
9	Matra Datavision	9.6	10.1	18.7	85.6	2.5
10	ISD Software	-	12.3	14.8	19.6	2.0
11	Bentley Systems	5.1	6.4	13.5	109.4	1.8
12	Wacom	4.9	7.1	12.0	70.0	1.6
13	Ansys	3.9	4.8	11.2	133.4	1.5
14	MCS	1.4	3.7	10.3	176.7	1.4
15	Omron	5.8	5.8	10.0	72.5	1.4
16	Radan Computational	-	5.1	8.7	72.0	1.2
17	Graphtec Engineering	-	2.6	8.7	235.0	1.2
18	Applicon	-	-	8.3	NA	1.1
19	NEC	5.2	4.5	7.6	70.0	1.0
20	Intergraph	1.5	4.1	6.7	63.7	0.9
21	Toshiba*	-	-	6.5	NA	0.9
22	Hitachi	-	-	6.0	NA	0.8
23	Delcam plc	-	4.2	5.9	41.0	0.8
24	Seiko*	-	-	5.9	NA	0.8
25	Toshiba Engineering*	-	2.5	5.4	111.2	0.7
26	CAD Lab	0.7	4.4	5.2	18.2	0.7
27	Agile Software	1.0	1.2	5.2	321.7	0.7
28	CAD Distribution	3.5	4.8	4.9	2.4	0.7
29	MacNeal-Schwendler	1.1	1.1	4.6	337.7	0.6
30	Hitachi Zosen Info Systems	-	-	4.3	NA	0.6
	All North American Companies	**85.5**	**239.9**	**525.4**	**119.0**	**71.3**
	All European Companies	**15.0**	**50.7**	**94.0**	**85.3**	**12.8**
	All Asian Companies	**15.9**	**22.2**	**117.4**	**428.7**	**15.9**
	All Companies	**116.4**	**312.8**	**736.8**	**135.5**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

Table 2-4
1997 Top 30 Mechanical Software Companies, Worldwide, Personal Computer (Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Autodesk	182.9	140.4	103.2	-26.5	18.8
2	MicroCADAM	71.1	88.2	82.5	-6.4	15.0
3	Hitachi	10.2	9.2	48.1	424.0	8.8
4	Toshiba*	16.7	20.0	29.2	46.2	5.3
5	Fujitsu	24.2	26.9	25.9	-3.9	4.7
6	CoCreate	22.4	27.6	23.1	-16.3	4.2
7	NEC	24.0	20.8	22.4	8.0	4.1
8	Andor*	15.9	17.8	19.2	8.0	3.5
9	Cimatron	8.9	12.9	15.8	22.3	2.9
10	Design Automation	11.6	13.3	14.2	7.5	2.6
11	Investronica SA	11.1	10.6	10.3	-3.2	1.9
12	CNC Software	8.4	8.7	8.8	1.8	1.6
13	Pathtrace Engineering Systems	3.2	4.2	8.7	109.1	1.6
14	Tebis	8.0	8.9	8.0	-9.5	1.5
15	Baystate Technologies	1.3	4.1	7.2	76.0	1.3
16	Surfware	5.0	5.4	6.5	20.0	1.2
17	Info. Services Int'l. Dentsu*	4.3	5.9	6.3	7.5	1.1
18	Formtek	5.7	6.2	6.2	0.5	1.1
19	Ashlar	5.7	5.9	5.9	-0.4	1.1
20	Viagrafix	5.6	5.4	5.6	2.6	1.0
21	Sumisho Electronics*	4.6	5.1	5.6	8.0	1.0
22	PAFEC	2.4	5.3	5.2	-1.2	1.0
23	Serbi	5.9	5.6	5.0	-10.8	0.9
24	Algor Interactive Systems	6.0	6.3	5.0	-21.1	0.9
25	Applicon	4.2	4.6	4.9	6.0	0.9
26	Wiechers Datentechnik	4.5	4.8	4.8	1.2	0.9
27	Matra Datavision	2.3	2.5	4.4	78.1	0.8
28	Ziegler Informatics	3.3	4.6	4.4	-3.8	0.8
29	Whessoe Computing Systems	4.1	4.2	4.2	-0.4	0.8
30	BCT GmbH	3.8	4.7	4.2	-10.4	0.8
	All North American Companies	**388.1**	**368.8**	**311.2**	**-15.6**	**56.6**
	All European Companies	**78.5**	**83.9**	**92.4**	**10.2**	**16.8**
	All Asian Companies	**79.2**	**85.9**	**146.2**	**70.1**	**26.6**
	All Companies	**545.8**	**538.6**	**549.8**	**2.1**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-5
1997 Top 24 Mechanical Software Companies, Worldwide, Host/Proprietary
(Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	IBM	89.3	69.2	27.3	-60.6	72.3
2	Dassault Systemes	44.2	27.2	15.5	-43.1	41.0
3	MacNeal-Schwendler	25.1	23.2	4.8	-79.2	12.8
4	Fujitsu	7.8	7.7	2.1	-73.1	5.5
5	Matra Datavision	-	-	1.7	NA	4.5
6	C. Itoh Techno-Science*	2.4	2.4	1.7	-30.0	4.5
7	Hitachi	3.3	3.0	1.6	-45.5	4.3
8	Exapt	4.5	1.3	0.9	-25.1	2.5
9	Mitsubishi Electric*	1.2	0.9	0.6	-30.0	1.6
10	Toyo Information Systems*	0.8	0.6	0.4	-30.0	1.1
11	Nihon Unisys	1.1	0.8	0.4	-51.8	1.1
12	Ansys	1.3	1.1	0.4	-68.4	0.9
13	Kubota Computer	0.8	0.5	0.3	-32.3	0.9
14	Whessoe Computing Systems	0.5	0.4	0.3	-19.2	0.8
15	Sherpa Corp.	0.2	0.2	0.3	12.4	0.7
16	Computational Mechanics	0.5	0.3	0.2	-25.4	0.6
17	Mechanical Dynamics	1.9	1.6	0.2	-89.1	0.5
18	Century Research Center	0.3	0.2	0.1	-30.0	0.4
19	Altair Computing	-	0.2	0.1	-45.1	0.3
20	ESI Group	0.4	0.2	0.1	-49.7	0.2
21	debis Systemhaus	0.2	0.2	0	-79.5	0.1
22	Technodia*	0	0	0	-30.0	0
23	Access Corp.	0.4	0.2	-	-100.0	-
24	CIMTEK	0.1	0.1	-	-100.0	-
	All North American Companies	**102.3**	**85.1**	**29.5**	**-65.4**	**78.2**
	All European Companies	**3.1**	**2.2**	**3.2**	**45.9**	**8.6**
	All Asian Companies	**11.9**	**11.3**	**5.0**	**-55.7**	**13.2**
	All Companies	**117.3**	**98.6**	**37.7**	**-61.8**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-6
1997 Top 30 Mechanical Software Companies, North America, All Operating Systems (Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Parametric Technology	160.6	218.3	277.4	27.1	26.9
2	IBM	95.1	100.8	120.6	19.7	11.7
3	Dassault Systemes	57.8	74.7	98.0	31.3	9.5
4	Autodesk	85.4	72.3	94.9	31.3	9.2
5	Structural Dynamics Research Corporation	59.1	73.3	83.8	14.4	8.1
6	Unigraphics Solutions	45.1	125.9	53.2	-57.7	5.2
7	MacNeal-Schwendler	50.0	46.8	44.2	-5.5	4.3
8	CoCreate	16.1	22.7	25.1	10.7	2.4
9	Computervision	48.1	64.0	23.4	-63.5	2.3
10	Ansys	15.4	18.7	17.2	-8.2	1.7
11	Sherpa Corp.	13.4	14.4	15.1	5.0	1.5
12	Formtek	10.0	10.5	11.3	7.1	1.1
13	MCS	8.6	8.8	10.9	23.5	1.1
14	Altair Computing	6.0	10.0	10.8	8.3	1.0
15	Tecnomatix Technology	7.4	8.1	10.7	31.6	1.0
16	MicroCADAM	9.0	10.6	10.5	-1.3	1.0
17	Gerber Systems	8.3	9.4	10.2	9.0	1.0
18	Intergraph	8.2	8.1	9.6	18.7	0.9
19	Alias Research	8.6	8.6	9.4	9.0	0.9
20	Algor Interactive Systems	9.7	9.0	8.6	-5.2	0.8
21	Applicon	8.3	8.8	8.3	-5.9	0.8
22	CGTech	5.5	5.8	7.1	22.2	0.7
23	Bentley Systems	6.0	5.8	6.9	17.9	0.7
24	ADRA Systems	8.1	9.2	6.2	-33.0	0.6
25	Mechanical Dynamics	4.3	4.8	6.1	27.6	0.6
26	Matra Datavision	4.4	5.5	6.1	11.3	0.6
27	ICEM Technologies	6.2	7.4	5.9	-19.2	0.6
28	CNC Software	5.6	5.8	5.9	2.5	0.6
29	DP Technology	3.8	4.3	5.8	34.6	0.6
30	Agile Software	1.4	1.8	5.7	224.0	0.5
	All North American Companies	**762.0**	**950.6**	**966.3**	**1.7**	**93.6**
	All European Companies	**32.2**	**44.6**	**64.2**	**43.9**	**6.2**
	All Asian Companies	**1.6**	**1.8**	**2.2**	**26.5**	**0.2**
	All Companies	**795.8**	**996.9**	**1,032.7**	**3.6**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-7
1997 Top 30 Mechanical Software Companies, North America, UNIX
(Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Parametric Technology	134.9	170.3	208.1	22.2	32.0
2	IBM	77.2	88.8	115.8	30.3	17.8
3	Dassault Systemes	46.7	60.7	73.9	21.9	11.4
4	Structural Dynamics Research Corporation	54.0	65.3	58.2	-11.0	8.9
5	MacNeal-Schwendler	38.0	34.4	39.6	15.1	6.1
6	Unigraphics Solutions	45.1	113.3	37.3	-67.1	5.7
7	Computervision	46.0	61.2	22.3	-63.5	3.4
8	Sherpa Corp.	13.3	14.3	14.2	-0.4	2.2
9	Tecnomatix Technology	7.4	8.1	10.7	31.6	1.6
10	Ansys	11.6	14.0	10.7	-24.1	1.6
11	CoCreate	12.1	15.2	10.6	-30.2	1.6
12	Altair Computing	5.9	9.5	10.3	9.0	1.6
13	Gerber Systems	8.3	9.4	10.2	9.0	1.6
14	Alias Research	8.6	8.6	9.4	9.0	1.4
15	Formtek	7.0	7.4	8.0	9.0	1.2
16	ICEM Technologies	6.2	7.1	5.5	-22.4	0.9
17	Mechanical Dynamics	3.4	3.7	5.0	36.0	0.8
18	Intergraph	7.6	5.9	4.8	-17.6	0.7
19	CGTech	3.9	4.0	4.6	15.2	0.7
20	Matra Datavision	3.8	4.8	4.4	-7.2	0.7
21	ADRA Systems	5.9	6.2	4.3	-31.1	0.7
22	Cadis Software	1.1	3.3	3.8	15.0	0.6
23	CIMLINC	3.4	3.4	3.8	9.0	0.6
24	First Cadcam Inc.	2.6	3.0	3.4	11.2	0.5
25	Adina R&D	2.7	3.1	3.3	9.0	0.5
26	MARC	2.6	2.8	3.1	9.0	0.5
27	Delcam plc	3.2	2.1	3.0	39.8	0.5
28	Applicon	6.6	6.9	2.7	-60.7	0.4
29	Concentra	8.0	8.1	2.7	-66.9	0.4
30	CSAR Corp.	1.7	2.6	2.5	-2.4	0.4
	All North American Companies	**540.1**	**688.2**	**616.8**	**-10.4**	**94.7**
	All European Companies	**27.8**	**30.1**	**32.3**	**7.4**	**5.0**
	All Asian Companies	**1.4**	**1.6**	**1.8**	**11.8**	**0.3**
	All Companies	**569.3**	**719.9**	**651.0**	**-9.6**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

Table 2-8
1997 Top 30 Mechanical Software Companies, North America, Windows NT
(Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Parametric Technology	25.7	48.0	69.4	44.4	28.8
2	Autodesk	-	11.9	47.5	298.0	19.7
3	Structural Dynamics Research Corporation	3.0	7.3	24.9	240.4	10.4
4	Dassault Systemes	-	6.5	18.2	180.2	7.6
5	Unigraphics Solutions	-	12.6	16.0	26.8	6.6
6	CoCreate	0.7	2.0	9.9	406.1	4.1
7	MCS	0.9	2.2	6.5	191.0	2.7
8	Bentley Systems	2.3	2.9	6.0	109.4	2.5
9	Ansys	1.9	2.4	5.5	126.1	2.3
10	Agile Software	1.0	1.2	4.6	279.5	1.9
11	Applicon	-	-	3.5	NA	1.5
12	Intergraph	0.7	2.2	3.4	54.3	1.4
13	MicroCADAM	0.5	1.3	3.2	146.7	1.3
14	3D/Eye Inc.	-	1.8	3.0	72.0	1.3
15	Algor Interactive Systems	-	-	3.0	NA	1.2
16	DP Technology	0.8	1.5	2.8	84.6	1.2
17	MacNeal-Schwendler	0.5	0.5	2.0	322.8	0.8
18	Spatial Technology	-	0.8	1.6	102.4	0.6
19	CGTech	0.6	0.6	1.4	122.3	0.6
20	Matra Datavision	0.5	0.6	1.3	107.2	0.5
21	Gibbs and Assoc.	-	0.5	0.9	95.8	0.4
22	Mechanical Dynamics	-	0.4	0.8	107.5	0.3
23	Sherpa Corp.	-	-	0.8	NA	0.3
24	NOVASOFT Systems	0.2	0.5	0.7	49.3	0.3
25	Delcam plc	-	0.5	0.7	41.0	0.3
26	Auto-Trol	-	0.1	0.6	311.2	0.2
27	Ricoh	-	-	0.6	NA	0.2
28	CSAR Corp.	-	-	0.5	NA	0.2
29	Open Mind	-	0.4	0.5	19.5	0.2
30	SRAC	0.4	0.4	0.4	10.1	0.2
	All North American Companies	**39.3**	**101.8**	**218.6**	**114.8**	**90.9**
	All European Companies	**0.5**	**8.3**	**21.6**	**159.4**	**9.0**
	All Asian Companies	**-**	**-**	**0.1**	**NA**	**0.1**
	All Companies	**39.7**	**110.1**	**240.4**	**118.4**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-9
1997 Top 30 Mechanical Software Companies, North America, Personal Computer (Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Autodesk	80.3	58.2	47.5	-18.4	35.3
2	CNC Software	5.6	5.8	5.9	2.5	4.4
3	MicroCADAM	5.0	6.2	5.8	-6.4	4.3
4	Baystate Technologies	1.1	3.5	5.5	57.0	4.1
5	Ashlar	3.0	3.1	5.3	69.1	3.9
6	Viagrafix	5.0	5.1	5.3	2.5	3.9
7	CoCreate	3.4	5.5	4.6	-16.3	3.4
8	Surfware	3.6	3.8	4.5	20.0	3.4
9	Algor Interactive Systems	5.8	5.4	3.9	-28.9	2.9
10	Cimatron	1.2	2.1	3.4	65.5	2.6
11	Formtek	3.0	3.2	3.2	2.5	2.4
12	Pathtrace Engineering Systems	1.5	2.0	3.0	55.7	2.3
13	DP Technology	1.9	2.1	2.8	34.6	2.1
14	SRAC	1.5	2.2	2.4	10.1	1.8
15	MCS	4.7	5.2	2.2	-58.3	1.6
16	Gibbs and Assoc.	2.2	1.9	2.1	14.2	1.6
17	Applicon	1.7	1.8	2.0	10.4	1.5
18	Dassault Systemes	-	0.7	2.0	180.2	1.5
19	3D/Eye Inc.	-	1.8	1.8	2.5	1.3
20	ADRA Systems	2.2	2.4	1.6	-31.4	1.2
21	Spatial Technology	2.7	2.7	1.6	-42.2	1.2
22	Workgroup Tech.	1.8	2.9	1.4	-52.3	1.0
23	Intergraph	-	-	1.3	NA	1.0
24	Variation Systems Analysis	1.3	1.3	1.3	2.5	1.0
25	Consensys	0.5	0.8	1.2	50.0	0.9
26	Engineering Mechanics	1.0	1.1	1.1	2.5	0.8
27	CGTech	1.1	1.2	1.1	-8.3	0.8
28	Boothroyd Dewhurst	1.0	1.0	1.0	2.5	0.8
29	Computervision	2.1	2.8	1.0	-63.5	0.8
30	Agile Software	0.4	0.5	1.0	94.4	0.8
	All North American Companies	155.0	138.9	124.2	-10.5	92.4
	All European Companies	3.7	6.1	10.0	64.4	7.5
	All Asian Companies	0.1	0.1	0.2	278.5	0.2
	All Companies	158.8	145.0	134.5	-7.3	100.0

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-10
1997 Top 14 Mechanical Software Companies, North America, Host/Proprietary
(Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	IBM	17.9	11.8	4.6	-60.6	68.2
2	Dassault Systemes	11.1	6.8	3.9	-42.8	56.9
3	MacNeal-Schwendler	11.0	10.2	2.1	-79.9	30.2
4	Ansys	0.6	0.6	0.2	-69.4	2.5
5	Matra Datavision	-	-	0.2	NA	2.5
6	Sherpa Corp.	0.1	0.1	0.2	12.4	2.2
7	Altair Computing	-	0.2	0.1	-50.0	1.5
8	Mechanical Dynamics	0.6	0.5	0.1	-88.6	0.9
9	Kubota Computer	0.1	0.1	0	-50.0	0.4
10	Computational Mechanics	0.2	0	0	-50.0	0.4
11	Fujitsu	-	-	0	NA	0.2
12	debis Systemhaus	-	0	0	-93.2	0
13	ESI Group	-	0	0	-43.7	0
14	Access Corp.	0.4	0.2	-	-100.0	-
	All North American Companies	**27.7**	**21.7**	**6.6**	**-69.8**	**96.5**
	All European Companies	**0.2**	**0.1**	**0.2**	**163.5**	**2.9**
	All Asian Companies	**0.1**	**0.1**	**0**	**-32.4**	**0.6**
	All Companies	**28.0**	**21.9**	**6.8**	**-68.9**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-11
1997 Top 30 Mechanical Software Companies, Europe, All Operating Systems (Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	IBM	249.5	225.5	238.1	5.6	21.5
2	Parametric Technology	109.2	171.3	203.5	18.8	18.4
3	Dassault Systemes	113.2	140.7	150.8	7.2	13.6
4	Matra Datavision	70.0	68.8	72.7	5.6	6.6
5	Autodesk	61.5	54.5	64.0	17.5	5.8
6	CoCreate	59.0	54.4	60.3	10.7	5.4
7	Structural Dynamics Research Corporation	33.2	43.1	52.5	21.8	4.7
8	Unigraphics Solutions	32.1	59.3	37.9	-36.0	3.4
9	MacNeal-Schwendler	32.0	30.8	28.3	-8.2	2.6
10	Computervision	73.6	81.1	27.1	-66.6	2.4
11	Tecnomatix Technology	11.6	15.8	20.7	31.1	1.9
12	ISD Software	14.5	22.4	19.9	-11.2	1.8
13	ASCAD	14.9	16.5	19.7	19.2	1.8
14	Delcam plc	7.7	12.5	17.6	40.0	1.6
15	Tebis	12.5	14.0	13.1	-6.4	1.2
16	CAD Lab	13.6	10.9	12.9	18.2	1.2
17	Radan Computational	7.6	8.2	11.8	43.5	1.1
18	ICEM Technologies	10.4	11.9	11.7	-1.9	1.1
19	Applicon	12.4	12.1	10.6	-12.5	1.0
20	Ansys	10.1	11.1	10.5	-5.2	1.0
21	MicroCADAM	10.3	12.2	10.5	-13.7	0.9
22	Sherpa Corp.	7.2	9.2	9.6	5.0	0.9
23	Investronica SA	6.0	8.6	8.2	-5.0	0.7
24	BCT GmbH	4.2	7.2	8.1	12.8	0.7
25	Eigner + Partner	6.3	6.8	7.6	11.8	0.7
26	Sescoi	6.0	7.5	7.1	-5.2	0.6
27	Bentley Systems	6.2	5.9	7.0	17.9	0.6
28	PROCAD GmbH & Co KG	5.8	6.5	6.8	5.3	0.6
29	MARC	4.5	5.9	6.2	5.3	0.6
30	Mechanical Dynamics	4.9	5.7	6.1	7.0	0.6
	All North American Companies	**744.0**	**826.5**	**824.8**	**-0.2**	**74.6**
	All European Companies	**262.4**	**257.8**	**281.6**	**9.2**	**25.4**
	All Asian Companies	-	-	-	**NA**	-
	All Companies	**1,006.5**	**1,084.2**	**1,106.3**	**2.0**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-12
1997 Top 30 Mechanical Software Companies, Europe, UNIX
(Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	IBM	206.0	199.0	227.6	14.4	31.4
2	Parametric Technology	91.7	133.6	152.7	14.3	21.0
3	Dassault Systemes	87.6	123.3	135.7	10.1	18.7
4	Matra Datavision	60.4	59.4	53.0	-10.8	7.3
5	Structural Dynamics Research Corporation	31.5	38.4	36.5	-5.1	5.0
6	Unigraphics Solutions	32.1	53.3	26.5	-50.3	3.7
7	Computervision	70.4	77.5	25.9	-66.6	3.6
8	CoCreate	44.3	36.5	25.5	-30.2	3.5
9	MacNeal-Schwendler	24.3	22.7	25.3	11.8	3.5
10	Tecnomatix Technology	11.6	15.8	20.7	31.1	2.9
11	Delcam plc	7.4	10.1	14.2	39.8	2.0
12	ASCAD	12.8	14.1	13.9	-2.0	1.9
13	ICEM Technologies	10.4	11.5	10.9	-4.9	1.5
14	Sherpa Corp.	7.1	9.1	9.1	-0.4	1.2
15	Eigner + Partner	6.3	6.8	7.6	11.8	1.1
16	Ansys	7.6	8.3	6.5	-21.6	0.9
17	CAD Lab	7.5	5.4	6.4	18.2	0.9
18	Sescoi	4.8	6.0	5.8	-3.5	0.8
19	PROCAD GmbH & Co KG	5.2	5.7	5.6	-1.9	0.8
20	ESI Group	6.5	5.5	5.4	-0.5	0.8
21	MARC	4.5	5.3	5.4	0.6	0.7
22	Tebis	4.6	5.3	5.2	-1.0	0.7
23	Mechanical Dynamics	3.9	4.4	5.0	14.1	0.7
24	debis Systemhaus	3.0	3.2	4.7	48.1	0.7
25	Alias Research	4.3	4.3	4.3	0.6	0.6
26	Radan Computational	7.5	3.7	4.0	8.4	0.6
27	Formtek	3.2	3.6	3.7	1.2	0.5
28	Applicon	10.0	9.6	3.5	-63.5	0.5
29	ADRA Systems	5.0	5.2	3.5	-33.5	0.5
30	Adina R&D	2.3	2.6	2.7	2.1	0.4
	All North American Companies	**567.6**	**632.0**	**580.1**	**-8.2**	**79.9**
	All European Companies	**186.0**	**153.0**	**145.6**	**-4.8**	**20.1**
	All Asian Companies	**-**	**-**	**-**	**NA**	**-**
	All Companies	**753.7**	**785.0**	**725.7**	**-7.6**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-13
1997 Top 30 Mechanical Software Companies, Europe, Windows NT
(Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Parametric Technology	17.5	37.7	50.9	35.0	22.0
2	Autodesk	-	9.0	32.0	256.2	13.8
3	CoCreate	2.4	4.7	23.7	406.1	10.2
4	Structural Dynamics Research Corporation	1.0	4.3	15.6	262.7	6.8
5	Matra Datavision	7.7	7.5	15.0	99.2	6.5
6	ISD Software	-	12.2	14.7	19.8	6.3
7	Unigraphics Solutions	-	5.9	11.4	91.9	4.9
8	Radan Computational	-	4.5	7.8	72.2	3.4
9	Dassault Systemes	-	0.9	6.1	567.2	2.6
10	Bentley Systems	2.3	2.9	6.1	109.4	2.6
11	CAD Lab	0.7	4.4	5.2	18.2	2.2
12	CAD Distribution	3.5	4.8	4.9	2.4	2.1
13	Applicon	-	-	4.5	NA	1.9
14	BCT GmbH	0.4	2.5	3.9	56.0	1.7
15	Delcam plc	-	2.4	3.4	41.0	1.5
16	Ansys	1.2	1.4	3.4	133.3	1.5
17	ASCAD	0.9	1.0	3.2	220.6	1.4
18	MicroCADAM	0.5	1.5	3.2	115.9	1.4
19	Vero International Software	-	1.3	2.4	80.5	1.0
20	Open Mind	-	1.8	2.1	19.5	0.9
21	MCS	0.3	0.7	2.0	167.0	0.9
22	Intergraph	0.5	0.7	1.3	98.7	0.6
23	PROCAD GmbH & Co KG	0.6	0.8	1.3	55.9	0.5
24	MacNeal-Schwendler	0.3	0.3	1.3	310.6	0.5
25	Modultek Oy	-	-	1.2	NA	0.5
26	Mechanical Dynamics	-	0.5	0.8	74.1	0.3
27	ICEM Technologies	-	0.4	0.8	75.0	0.3
28	Catalpa groupe Missler	-	0.5	0.8	73.5	0.3
29	Spatial Technology	-	0.3	0.8	131.2	0.3
30	MARC	-	0.5	0.7	60.0	0.3
	All North American Companies	**27.6**	**76.0**	**165.7**	**118.2**	**71.6**
	All European Companies	**13.1**	**38.0**	**65.6**	**72.6**	**28.4**
	All Asian Companies	**-**	**-**	**-**	**NA**	**-**
	All Companies	**40.7**	**114.0**	**231.4**	**103.0**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-14
1997 Top 30 Mechanical Software Companies, Europe, Personal Computer (Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Autodesk	59.1	43.8	32.0	-27.0	23.5
2	CoCreate	12.3	13.3	11.1	-16.3	8.1
3	Investronica SA	6.0	8.6	8.2	-5.0	6.0
4	Tebis	7.9	8.8	7.9	-9.6	5.8
5	MicroCADAM	5.7	7.1	5.8	-18.1	4.2
6	Cimatron	3.3	4.5	5.4	20.6	3.9
7	Serbi	5.9	5.6	5.0	-10.8	3.7
8	Wiechers Datentechnik	4.5	4.6	4.6	0.2	3.4
9	Pathtrace Engineering Systems	1.6	2.1	4.4	109.1	3.2
10	Ziegler Informatics	3.3	4.6	4.4	-3.8	3.2
11	BCT GmbH	3.8	4.7	4.2	-10.4	3.1
12	Whessoe Computing Systems	3.8	3.9	3.8	-0.5	2.8
13	PAFEC	-	3.7	3.6	-3.0	2.6
14	Matra Datavision	1.8	1.9	3.6	91.1	2.6
15	Anilam Electronics	2.6	2.7	2.7	-1.2	2.0
16	ISD Software	4.0	2.6	2.6	-1.0	1.9
17	Applicon	2.4	2.6	2.6	2.7	1.9
18	ASCAD	1.2	1.3	2.6	90.1	1.9
19	Just In Time Systems	2.5	2.1	1.9	-10.5	1.4
20	CADdy Spain	1.4	1.4	1.7	17.2	1.2
21	RoboCAD Solutions	1.9	1.6	1.5	-4.1	1.1
22	Formtek	1.4	1.5	1.4	-7.6	1.0
23	ADRA Systems	1.8	2.0	1.3	-33.7	1.0
24	Sescoi	1.2	1.5	1.3	-12.0	1.0
25	CAD Lab	5.4	1.1	1.3	18.2	0.9
26	Vero International Software	1.7	1.2	1.2	0.8	0.9
27	Computervision	3.2	3.6	1.2	-66.6	0.9
28	CNC Software	1.3	1.2	1.1	-3.9	0.8
29	B.A. Intelligence Networks	0.8	0.7	1.1	54.1	0.8
30	Superdraft	1.2	1.1	1.1	-3.5	0.8
	All North American Companies	**104.8**	**88.6**	**68.6**	**-22.5**	**50.3**
	All European Companies	**60.7**	**64.8**	**67.8**	**4.6**	**49.7**
	All Asian Companies	**-**	**-**	**-**	**NA**	**-**
	All Companies	**165.5**	**153.4**	**136.4**	**-11.1**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-15
1997 Top 14 Mechanical Software Companies, Europe, Host/Proprietary (Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	IBM	43.6	26.2	10.1	-61.5	78.5
2	Dassault Systemes	25.6	16.4	8.4	-48.6	65.6
3	MacNeal-Schwendler	7.0	6.7	1.3	-80.5	10.2
4	Matra Datavision	-	-	1.1	NA	8.6
5	Exapt	3.0	1.3	0.9	-25.1	7.4
6	Whessoe Computing Systems	0.3	0.3	0.2	-18.6	1.7
7	Computational Mechanics	0.2	0.2	0.2	-21.2	1.3
8	Ansys	0.4	0.3	0.1	-68.4	0.8
9	Sherpa Corp.	0.1	0.1	0.1	12.4	0.8
10	ESI Group	0.4	0.1	0.1	-45.8	0.6
11	Mechanical Dynamics	0.7	0.6	0.1	-90.5	0.5
12	debis Systemhaus	0.2	0.2	0	-78.6	0.4
13	CIMTEK	0.1	0.1	-	-100.0	-
14	Access Corp.	0	0	-	-100.0	-
	All North American Companies	**44.0**	**29.9**	**10.3**	**-65.4**	**80.5**
	All European Companies	**2.6**	**2.0**	**2.5**	**25.7**	**19.5**
	All Asian Companies	**-**	**-**	**-**	**NA**	**-**
	All Companies	**46.6**	**31.9**	**12.8**	**-59.8**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-16
1997 Top 30 Mechanical Software Companies, Japan, All Operating Systems
(Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	IBM	106.0	193.2	232.5	20.4	20.7
2	Info. Services Int'l. Dentsu*	85.2	117.2	125.9	7.5	11.2
3	MicroCADAM	104.7	123.1	123.0	-0.1	11.0
4	Fujitsu	97.0	107.3	102.4	-4.6	9.1
5	Parametric Technology	41.8	72.8	72.1	-0.9	6.4
6	NEC	72.9	62.9	70.9	12.7	6.3
7	Hitachi	70.9	63.7	68.1	6.8	6.1
8	Toshiba*	66.7	62.5	65.0	3.9	5.8
9	Nihon Unisys	52.8	54.4	54.6	0.3	4.9
10	Hitachi Zosen Info Systems	38.3	38.9	42.3	8.8	3.8
11	CoCreate	31.1	32.9	36.4	10.7	3.2
12	C. Itoh Techno-Science*	30.8	30.8	32.5	5.5	2.9
13	Dassault Systemes	17.0	18.2	28.3	55.8	2.5
14	Marubeni Hytech*	19.9	23.0	24.9	8.5	2.2
15	Sumisho Electronics*	18.8	21.6	23.4	8.4	2.1
16	Tokyo Electron*	17.4	20.0	21.8	8.5	1.9
17	Seiko*	19.7	19.0	21.1	11.0	1.9
18	MacNeal-Schwendler	29.6	21.3	20.8	-2.2	1.9
19	Structural Dynamics Research Corporation	15.5	18.4	19.3	4.8	1.7
20	Andor*	15.9	17.8	19.2	8.0	1.7
21	Autodesk	19.2	19.6	18.6	-5.2	1.7
22	Mitsui Engineering	14.0	16.1	17.5	8.5	1.6
23	Design Automation	10.0	11.5	13.5	17.9	1.2
24	Wacom	6.0	8.4	13.5	60.1	1.2
25	Omron	7.8	7.7	11.9	54.0	1.1
26	MARC	11.1	9.8	11.1	13.4	1.0
27	Graphtec Engineering	8.6	8.6	10.8	25.4	1.0
28	Mutoh Industries*	13.1	9.3	10.5	13.4	0.9
29	Toyo Information Systems*	8.1	9.0	9.5	6.0	0.8
30	Adam Net	7.5	8.5	9.2	8.5	0.8
	All North American Companies	**396.6**	**525.5**	**558.8**	**6.3**	**49.8**
	All European Companies	**19.4**	**23.9**	**22.9**	**-4.3**	**2.0**
	All Asian Companies	**475.8**	**469.8**	**540.3**	**15.0**	**48.2**
	All Companies	**891.7**	**1,019.3**	**1,122.0**	**10.1**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-17
1997 Top 30 Mechanical Software Companies, Japan, UNIX
(Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	IBM	86.1	167.8	222.2	32.4	34.2
2	Info. Services Int'l. Dentsu*	80.9	111.3	119.6	7.5	18.4
3	Parametric Technology	35.1	56.8	54.1	-4.7	8.3
4	Nihon Unisys	51.8	53.6	53.6	0.1	8.2
5	NEC	43.7	37.7	40.9	8.5	6.3
6	Hitachi Zosen Info Systems	38.3	38.9	38.1	-2.0	5.9
7	C. Itoh Techno-Science*	28.4	28.4	30.8	8.5	4.7
8	Toshiba*	50.0	42.5	29.2	-31.2	4.5
9	Dassault Systemes	13.4	15.8	25.6	62.2	3.9
10	Marubeni Hytech*	19.9	23.0	24.9	8.5	3.8
11	Tokyo Electron*	17.4	20.0	21.8	8.5	3.3
12	Fujitsu	65.0	72.7	19.5	-73.2	3.0
13	MacNeal-Schwendler	22.5	15.6	18.6	19.2	2.9
14	MicroCADAM	41.9	36.9	18.5	-50.0	2.8
15	Sumisho Electronics*	14.2	16.4	17.8	8.5	2.7
16	Mitsui Engineering	13.5	15.5	16.9	8.5	2.6
17	CoCreate	23.4	22.1	15.4	-30.2	2.4
18	Seiko*	19.7	19.0	15.2	-19.9	2.3
19	Structural Dynamics Research Corporation	14.8	16.4	13.3	-18.7	2.0
20	Hitachi	57.3	51.6	12.3	-76.2	1.9
21	MARC	11.1	8.9	9.6	8.5	1.5
22	Toyo Information Systems*	7.3	8.4	9.1	8.5	1.4
23	Adam Net	7.2	7.7	8.4	8.5	1.3
24	Kubota Computer	6.6	7.6	8.2	8.5	1.3
25	Nihon Itek*	5.5	6.4	6.9	8.5	1.1
26	Sharp*	8.3	7.5	6.7	-10.1	1.0
27	Computervision	13.4	15.0	5.3	-64.6	0.8
28	Unigraphics Solutions	2.8	5.5	5.1	-6.9	0.8
29	Adina R&D	4.1	4.7	5.1	8.5	0.8
30	Technodia*	3.9	4.4	4.8	8.5	0.7
	All North American Companies	**267.4**	**352.1**	**365.5**	**3.8**	**56.2**
	All European Companies	**14.2**	**15.6**	**11.2**	**-28.1**	**1.7**
	All Asian Companies	**370.2**	**352.0**	**273.2**	**-22.4**	**42.0**
	All Companies	**651.8**	**719.7**	**649.9**	**-9.7**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-18
1997 Top 30 Mechanical Software Companies, Japan, Windows NT
(Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Fujitsu	-	-	55.3	NA	25.8
2	MicroCADAM	5.2	14.8	36.9	149.8	17.2
3	Parametric Technology	6.7	16.0	18.0	12.6	8.4
4	CoCreate	1.3	2.8	14.3	406.1	6.7
5	Wacom	4.9	7.1	12.0	70.0	5.6
6	Omron	5.8	5.8	10.0	72.5	4.6
7	Autodesk	-	3.2	9.3	187.3	4.3
8	Graphtec Engineering	-	2.6	8.7	235.0	4.0
9	NEC	5.2	4.5	7.6	70.0	3.6
10	Toshiba*	-	-	6.5	NA	3.0
11	Hitachi	-	-	6.0	NA	2.8
12	Seiko*	-	-	5.9	NA	2.7
13	Structural Dynamics Research Corporation	0.4	1.8	5.7	210.8	2.7
14	Toshiba Engineering*	-	2.5	5.4	111.2	2.5
15	Hitachi Zosen Info Systems	-	-	4.2	NA	2.0
16	Ricoh	-	-	3.1	NA	1.4
17	Mutoh Industries*	2.3	2.4	2.9	21.7	1.4
18	Kozo Keikaku Engineering	-	-	2.7	NA	1.3
19	Unigraphics Solutions	-	0.6	2.2	259.3	1.0
20	Ansys	0.5	0.6	1.7	169.3	0.8
21	MARC	-	0.8	1.3	70.0	0.6
22	Matra Datavision	0.6	1.3	1.3	-2.9	0.6
23	Dassault Systemes	-	0.4	1.1	161.5	0.5
24	MacNeal-Schwendler	0.3	0.2	0.9	337.7	0.4
25	Radan Computational	-	0.4	0.7	70.0	0.3
26	Mechanical Dynamics	-	0.2	0.6	123.7	0.3
27	Spatial Technology	-	0.3	0.6	118.7	0.3
28	Vero International Software	-	0.6	0.5	-13.3	0.2
29	CGTech	0.2	0.2	0.4	58.1	0.2
30	IBM	-	0.3	0.4	7.4	0.2
	All North American Companies	**14.9**	**42.3**	**93.1**	**120.1**	**43.4**
	All European Companies	**0.6**	**3.2**	**4.4**	**38.1**	**2.0**
	All Asian Companies	**15.9**	**22.2**	**116.9**	**426.7**	**54.5**
	All Companies	**31.3**	**67.7**	**214.4**	**216.8**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-19
1997 Top 30 Mechanical Software Companies, Japan, Personal Computer (Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	MicroCADAM	57.6	71.4	67.7	-5.3	27.9
2	Hitachi	10.2	9.2	48.1	424.0	19.8
3	Toshiba*	16.7	20.0	29.2	46.2	12.0
4	Fujitsu	24.2	26.9	25.6	-4.8	10.5
5	NEC	24.0	20.8	22.4	8.0	9.2
6	Andor*	15.9	17.8	19.2	8.0	7.9
7	Design Automation	10.0	11.5	13.5	17.9	5.6
8	Autodesk	18.3	16.0	9.3	-41.8	3.8
9	CoCreate	6.5	8.0	6.7	-16.3	2.8
10	Info. Services Int'l. Dentsu*	4.3	5.9	6.3	7.5	2.6
11	Sumisho Electronics*	4.6	5.1	5.6	8.0	2.3
12	Mutoh Industries*	3.5	3.6	3.9	7.6	1.6
13	Cimatron	0.8	1.8	2.9	56.7	1.2
14	Argo Graphics*	2.0	2.3	2.4	8.0	1.0
15	Kozo Keikaku Engineering	3.3	4.2	2.3	-44.3	1.0
16	Mitsubishi Electric*	1.7	1.9	2.0	8.0	0.8
17	Toshiba Engineering*	-	-	1.9	NA	0.8
18	Wacom	1.1	1.3	1.4	8.0	0.6
19	Anilam Electronics	1.2	1.3	1.4	8.0	0.6
20	Graphtec Engineering	-	2.6	1.1	-59.0	0.4
21	Pathtrace Engineering Systems	0	0	1.0	2409.1	0.4
22	Surfware	0.3	0.8	1.0	20.0	0.4
23	Adam Net	0.2	0.8	0.8	8.0	0.3
24	Investronica SA	-	0.7	0.7	8.0	0.3
25	Formtek	0.9	0.6	0.7	8.0	0.3
26	Mitsui Engineering	0.5	0.6	0.6	8.0	0.3
27	ADRA Systems	0.8	0.8	0.6	-27.2	0.2
28	Spatial Technology	1.2	0.9	0.6	-37.5	0.2
29	Nihon Unisys	-	-	0.6	NA	0.2
30	Uchida Yoko	0.8	1.3	0.5	-61.2	0.2
	All North American Companies	**90.8**	**104.8**	**90.6**	**-13.6**	**37.3**
	All European Companies	**4.5**	**5.1**	**7.0**	**38.3**	**2.9**
	All Asian Companies	**77.9**	**84.4**	**145.2**	**72.1**	**59.8**
	All Companies	**173.2**	**194.2**	**242.8**	**25.0**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-20
1997 Top 20 Mechanical Software Companies, Japan, Host/Proprietary
(Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	IBM	20.0	25.0	9.9	-60.3	66.3
2	Fujitsu	7.8	7.7	2.0	-73.4	13.7
3	C. Itoh Techno-Science*	2.4	2.4	1.7	-30.0	11.3
4	Hitachi	3.3	3.0	1.6	-45.5	10.9
5	Dassault Systemes	3.6	1.9	1.5	-21.9	10.1
6	MacNeal-Schwendler	6.5	4.6	1.0	-79.2	6.5
7	Mitsubishi Electric*	1.2	0.9	0.6	-30.0	4.0
8	Toyo Information Systems*	0.8	0.6	0.4	-30.0	2.7
9	Nihon Unisys	1.1	0.8	0.4	-51.8	2.7
10	Kubota Computer	0.6	0.4	0.3	-30.0	2.1
11	Matra Datavision	-	-	0.2	NA	1.6
12	Century Research Center	0.3	0.2	0.1	-30.0	1.0
13	Ansys	0.2	0.1	0.1	-63.5	0.4
14	Mechanical Dynamics	0.4	0.3	0	-87.8	0.3
15	Whessoe Computing Systems	0.1	0.1	0	-30.0	0.3
16	Altair Computing	-	0	0	-30.0	0.1
17	Technodia*	0	0	0	-30.0	0.1
18	Computational Mechanics	0	0	0	-30.0	0.1
19	Sherpa Corp.	-	0	0	12.4	0.1
20	ESI Group	0	0	0	-93.4	0
	All North American Companies	**23.5**	**26.4**	**9.7**	**-63.1**	**65.0**
	All European Companies	**0.1**	**0.1**	**0.3**	**242.4**	**1.9**
	All Asian Companies	**11.7**	**11.2**	**4.9**	**-55.9**	**33.1**
	All Companies	**35.4**	**37.7**	**15.0**	**-60.3**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-21
1997 Top 30 Mechanical Software Companies, Asia/Pacific, All Operating Systems (Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Parametric Technology	9.6	32.7	52.7	61.3	24.8
2	IBM	38.8	42.0	48.6	15.9	22.9
3	Dassault Systemes	16.9	17.8	28.8	61.6	13.6
4	Autodesk	21.1	22.6	23.7	4.8	11.2
5	Unigraphics Solutions	9.1	18.2	17.1	-6.3	8.0
6	Structural Dynamics Research Corporation	16.8	18.4	16.6	-9.5	7.8
7	MacNeal-Schwendler	2.4	6.4	6.6	2.7	3.1
8	Delcam plc	2.8	3.3	4.6	40.0	2.2
9	Matra Datavision	7.0	4.6	4.6	0.6	2.2
10	MicroCADAM	3.9	4.6	4.5	-1.3	2.1
11	Computervision	10.3	10.1	4.0	-60.4	1.9
12	Formtek	0.8	2.1	2.3	10.0	1.1
13	Intergraph	0.5	1.4	2.3	64.5	1.1
14	Alias Research	1.7	1.7	2.1	20.0	1.0
15	MCS	1.8	1.8	1.8	3.7	0.9
16	Gerber Systems	1.2	1.5	1.8	18.5	0.8
17	Cimatron	1.7	1.9	1.7	-10.3	0.8
18	Sharp*	2.1	1.9	1.7	-10.1	0.8
19	Ansys	2.0	1.9	1.4	-24.1	0.7
20	Sherpa Corp.	-	1.3	1.4	5.0	0.6
21	Mechanical Dynamics	0.8	1.0	1.4	31.7	0.6
22	Tecnomatix Technology	-	1.2	1.2	0	0.6
23	Concentra	0.3	4.0	1.1	-72.9	0.5
24	Bentley Systems	0.9	0.9	1.1	17.9	0.5
25	MARC	-	0.8	1.0	30.5	0.5
26	PAFEC	-	1.0	1.0	5.2	0.5
27	Open Mind	-	0.7	0.9	19.5	0.4
28	ADRA Systems	1.1	1.3	0.9	-33.4	0.4
29	Investronica SA	3.9	0.8	0.8	2.8	0.4
30	Design Automation	1.6	1.8	0.7	-59.9	0.3
	All North American Companies	**123.2**	**174.3**	**192.9**	**10.7**	**90.8**
	All European Companies	**17.8**	**13.5**	**16.3**	**20.6**	**7.7**
	All Asian Companies	**4.1**	**3.8**	**3.2**	**-14.4**	**1.5**
	All Companies	**145.1**	**191.6**	**212.4**	**10.9**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-22
1997 Top 30 Mechanical Software Companies, Asia/Pacific, UNIX
(Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	IBM	31.9	36.0	46.0	27.9	32.7
2	Parametric Technology	8.1	25.5	39.5	55.1	28.1
3	Dassault Systemes	13.0	15.4	26.2	70.4	18.6
4	Unigraphics Solutions	9.1	16.4	11.9	-27.2	8.5
5	Structural Dynamics Research Corporation	16.1	16.4	11.6	-29.4	8.2
6	MacNeal-Schwendler	1.8	4.7	5.9	25.1	4.2
7	Computervision	9.8	9.7	3.8	-60.4	2.7
8	Delcam plc	2.7	2.7	3.7	39.8	2.6
9	Matra Datavision	6.0	4.0	3.3	-16.9	2.3
10	Alias Research	1.7	1.7	2.1	20.0	1.5
11	Gerber Systems	1.2	1.5	1.8	18.5	1.3
12	Sharp*	2.1	1.9	1.7	-10.1	1.2
13	Formtek	0.5	1.4	1.6	13.2	1.2
14	Sherpa Corp.	-	1.3	1.3	-0.4	0.9
15	Tecnomatix Technology	-	1.2	1.2	0	0.9
16	Intergraph	0.4	0.9	1.1	26.6	0.8
17	Mechanical Dynamics	0.7	0.8	1.1	39.0	0.8
18	Concentra	0.3	4.0	1.1	-72.9	0.8
19	Ansys	1.5	1.4	0.9	-37.3	0.6
20	MARC	-	0.7	0.9	20.0	0.6
21	MicroCADAM	1.6	1.4	0.7	-50.7	0.5
22	Altair Computing	0.4	0.6	0.6	13.2	0.5
23	Pacific Numerix	-	0.1	0.6	537.0	0.4
24	ADRA Systems	0.8	0.9	0.6	-31.6	0.4
25	ICEM Technologies	0.1	-	0.6	NA	0.4
26	Hitachi Zosen Info Systems	0.4	0.4	0.4	-2.0	0.3
27	MCS	0.6	0.3	0.4	35.8	0.3
28	PAFEC	-	0.3	0.4	10.4	0.3
29	Eigner + Partner	-	-	0.3	NA	0.2
30	CIMLINC	0.3	0.3	0.3	12.1	0.2
	All North American Companies	**86.0**	**123.8**	**130.0**	**5.0**	**92.3**
	All European Companies	**10.8**	**7.1**	**8.6**	**21.1**	**6.1**
	All Asian Companies	**2.8**	**2.3**	**2.2**	**-4.0**	**1.5**
	All Companies	**99.7**	**133.2**	**140.9**	**5.7**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-23
1997 Top 30 Mechanical Software Companies, Asia/Pacific, Windows NT (Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Parametric Technology	1.5	7.2	13.2	83.3	29.5
2	Autodesk	-	3.7	11.9	217.6	26.5
3	Unigraphics Solutions	-	1.8	5.1	181.0	11.5
4	Structural Dynamics Research Corporation	0.4	1.8	5.0	169.9	11.1
5	MicroCADAM	0.2	0.5	1.4	146.7	3.0
6	MCS	0.2	0.4	1.1	144.4	2.4
7	Bentley Systems	0.4	0.4	0.9	109.4	2.1
8	Matra Datavision	0.8	0.5	0.9	85.6	2.1
9	Delcam plc	-	0.6	0.9	41.0	2.0
10	Dassault Systemes	-	0.3	0.9	161.5	1.9
11	Intergraph	0.1	0.5	0.8	70.2	1.8
12	Open Mind	-	0.5	0.6	19.5	1.3
13	Ansys	0.2	0.2	0.4	86.7	1.0
14	MacNeal-Schwendler	0	0.1	0.3	359.6	0.7
15	Fujitsu	-	-	0.3	NA	0.6
16	DP Technology	0.1	0.1	0.2	44.6	0.5
17	Mechanical Dynamics	-	0.1	0.2	119.5	0.4
18	Vero International Software	-	0.4	0.2	-54.9	0.4
19	MARC	-	0.1	0.2	150.0	0.3
20	B.A. Intelligence Networks	0.1	0.3	0.1	-53.4	0.3
21	Applicon	-	-	0.1	NA	0.2
22	IBM	-	0.1	0.1	6.5	0.2
23	Algor Interactive Systems	-	-	0.1	NA	0.2
24	Ricoh	-	-	0.1	NA	0.2
25	Gibbs and Assoc.	-	0	0.1	95.8	0.2
26	Sherpa Corp.	-	-	0.1	NA	0.2
27	Spatial Technology	-	0.1	0.1	-28.9	0.1
28	CAD Lab	-	0	0.1	18.2	0.1
29	CSAR Corp.	-	-	0	NA	0.1
30	Hitachi Zosen Info Systems	-	-	0	NA	0.1
	All North American Companies	**3.3**	**17.5**	**41.1**	**134.5**	**91.9**
	All European Companies	**0.8**	**2.2**	**3.3**	**50.1**	**7.4**
	All Asian Companies	**-**	**-**	**0.3**	**NA**	**0.7**
	All Companies	**4.0**	**19.7**	**44.7**	**126.6**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-24
1997 Top 30 Mechanical Software Companies, Asia/Pacific, Personal Computer (Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Autodesk	19.9	18.2	11.9	-34.9	49.1
2	MicroCADAM	2.1	2.6	2.5	-6.4	10.2
3	Cimatron	1.4	1.7	1.6	-5.4	6.7
4	Investronica SA	3.9	0.8	0.8	2.8	3.4
5	Design Automation	1.6	1.8	0.7	-59.9	2.9
6	CNC Software	0.6	0.7	0.7	2.4	2.9
7	PAFEC	-	0.6	0.7	2.7	2.7
8	Formtek	0.2	0.6	0.6	2.7	2.6
9	Baystate Technologies	-	-	0.6	NA	2.4
10	Just In Time Systems	-	0.4	0.4	2.5	1.5
11	MCS	1.0	1.0	0.4	-65.0	1.5
12	Intergraph	-	-	0.3	NA	1.3
13	B.A. Intelligence Networks	0.2	0.3	0.3	5.9	1.2
14	Surfware	0.5	0.2	0.3	20.0	1.1
15	ADRA Systems	0.3	0.3	0.2	-31.8	0.9
16	Matra Datavision	0.2	0.1	0.2	78.1	0.9
17	DP Technology	0.2	0.2	0.2	5.5	0.8
18	Computervision	0.5	0.4	0.2	-60.4	0.7
19	Pathtrace Engineering Systems	0	0	0.2	318.2	0.7
20	Gibbs and Assoc.	-	0.1	0.2	14.2	0.7
21	Research Engineers	0.1	0.1	0.1	31.9	0.6
22	Open Mind	-	0.1	0.1	19.5	0.6
23	Fujitsu	-	-	0.1	NA	0.5
24	Bentley Systems	0.5	0.4	0.1	-74.4	0.4
25	Algor Interactive Systems	0	0.1	0.1	57.8	0.4
26	SRAC	-	0.2	0.1	-50.9	0.4
27	IMSI	0.1	0.1	0.1	4.4	0.4
28	Dassault Systemes	-	0	0.1	161.5	0.4
29	Structural Dynamics Research Corporation	0.3	0.1	0.1	-36.6	0.4
30	MacNeal-Schwendler	0	0.2	0.1	-60.9	0.4
	All North American Companies	**27.5**	**26.4**	**19.2**	**-27.1**	**79.6**
	All European Companies	**6.2**	**4.2**	**4.2**	**0.2**	**17.3**
	All Asian Companies	**1.2**	**1.5**	**0.8**	**-50.4**	**3.1**
	All Companies	**34.9**	**32.1**	**24.2**	**-24.7**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-25
1997 Top 10 Mechanical Software Companies, Asia/Pacific, Host/Proprietary (Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	IBM	6.9	5.9	2.5	-57.3	92.2
2	Dassault Systemes	3.9	2.1	1.7	-20.3	61.4
3	MacNeal-Schwendler	0.5	1.4	0.3	-78.1	11.2
4	Matra Datavision	-	-	0.2	NA	6.3
5	Ansys	0.1	0.1	0	-74.7	0.5
6	Sherpa Corp.	-	0	0	12.4	0.5
7	Mechanical Dynamics	0.1	0.1	0	-87.7	0.5
8	Altair Computing	-	0	0	0.7	0.4
9	Fujitsu	-	-	0	NA	0.4
10	ESI Group	0	0	0	-76.8	0
	All North American Companies	**6.4**	**6.6**	**2.5**	**-61.3**	**93.3**
	All European Companies	**0**	**0**	**0.2**	**2,776.8**	**6.3**
	All Asian Companies	**-**	**-**	**0**	**NA**	**0.4**
	All Companies	**6.4**	**6.6**	**2.7**	**-58.6**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-26
1997 Top 30 Mechanical Software Companies, Rest of World, All Operating Systems (Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Engineering Mechanics	4.5	5.2	5.3	0.3	13.5
2	Autodesk	5.8	5.2	5.2	-1.3	13.2
3	MacNeal-Schwendler	-	1.1	4.2	291.3	10.6
4	CoCreate	-	3.4	3.8	10.7	9.6
5	Delcam plc	2.2	2.2	3.1	40.0	7.9
6	Cimatron	2.7	3.1	2.6	-16.7	6.6
7	Intergraph	1.1	1.7	2.3	31.3	5.8
8	IBM	5.0	2.1	2.0	-6.0	5.0
9	Computervision	3.0	3.5	1.7	-52.3	4.3
10	MicroCADAM	1.3	1.5	1.5	-0.7	3.8
11	NOVASOFT Systems	1.0	1.1	1.3	19.7	3.4
12	Matra Datavision	0.9	0.9	0.9	-1.2	2.3
13	Formtek	0.8	0.8	0.8	0.3	2.1
14	MCS	0.1	0.7	0.8	3.3	1.9
15	Ansys	0.7	0.5	0.7	35.5	1.8
16	Investronica SA	0.5	0.6	0.6	1.0	1.5
17	CNC Software	0.5	0.5	0.5	1.0	1.4
18	Whessoe Computing Systems	0.5	0.5	0.5	-0.2	1.2
19	Algor Interactive Systems	0.1	0.2	0.4	110.4	1.1
20	Baystate Technologies	0	0.2	0.3	84.9	0.7
21	Open Mind	-	0.2	0.3	19.5	0.7
22	DP Technology	0.1	0.2	0.2	5.5	0.5
23	Viagrafix	0.2	0.2	0.2	1.0	0.5
24	B.A. Intelligence Networks	0.1	0.2	0.2	6.0	0.4
25	Bentley Systems	0.1	0.1	0.2	17.9	0.4
26	Camcentre	-	-	0.2	NA	0.4
27	Tebis	0.1	0.1	0.1	0.6	0.4
28	Computational Mechanics	0.1	0.1	0.1	-1.9	0.4
29	Surfware	0.1	0.1	0.1	20.0	0.3
30	CGTech	0.1	0.1	0.1	22.0	0.3
	All North American Companies	**24.1**	**27.9**	**30.9**	**10.4**	**78.9**
	All European Companies	**7.7**	**7.6**	**8.2**	**8.5**	**21.1**
	All Asian Companies	**-**	**-**	**-**	**NA**	**-**
	All Companies	**31.8**	**35.5**	**39.1**	**10.0**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-27
1997 Top 29 Mechanical Software Companies, Rest of World, UNIX
(Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	MacNeal-Schwendler	-	0.8	3.7	376.7	19.9
2	Engineering Mechanics	3.0	3.6	3.6	-	19.2
3	Delcam plc	2.1	1.8	2.5	39.8	13.3
4	IBM	4.1	1.7	1.8	3.8	9.7
5	Computervision	2.8	3.3	1.6	-52.3	8.5
6	CoCreate	-	2.3	1.6	-30.2	8.5
7	Intergraph	1.0	1.2	1.1	-6.6	6.1
8	NOVASOFT Systems	0.5	0.6	0.7	14.9	3.5
9	Matra Datavision	0.8	0.8	0.7	-16.9	3.5
10	Formtek	0.5	0.6	0.6	-	3.1
11	Ansys	0.5	0.4	0.4	12.0	2.3
12	MicroCADAM	0.5	0.5	0.2	-50.7	1.2
13	MCS	0	0.1	0.2	35.3	0.8
14	Camcentre	-	-	0.1	NA	0.8
15	Cimatron	0.5	0.3	0.1	-63.0	0.6
16	Computational Mechanics	0.1	0.1	0.1	-	0.5
17	Algor Interactive Systems	0	0.1	0.1	5.2	0.5
18	CGTech	0.1	0.1	0.1	7.5	0.4
19	Whessoe Computing Systems	0	0.1	0.1	-	0.3
20	Open Mind	-	0	0.1	19.5	0.3
21	Tebis	0	0.1	0.1	-	0.3
22	First Cadcam Inc.	0	0	0	11.2	0.2
23	SRAC	0	0	0	-1.8	0.2
24	B.A. Intelligence Networks	0	0	0	1.1	0.1
25	ADRA Systems	0.1	0.1	0	-68.3	0.1
26	ESI Group	-	-	0	NA	0.1
27	DP Technology	0	0	0	-75.2	0
28	Bentley Systems	0	0	0	-29.2	0
29	Autodesk	0.3	0.2	-	-100.0	-
	All North American Companies	**12.8**	**14.8**	**15.1**	**2.0**	**81.0**
	All European Companies	**4.1**	**3.0**	**3.6**	**19.7**	**19.0**
	All Asian Companies	**-**	**-**	**-**	**NA**	**-**
	All Companies	**16.9**	**17.8**	**18.7**	**4.9**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-28
1997 Top 22 Mechanical Software Companies, Rest of World, Windows NT (Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Autodesk	-	0.9	2.6	199.2	32.9
2	CoCreate	-	0.3	1.5	406.1	18.9
3	Intergraph	0.1	0.5	0.8	60.7	10.3
4	Delcam plc	-	0.4	0.6	41.0	7.6
5	MCS	-	0.2	0.5	143.5	5.8
6	MicroCADAM	0.1	0.2	0.5	159.7	5.7
7	NOVASOFT Systems	0.1	0.1	0.3	127.8	3.6
8	Ansys	0.1	0.1	0.2	233.5	2.9
9	Matra Datavision	0.1	0.1	0.2	85.6	2.4
10	MacNeal-Schwendler	-	0	0.2	1,650.9	2.4
11	Open Mind	-	0.2	0.2	19.5	2.3
12	Algor Interactive Systems	-	-	0.2	NA	2.0
13	Bentley Systems	0.1	0.1	0.1	109.4	1.7
14	DP Technology	0	0.1	0.1	44.6	1.1
15	Vero International Software	-	0	0.1	301.4	0.9
16	B.A. Intelligence Networks	0	0	0	-6.7	0.5
17	CGTech	-	0	0	406.0	0.3
18	IBM	-	-	0	NA	0.2
19	SRAC	0	0	0	227.4	0.2
20	IMSI	-	0	0	48.0	0.2
21	Research Engineers	-	0	0	66.8	0.1
22	ADRA Systems	-	0	0	-79.2	0
	All North American Companies	**0.6**	**2.4**	**6.9**	**188.5**	**87.6**
	All European Companies	**0.1**	**0.6**	**1.0**	**53.1**	**12.4**
	All Asian Companies	**-**	**-**	**-**	**NA**	**-**
	All Companies	**0.7**	**3.0**	**7.8**	**159.9**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-29
1997 Top 30 Mechanical Software Companies, Rest of World, Personal Computer (Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	Autodesk	5.4	4.2	2.6	-38.7	21.1
2	Cimatron	2.2	2.8	2.5	-12.2	20.3
3	Engineering Mechanics	1.5	1.6	1.7	1.0	13.6
4	MicroCADAM	0.7	0.9	0.8	-6.4	6.8
5	CoCreate	-	0.8	0.7	-16.3	5.7
6	Investronica SA	0.5	0.6	0.6	1.0	4.7
7	CNC Software	0.5	0.5	0.5	1.0	4.4
8	NOVASOFT Systems	0.4	0.4	0.4	-6.4	3.1
9	Whessoe Computing Systems	0.3	0.4	0.4	1.0	3.1
10	Intergraph	-	-	0.3	NA	2.6
11	Baystate Technologies	0	0.2	0.3	84.9	2.4
12	Formtek	0.2	0.2	0.2	1.0	2.0
13	Algor Interactive Systems	0	0.1	0.2	57.8	1.6
14	Viagrafix	0.2	0.2	0.2	1.0	1.5
15	MCS	0.1	0.4	0.2	-65.1	1.2
16	Surfware	0.1	0.1	0.1	20.0	1.1
17	B.A. Intelligence Networks	0.1	0.1	0.1	13.9	0.8
18	Tebis	0.1	0.1	0.1	1.0	0.7
19	DP Technology	0.1	0.1	0.1	5.5	0.7
20	Computervision	0.1	0.2	0.1	-52.3	0.6
21	SRAC	0.1	0.1	0.1	-1.8	0.5
22	MacNeal-Schwendler	-	0	0.1	48.8	0.5
23	IMSI	0	0	0	4.4	0.4
24	Matra Datavision	0	0	0	78.1	0.4
25	Ziegler Informatics	0	0	0	-3.8	0.4
26	Superdraft	0	0	0	1.0	0.4
27	Open Mind	-	0	0	19.5	0.3
28	Diehl Graphsoft	0	0	0	23.2	0.3
29	Ansys	0.1	0	0	-24.7	0.3
30	Engineered Software	-	0	0	1.0	0.3
	All North American Companies	**10.0**	**10.2**	**8.6**	**-16.1**	**70.1**
	All European Companies	**3.4**	**3.9**	**3.6**	**-7.3**	**29.9**
	All Asian Companies	**-**	**-**	**-**	**NA**	**-**
	All Companies	**13.4**	**14.1**	**12.2**	**-13.7**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-30
1997 Top Seven Mechanical Software Companies, Rest of World, Host/Proprietary
(Revenue in Millions of U.S. Dollars)

Rank	Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
1	MacNeal-Schwendler	-	0.2	0.2	-16.7	50.6
2	IBM	0.9	0.3	0.1	-61.5	34.1
3	Whessoe Computing Systems	0.1	0	0	-10.0	11.3
4	Computational Mechanics	0	0	0	-10.0	6.8
5	Matra Datavision	-	-	0	NA	4.5
6	Ansys	0	0	0	-54.8	1.8
7	ESI Group	-	-	0	NA	0.1
	All North American Companies	**0.8**	**0.5**	**0.3**	**-41.4**	**82.1**
	All European Companies	**0.1**	**0.1**	**0.1**	**20.8**	**17.9**
	All Asian Companies	**-**	**-**	**-**	**NA**	**-**
	All Companies	**0.9**	**0.6**	**0.4**	**-35.4**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-31
All Mechanical Software Companies, Worldwide, All Operating Systems
(Revenue in Millions of U.S. Dollars)

Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
3D/Eye Inc.	-	3.5	4.8	37.3	0.1
Access Corp.	0.6	0.5	-	-100.0	-
Adam Net	7.5	8.5	9.2	8.5	0.3
Adina R&D	9.0	10.3	11.1	7.0	0.3
ADRA Systems	19.0	21.7	14.5	-33.4	0.4
Agile Software	1.4	1.8	6.3	260.0	0.2
Algor Interactive Systems	10.0	10.5	11.0	5.2	0.3
Alias Research	17.3	17.3	18.6	7.9	0.5
Altair Computing	8.0	12.0	13.0	8.6	0.4
Andor*	15.9	17.8	19.2	8.0	0.5
Anilam Electronics	3.8	4.1	4.1	1.8	0.1
Ansys	32.6	37.0	35.1	-5.2	1.0
Applicon	21.5	21.8	19.7	-9.7	0.6
Argo Graphics*	3.8	4.3	4.7	8.2	0.1
ASCAD	14.9	16.5	19.7	19.2	0.6
Ashlar	5.7	5.9	5.9	-0.4	0.2
Auto-Trol	4.1	4.2	4.0	-4.5	0.1
Autodesk	192.9	174.2	206.4	18.5	5.9
B.A. Intelligence Networks	2.7	3.3	3.9	18.5	0.1
Baystate Technologies	1.3	4.1	7.2	76.0	0.2
BCT GmbH	4.2	7.2	8.1	12.8	0.2
Bentley Systems	13.4	13.1	15.5	17.9	0.4
Boothroyd Dewhurst	1.6	1.6	1.6	4.7	0
C. Itoh Techno-Science*	30.8	30.8	32.5	5.5	0.9
CAD Distribution	5.8	5.1	4.9	-2.7	0.1
CAD Lab	13.6	11.0	13.0	18.2	0.4
CADdy Spain	1.4	1.4	1.7	17.2	0
Cadis Software	1.2	3.3	3.8	15.0	0.1
CADIX	4.7	7.3	5.3	-27.6	0.2
CADSI	3.1	3.2	3.8	18.8	0.1
Camcentre	-	-	1.9	NA	0.1
Catalpa groupe Missler	1.5	1.3	1.5	17.0	0
Century Research Center	1.1	1.1	1.1	1.0	0
CGTech	10.0	10.4	11.9	14.2	0.3
Cimatron	10.7	14.2	16.4	16.0	0.5
CIMLINC	5.8	5.9	6.4	8.4	0.2
CIMTEK	1.2	1.6	1.8	13.9	0.1
CMstat	0.7	1.9	2.1	9.0	0.1
CNC Software	8.4	8.7	8.8	1.8	0.3

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Table 2-31 (Continued)
All Mechanical Software Companies, Worldwide, All Operating Systems
(Revenue in Millions of U.S. Dollars)

Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
CoCreate	107.3	113.4	125.5	10.7	3.6
Computational Mechanics	2.1	2.1	2.1	0.6	0.1
Computervision	149.0	174.4	61.7	-64.6	1.8
Concentra	12.7	19.6	6.4	-67.3	0.2
Concurrent Engineering	1.0	1.0	0.8	-22.0	0
Consensys	0.6	1.6	2.4	50.0	0.1
CSAR Corp.	3.4	5.2	6.1	17.1	0.2
Dassault Systemes	204.9	249.5	303.8	21.8	8.7
Database Applications	0.5	0.7	-	-100.0	-
debis Systemhaus	3.5	4.0	4.9	23.2	0.1
Delcam plc	16.7	22.0	30.8	40.0	0.9
Design Automation	11.6	13.3	14.2	7.5	0.4
Diehl Graphsoft	1.5	1.5	1.9	21.5	0.1
DP Technology	4.8	5.7	7.5	30.2	0.2
Drawbase Software	0.2	0.1	0.1	29.5	0
Eigner + Partner	6.3	7.0	8.7	23.9	0.2
Engineered Software	0.6	0.6	0.6	0.5	0
Engineering Mechanics	7.6	8.6	8.8	2.9	0.3
ESI Group	9.2	7.9	7.8	-1.5	0.2
Exapt	5.7	2.6	2.3	-12.6	0.1
FHECOR	0.6	0.6	0.6	2.7	0
First Cadcam Inc.	3.7	3.8	4.3	11.2	0.1
Formtek	18.9	20.6	21.7	5.1	0.6
Fujitsu	97.0	107.3	103.5	-3.6	2.9
Gerber Systems	13.1	14.9	16.2	8.8	0.5
Gibbs and Assoc.	2.2	3.6	4.7	30.6	0.1
Graphtec Engineering	8.6	8.6	10.8	25.4	0.3
Hakuto*	29.8	0.2	0.2	-4.5	0
Han Dataport	7.8	6.5	2.5	-62.0	0.1
Hitachi	70.9	63.7	68.1	6.8	1.9
Hitachi Zosen Info Systems	38.7	39.3	42.7	8.8	1.2
IBM	494.5	563.5	641.8	13.9	18.3
ICEM Technologies	17.6	20.3	19.8	-2.6	0.6
IMSI	1.0	1.4	1.5	11.0	0
Info. Services Int'l. Dentsu*	85.2	117.2	125.9	7.5	3.6
Intergraph	14.8	15.1	18.8	25.1	0.5
Investronica SA	11.1	10.6	10.3	-3.2	0.3
ISD Software	14.5	22.7	20.1	-11.4	0.6
ISKA	1.1	1.2	1.2	-1.5	0

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Table 2-31 (Continued)
All Mechanical Software Companies, Worldwide, All Operating Systems
(Revenue in Millions of U.S. Dollars)

Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
Just In Time Systems	2.5	2.4	2.2	-8.5	0.1
Kozo Keikaku Engineering	7.3	8.4	5.1	-39.6	0.1
Kubota Computer	8.9	9.8	10.5	6.4	0.3
Livermore Software Tech.	1.6	1.5	1.6	6.1	0
MacNeal-Schwendler	114.0	106.3	104.0	-2.2	3.0
MARC	18.2	19.5	21.8	11.7	0.6
Marubeni Hytech*	19.9	23.0	24.9	8.5	0.7
Matra Datavision	87.4	91.8	90.6	-1.2	2.6
MCS	13.6	14.7	17.2	17.4	0.5
Mechanical Dynamics	12.6	14.7	17.9	22.0	0.5
MicroCADAM	129.2	152.0	150.0	-1.3	4.3
Mitsubishi Electric*	6.3	6.7	6.9	3.4	0.2
Mitsui Engineering	14.0	16.1	17.5	8.5	0.5
Modultek Oy	-	-	2.9	NA	0.1
Mutoh Industries*	13.1	9.3	10.5	13.4	0.3
NEC	72.9	62.9	70.9	12.7	2.0
Nihon Itek*	5.5	6.4	6.9	8.5	0.2
Nihon Unisys	52.8	54.4	54.6	0.3	1.6
NOVASOFT Systems	4.8	3.9	4.7	18.8	0.1
Omron	7.8	7.7	11.9	54.0	0.3
Open Mind	-	4.7	5.6	19.5	0.2
Pacific Numerix	-	0.3	2.5	696.2	0.1
PAFEC	6.0	7.9	8.1	1.6	0.2
Parametric Technology	321.2	495.0	605.8	22.4	17.3
Pathtrace Engineering Systems	3.2	4.2	8.7	109.1	0.2
PROCAD GmbH & Co KG	5.8	6.5	6.8	5.3	0.2
Radan Computational	8.2	9.2	13.2	43.4	0.4
Research Engineers	0.6	0.8	1.1	34.0	0
Ricoh	4.8	3.9	3.9	-0.3	0.1
RoboCAD Solutions	1.9	1.6	1.6	-4.0	0
Seiko*	19.7	19.0	21.1	11.0	0.6
Serbi	5.9	5.6	5.0	-10.8	0.1
Sescoi	8.0	10.0	9.8	-2.0	0.3
Sharp*	10.4	9.4	8.4	-10.1	0.2
Sherpa Corp.	20.6	26.2	27.5	5.0	0.8
Softronics	2.0	1.0	1.0	2.7	0
Spatial Technology	6.4	7.2	7.3	2.2	0.2
SRAC	4.8	5.6	5.5	-1.6	0.2

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Table 2-31 (Continued)
All Mechanical Software Companies, Worldwide, All Operating Systems
(Revenue in Millions of U.S. Dollars)

Company Name	1995	1996	1997	Growth (%) 1996-1997	Market Share (%) 1997
Structural Dynamics Research Corporation	124.7	153.1	172.1	12.4	4.9
Sumisho Electronics*	18.8	21.6	23.4	8.4	0.7
Superdraft	1.4	1.3	1.2	-2.5	0
Surfware	5.0	5.4	6.5	20.0	0.2
Tebis	12.6	14.2	13.3	-6.3	0.4
Technodia*	3.9	4.5	4.8	8.3	0.1
Tecnomatix Technology	20.1	26.3	34.2	30.0	1.0
Tokyo Electron*	17.4	20.0	21.8	8.5	0.6
Toshiba Engineering*	11.8	4.2	9.0	112.7	0.3
Toshiba*	66.7	62.5	65.0	3.9	1.9
Toyo Information Systems*	8.1	9.0	9.5	6.0	0.3
Uchida Yoko	1.4	2.2	2.6	16.4	0.1
Unigraphics Solutions	89.1	209.5	115.5	-44.9	3.3
Variation Systems Analysis	2.6	2.8	3.0	5.8	0.1
Vero International Software	2.1	4.5	5.1	14.1	0.1
Viagrafix	5.6	5.4	5.6	2.6	0.2
Wacom	6.0	8.4	13.5	60.1	0.4
Whessoe Computing Systems	5.4	5.5	5.5	-0.2	0.2
Wiechers Datentechnik	5.0	4.8	4.8	1.2	0.1
Workgroup Tech.	6.3	7.8	3.7	-52.3	0.1
Yokogawa Digital Computer	0.2	0.2	0.2	-7.4	0
Ziegler Informatics	3.3	4.6	4.4	-3.8	0.1
All North American Companies	**2,049.9**	**2,504.8**	**2,573.6**	**2.7**	**73.3**
All European Companies	**339.5**	**345.6**	**390.9**	**13.1**	**11.1**
All Asian Companies	**481.5**	**475.4**	**545.7**	**14.8**	**15.5**
All Companies	**2,870.9**	**3,325.7**	**3,510.3**	**5.5**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-32
1997 Top 30 Mechanical Software Companies, Worldwide, All Operating Systems (Revenue in Millions of U.S. Dollars, Shipments in Actual Units)

Rank	Company Name	CPU Shipments	Software ($M)	CPU ($M)	Service ($M)	Total Distribution ($M)	Market Share (%) 1997
1	IBM	85,039	641.8	906.1	377.4	2,061.8	19.3
2	Hewlett-Packard	71,320	-	1,066.0	173.0	1,238.9	11.6
3	Sun Microsystems	47,809	-	971.3	266.0	1,237.3	11.6
4	Parametric Technology	-	605.8	-	242.5	848.3	7.9
5	Digital Equipment	80,291	-	572.2	80.5	652.7	6.1
6	Silicon Graphics	24,038	-	507.9	56.4	564.3	5.3
7	Fujitsu	14,146	103.5	152.8	143.8	400.0	3.7
8	Structural Dynamics Research Corporation	-	172.1	-	182.0	354.1	3.3
9	Dassault Systemes	-	303.8	-	44.9	352.1	3.3
10	Unigraphics Solutions	5,158	115.5	61.3	137.8	314.6	2.9
11	NEC	18,241	70.9	127.4	32.9	285.0	2.7
12	Autodesk	-	206.4	-	3.3	209.7	2.0
13	CoCreate	-	125.5	-	55.9	181.4	1.7
14	Nihon Unisys	1,477	54.6	64.9	26.3	175.3	1.6
15	Computervision	-	61.7	-	93.9	155.6	1.5
16	MicroCADAM	-	150.0	-	5.0	155.0	1.5
17	Intergraph	4,505	18.8	61.2	49.1	151.1	1.4
18	Info. Services Int'l. Dentsu*	3,663	125.9	22.9	-	148.9	1.4
19	Argo Graphics*	1,847	4.7	72.0	-	147.7	1.4
20	Toshiba*	-	65.0	80.7	-	145.7	1.4
21	Sumisho Electronics*	1,416	23.4	43.2	-	138.4	1.3
22	Hitachi	59,956	68.1	50.1	4.7	137.5	1.3
23	MacNeal-Schwendler	-	104.0	-	30.3	134.3	1.3
24	Mitsubishi Electric*	1,156	6.9	44.3	-	116.4	1.1
25	Hitachi Zosen Info Systems	7,931	42.7	37.8	14.2	103.6	1.0
26	Matra Datavision	1,380	90.6	20.3	17.3	91.3	0.9
27	Technodia*	335	4.8	25.3	13.6	79.8	0.7
28	Mitsui Engineering	216	17.5	8.9	27.3	62.5	0.6
29	C. Itoh Techno-Science*	823	32.5	15.6	5.3	56.4	0.5
30	Tecnomatix Technology	323	34.2	6.6	15.3	56.1	0.5
	Other Companies	40,042	-	95.4	-	95.4	0.9
	All North American Companies	**263,916**	**2,573.6**	**3,371.3**	**1,913.7**	**8,026.0**	**75.2**
	All European Companies	**10,783**	**390.9**	**104.6**	**168.3**	**656.3**	**6.1**
	All Asian Companies	**117,814**	**545.7**	**874.2**	**319.9**	**1,901.3**	**17.8**
	All Companies	**432,555**	**3,510.3**	**4,445.4**	**2,401.9**	**10,679.0**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue and shipments, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-33
1997 Top 30 Mechanical Software Companies, Worldwide, UNIX (Revenue in Millions of U.S. Dollars, Shipments in Actual Units)

Rank	Company Name	CPU Shipments	Software ($M)	CPU ($M)	Service ($M)	Total Distribution ($M)	Market Share (%) 1997
1	IBM	29,547	613.5	654.6	339.6	1,717.0	23.5
2	Sun Microsystems	47,809	-	971.3	266.0	1,237.3	17.0
3	Hewlett-Packard	30,775	-	834.7	147.3	982.0	13.5
4	Parametric Technology	-	454.3	-	181.9	636.2	8.7
5	Silicon Graphics	24,038	-	507.9	56.4	564.3	7.7
6	Dassault Systemes	-	261.4	-	42.2	306.9	4.2
7	Structural Dynamics Research Corporation	-	119.5	-	126.4	245.9	3.4
8	Unigraphics Solutions	5,158	80.8	42.9	96.5	220.2	3.0
9	Digital Equipment	10,274	-	168.4	27.4	195.8	2.7
10	Nihon Unisys	1,475	53.6	64.5	18.3	159.4	2.2
11	Computervision	-	59.0	-	89.8	148.8	2.0
12	NEC	3,765	40.9	53.3	18.1	148.7	2.0
13	Info. Services Int'l. Dentsu*	2,622	119.6	21.8	-	141.4	1.9
14	MacNeal-Schwendler	-	93.1	-	27.8	120.9	1.7
15	Sumisho Electronics*	223	17.8	33.4	-	108.7	1.5
16	Mitsubishi Electric*	578	4.3	40.1	-	103.2	1.4
17	Hitachi Zosen Info Systems	7,931	38.5	34.0	12.8	93.2	1.3
18	Intergraph	1,372	9.5	31.6	30.7	87.6	1.2
19	Fujitsu	1,057	19.7	35.1	27.7	82.5	1.1
20	CoCreate	-	53.1	-	28.6	81.6	1.1
21	Technodia*	335	4.8	25.3	13.6	79.8	1.1
22	Argo Graphics*	340	2.2	35.5	-	74.1	1.0
23	Matra Datavision	1,138	65.8	15.1	13.3	65.8	0.9
24	Toshiba*	-	29.2	36.3	-	65.6	0.9
25	Mitsui Engineering	158	16.9	8.1	27.0	59.9	0.8
26	Tecnomatix Technology	323	34.2	6.6	15.3	56.1	0.8
27	C. Itoh Techno-Science*	764	30.8	14.5	4.8	52.9	0.7
28	Tokyo Electron*	179	21.8	9.9	10.2	43.9	0.6
29	ASCAD	866	13.9	21.2	3.9	43.3	0.6
30	Gerber Systems	502	16.2	13.2	8.8	40.2	0.6
	All North American Companies	**111,848**	**1,707.5**	**2,491.2**	**1,538.2**	**5,871.5**	**80.5**
	All European Companies	**3,632**	**201.3**	**63.2**	**121.8**	**366.7**	**5.0**
	All Asian Companies	**31,079**	**277.2**	**499.4**	**160.9**	**1,055.9**	**14.5**
	All Companies	**146,558**	**2,186.0**	**3,053.9**	**1,820.9**	**7,294.1**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue and shipments, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-34
1997 Top 30 Mechanical Software Companies, Worldwide, Windows NT (Revenue in Millions of U.S. Dollars, Shipments in Actual Units)

Rank	Company Name	CPU Shipments	Software ($M)	CPU ($M)	Service ($M)	Total Distribution ($M)	Market Share (%) 1997
1	Digital Equipment	23,761	-	251.4	42.4	293.7	16.0
2	Fujitsu	8,249	55.9	82.5	77.7	216.0	11.7
3	Parametric Technology	-	151.4	-	60.6	212.1	11.5
4	Hewlett-Packard	20,338	-	189.6	21.1	210.6	11.4
5	Structural Dynamics Research Corporation	-	51.2	-	54.2	105.4	5.7
6	Autodesk	-	103.2	-	1.7	104.9	5.7
7	Unigraphics Solutions	-	34.6	18.4	41.3	94.4	5.1
8	CoCreate	-	49.3	-	23.2	72.6	3.9
9	IBM	14,040	1.0	70.2	-	71.2	3.9
10	MicroCADAM	-	45.0	-	1.5	46.5	2.5
11	Intergraph	1,215	6.7	17.6	12.1	42.3	2.3
12	ISD Software	490	14.8	2.4	6.7	25.1	1.4
13	Dassault Systemes	-	24.3	-	-	24.3	1.3
14	NEC	1,638	7.6	9.2	2.1	20.8	1.1
15	Matra Datavision	148	18.7	3.3	2.8	18.7	1.0
16	Radan Computational	362	8.7	5.7	3.4	18.2	1.0
17	Graphtec Engineering	153	8.7	6.8	0.8	17.8	1.0
18	Omron	342	10.0	5.7	-	17.3	0.9
19	Ansys	-	11.2	-	5.0	16.2	0.9
20	Bentley Systems	-	13.5	-	1.6	15.1	0.8
21	Toshiba*	-	6.5	8.1	-	14.6	0.8
22	Applicon	-	8.3	-	5.8	14.2	0.8
23	Toshiba Engineering*	284	5.4	5.1	3.7	14.2	0.8
24	Wacom	-	12.0	-	1.1	13.1	0.7
25	MCS	-	10.3	-	2.1	12.4	0.7
26	Hitachi	5,989	6.0	4.3	0.3	12.0	0.7
27	Hitachi Zosen Info Systems	-	4.3	3.8	1.4	10.4	0.6
28	Delcam plc	-	5.9	-	3.2	9.5	0.5
29	CAD Lab	-	5.2	1.4	1.6	8.8	0.5
30	Seiko*	-	5.9	2.0	2.1	8.3	0.5
	Other Companies	204	-	2.5	-	2.5	0.1
	All North American Companies	**59,354**	**525.4**	**548.6**	**284.7**	**1,365.4**	**74.2**
	All European Companies	**1,123**	**94.0**	**15.0**	**19.6**	**125.1**	**6.8**
	All Asian Companies	**16,896**	**117.4**	**131.0**	**92.1**	**348.0**	**18.9**
	All Companies	**77,577**	**736.8**	**697.1**	**396.4**	**1,841.0**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue and shipments, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-35
1997 Top 30 Mechanical Software Companies, Worldwide, Personal Computer (Revenue in Millions of U.S. Dollars, Shipments in Actual Units)

Rank	Company Name	CPU Shipments	Software ($M)	CPU ($M)	Service ($M)	Total Distribution ($M)	Market Share (%) 1997
1	IBM	41,242	-	129.4	-	129.4	9.7
2	Digital Equipment	43,788	-	113.4	4.1	117.5	8.8
3	NEC	12,838	22.4	64.9	12.7	115.5	8.6
4	Autodesk	-	103.2	-	1.7	104.9	7.8
5	Fujitsu	4,840	25.9	35.1	35.7	96.7	7.2
6	Hitachi	45,715	48.1	34.6	2.7	96.1	7.2
7	MicroCADAM	-	82.5	-	2.8	85.3	6.4
8	Argo Graphics*	1,507	2.4	36.5	-	73.5	5.5
9	Toshiba*	-	29.2	36.3	-	65.6	4.9
10	Hewlett-Packard	20,208	-	41.7	4.6	46.3	3.5
11	Investronica SA	4,183	10.3	12.5	9.0	45.4	3.4
12	Andor*	545	19.2	5.8	-	30.1	2.2
13	Sumisho Electronics*	1,193	5.6	9.8	-	29.7	2.2
14	CoCreate	-	23.1	-	4.1	27.2	2.0
15	Intergraph	1,918	2.6	12.0	6.3	21.2	1.6
16	Tebis	180	8.0	2.5	5.2	17.4	1.3
17	Design Automation	424	14.2	2.6	0.3	17.2	1.3
18	Cimatron	-	15.8	-	-	15.8	1.2
19	Pathtrace Engineering Systems	52	8.7	0.3	2.9	11.9	0.9
20	Mutoh Industries*	378	3.9	3.9	0.3	9.8	0.7
21	Mitsubishi Electric*	569	2.0	3.1	-	9.4	0.7
22	CNC Software	-	8.8	-	-	8.8	0.7
23	Formtek	120	6.2	0	1.8	8.0	0.6
24	Nihon Unisys	-	0.6	0.2	4.0	8.0	0.6
25	Wiechers Datentechnik	74	4.8	1.4	1.3	7.5	0.6
26	Info. Services Int'l. Dentsu*	1,041	6.3	1.1	-	7.4	0.6
27	Surfware	-	6.5	-	1.0	7.4	0.6
28	Baystate Technologies	-	7.2	-	-	7.2	0.5
29	Computervision	-	2.7	-	4.1	6.8	0.5
30	Serbi	530	5.0	1.6	-	6.6	0.5
	Other Companies	39,839	-	92.9	-	92.9	6.9
	All North American Companies	**91,318**	**311.2**	**259.2**	**45.3**	**614.7**	**45.9**
	All European Companies	**5,957**	**92.4**	**24.9**	**23.0**	**154.7**	**11.6**
	All Asian Companies	**69,472**	**146.2**	**238.4**	**58.8**	**477.1**	**35.6**
	All Companies	**206,585**	**549.8**	**615.4**	**127.1**	**1,339.4**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue and shipments, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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Table 2-36
1997 Top 23 Mechanical Software Companies, Worldwide, Host/Proprietary (Revenue in Millions of U.S. Dollars, Shipments in Actual Units)

Rank	Company Name	CPU Shipments	Software ($M)	CPU ($M)	Service ($M)	Total Distribution ($M)	Market Share (%) 1997
1	IBM	211	27.3	51.9	37.8	144.3	70.6
2	Digital Equipment	2,468	-	39.1	6.6	45.7	22.3
3	Dassault Systemes	-	15.5	-	2.7	18.2	8.9
4	Nihon Unisys	2	0.4	0.2	4.0	8.0	3.9
5	MacNeal-Schwendler	-	4.8	-	0.5	5.4	2.6
6	Fujitsu	-	2.1	-	2.7	4.7	2.3
7	Hitachi	286	1.6	1.9	0.5	4.1	2.0
8	Mitsubishi Electric*	9	0.6	1.1	-	3.8	1.9
9	Exapt	41	0.9	0.9	0.6	3.7	1.8
10	C. Itoh Techno-Science*	59	1.7	1.1	0.5	3.6	1.8
11	Matra Datavision	31	1.7	0.4	0.3	2.4	1.2
12	Toyo Information Systems*	9	0.4	0.7	0.2	1.6	0.8
13	Century Research Center	1	0.1	0.1	0.1	0.6	0.3
14	Kubota Computer	-	0.3	-	0.2	0.6	0.3
15	Ansys	-	0.4	-	0.2	0.5	0.2
16	Sherpa Corp.	-	0.3	-	-	0.4	0.2
17	Altair Computing	-	0.1	-	0.2	0.4	0.2
18	debis Systemhaus	-	0	0.1	0.2	0.3	0.2
19	Whessoe Computing Systems	-	0.3	-	-	0.3	0.2
20	Mechanical Dynamics	-	0.2	-	0.1	0.3	0.1
21	Computational Mechanics	-	0.2	-	-	0.2	0.1
22	ESI Group	0	0.1	0	0.1	0.2	0.1
23	Technodia*	-	0	-	-	0	0
	All North American Companies	**1,396**	**29.5**	**72.3**	**45.4**	**174.5**	**85.3**
	All European Companies	**71**	**3.2**	**1.5**	**3.9**	**9.8**	**4.8**
	All Asian Companies	**366**	**5.0**	**5.3**	**8.1**	**20.2**	**9.9**
	All Companies	**1,834**	**37.7**	**79.0**	**57.5**	**204.5**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
Vendor data includes OEM revenue and shipments, so sum of vendors is greater than total.
*Vendor software revenue contains at least 90 percent VAR/distributor revenue not counted in total.
Source: Dataquest (July 1998)

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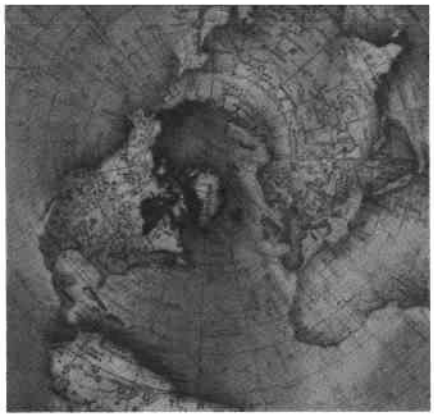
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1998 Mechanical CAD/CAM/CAE Preliminary Forecast

Market Statistics

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Product Code: CMEC-WW-MS-9802
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1998 Mechanical CAD/CAM/CAE Preliminary Forecast



Market Statistics

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Table of Contents

Page

1998 Mechanical CAD/CAM/CAE Forecast Update 1
Introduction 1
Worldwide Forecast Assumptions 1
All Applications 1
Mechanical Forecast Assumptions 4
AEC Forecast Assumptions 5
GIS/Mapping Forecast Assumptions 6
Electronic Design Automation Forecast Assumptions 7
History and Forecast for All Applications and Operating Systems 8
Forecast Methodology 9
Changes to the Forecast Database 10
Segmentation Definitions 11
Operating Systems 11
Line Items 11
Regions 12
Preliminary Market Forecast Tables 13

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List of Figures

Figure		Page
1	Mechanical CAD/CAM/CAE, AEC and GIS, and EDA Forecasting Model	10

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List of Tables

Table		Page
1	CAD/CAM/CAE and GIS Revenue Growth Comparison	2
2	Foreign Currency/U.S. Dollar	3
3	CAD/CAM/CAE/GIS Software Revenue History and Forecast	8
4	CAD/CAM/CAE/GIS Software Revenue Growth Rate History and Forecast	9
5	Top Level Mechanical Software Forecast, Worldwide, All Operating Systems	14
6	Detail Mechanical Software Forecast, Worldwide, All Operating Systems	15
7	Detail Mechanical Software Forecast, Worldwide, UNIX	16
8	Detail Mechanical Software Forecast, Worldwide, NT	17
9	Detail Mechanical Software Forecast, Worldwide, Personal Computer	18
10	Detail Mechanical Software Forecast, Worldwide, Host/Proprietary	19
11	Detail Mechanical Software Forecast, North America, All Operating Systems	20
12	Detail Mechanical Software Forecast, Europe, All Operating Systems	21
13	Detail Mechanical Software Forecast, Japan, All Operating Systems	22
14	Detail Mechanical Software Forecast, Asia/Pacific, All Operating Systems	23
15	Detail Mechanical Software Forecast, Rest of World, All Operating Systems	24

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1998 Mechanical CAD/CAM/CAE Forecast Update

Introduction

Dataquest's mechanical CAD/CAM/CAE, AEC and GIS, and EDA forecasts are based on market share software revenue gathered primarily during the first quarter of 1998. Dataquest's software forecast for all applications includes the following:

- 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 March 1998 exchange rate will remain stable in the future (see Tables 1 and 2).

Dataquest's 1997 market share documents for these three markets (CAEC-WW-MS-9801, CEDA-WW-MS-9801, and CMEC-WW-MS-9801) were published and sent to our clients in April.

The market share data for 1997 is being verified and updated, and it will be available in a July 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 mechanical CAD/CAM/CAE, AEC and GIS, and EDA worldwide software forecasts.

All Applications

As the mechanical CAD/CAM/CAE, AEC and GIS, and EDA markets become more replacement-oriented, market leaders 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.

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

	1996	1997	Forecast 2002	Growth (%) 1996-1997	CAGR (%) 1997-2002
Europe (U.S.$ Million)					
Software Revenue	2,180.75	2,362.94	3,872.28	8.4	10.4
Hardware Revenue	2,764.52	2,861.61	3,232.61	3.5	2.5
Service Revenue	1,372.43	1,540.69	2,095.02	12.3	6.3
Total Factory Revenue	6,317.70	6,765.23	9,199.91	7.1	6.3
Euro/U.S.$ Exchange Rate*	0.80	0.89	0.92	11.6	0.7
Europe (Euro Million)					
Software Revenue	1,739.31	2,103.01	3,562.49	20.9	11.1
Hardware Revenue	2,204.91	2,546.83	2,974.00	15.5	3.1
Service Revenue	1,094.61	1,371.21	1,927.42	25.3	7.0
Total Factory Revenue	5,038.84	6,021.05	8,463.92	19.5	7.0
Japan (U.S.$ Million)					
Software Revenue	1,745.84	1,892.92	3,203.78	8.4	11.1
Hardware Revenue	2,739.72	2,762.65	3,595.34	0.8	5.4
Service Revenue	1,319.53	1,386.72	2,411.11	5.1	11.7
Total Factory Revenue	5,805.09	6,042.30	9,210.23	4.1	8.8
Japan/U.S.$ Exchange Rate*	108.81	121.10	126.16	11.3	0.8
Japan (Yen Million)					
Software Revenue	189,965.00	229,233.21	404,189.17	20.7	12.0
Hardware Revenue	298,108.84	334,557.03	453,588.01	12.2	6.3
Service Revenue	143,578.39	167,932.18	304,185.14	17.0	12.6
Total Factory Revenue	631,652.23	731,722.43	1,161,962.33	15.8	9.7
North America (U.S.$ Million)					
Software Revenue	2,481.55	2,823.60	5,178.81	13.8	12.9
Hardware Revenue	2,925.91	3,278.24	4,789.38	12.0	7.9
Service Revenue	1,715.51	1,959.44	3,369.52	14.2	11.5
Total Factory Revenue	7,122.98	8,061.29	13,337.70	13.2	10.6
Worldwide (U.S.$ Million)					
Software Revenue	6,993.63	7,754.46	13,399.64	10.9	11.6
Hardware Revenue	9,187.11	9,730.81	12,741.57	5.9	5.5
Service Revenue	4,794.74	5,331.02	8,567.75	11.2	10.0
Total Factory Revenue	20,975.48	22,816.29	34,708.93	8.8	8.8

*Assuming a stable currency, the 2002 exchange rate is March 1998 exchange rate.
Source: Dataquest (May 1998)

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Table 2
Foreign Currency/U.S. Dollar

		Actual				Current			Year-to-Year Change (%)					
Country	Currency	1993	1994	1995	1996	1997	1998	1999	1993-1994	1994-1995	1995-1996	1996-1997	1997-1998	1998-1999
Austria	Schilling	11.65	11.40	10.06	10.59	12.20	12.74	12.74	-2.15	-11.8	5.3	15.2	4.4	0
Belgium	Franc	34.67	33.66	29.42	30.96	35.79	37.43	37.42	-2.91	-12.6	5.2	15.6	4.6	0
Denmark	Krone	6.49	6.35	5.59	5.81	6.61	6.91	6.91	-2.16	-12.0	3.9	13.8	4.5	0
Finland	Markka	5.73	5.21	4.37	4.59	5.19	5.50	5.50	-9.08	-16.1	5.0	13.1	6.0	0
France	Franc	5.67	5.54	4.97	5.12	5.84	6.08	6.07	-2.29	-10.3	3.0	14.1	4.1	-0.2
Germany	D-Mark	1.66	1.62	1.43	1.50	1.73	1.81	1.81	-2.41	-11.7	4.9	15.3	4.6	0
Italy	Lira	1,577.85	1,609.34	1,628.21	1,542.72	1,703.02	1,788.25	1,788.28	2.00	1.2	-5.3	10.4	5.0	0
Netherlands	Guilder	1.86	1.82	1.60	1.69	1.95	2.04	2.04	-2.15	-12.1	5.6	15.4	4.6	0
Norway	Krone	7.11	7.04	6.33	6.46	7.08	7.55	7.55	-0.98	-10.1	2.1	9.6	6.6	0
Spain	Peseta	127.87	133.48	124.40	126.68	146.45	153.64	153.61	4.39	-6.8	1.8	15.6	4.9	0
Sweden	Krona	7.82	7.70	7.14	6.71	7.64	8.07	8.07	-1.53	-7.3	-6.0	13.9	5.6	0
Switzerland	Franc	1.48	1.37	1.18	1.24	1.45	1.46	1.46	-7.43	-13.9	5.1	16.9	0.7	0
United Kingdom	Pound	0.67	0.65	0.63	0.64	0.61	0.61	0.61	-2.99	-3.1	1.6	-4.7	0	0
European Monetary Union	Euro	0.86	0.84	0.77	0.80	0.89	0.92	0.92	-1.52	-8.7	3.6	11.6	3.4	0
China	Renminbi	5.76	8.54	8.35	8.34	8.32	8.31	8.31	48.26	-2.2	-0.1	-0.2	-0.1	0
Hong Kong	Dollar	7.74	7.73	7.74	7.73	7.74	7.74	7.74	-0.13	0.1	-0.1	0.1	0	0
Japan	Yen	110.85	101.56	93.90	108.81	121.10	126.16	125.85	-8.38	-7.5	15.9	11.3	4.2	-0.2
Korea	Won	799.42	805.80	770.57	805.16	954.14	1,634.99	1,628.42	0.80	-4.4	4.5	18.5	71.4	-0.4
Singapore	Dollar	1.62	1.53	1.43	1.41	1.49	1.66	1.65	-5.32	-6.5	-1.4	5.7	11.4	-0.6
Taiwan	Dollar	26.15	26.45	26.48	27.47	28.79	33.05	32.95	1.15	0.1	3.7	4.8	14.8	-0.3

Source: Dataquest (May 1998)

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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 before manufacture. Meanwhile, increased computing power is allowing the nature of design to evolve to include constituencies in manufacturing, product support, and even users. 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 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, the won, 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 affect growth in the mechanical CAD/CAM/CAE market over the forecast period.

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 in years past. However, these companies have now completed their investment cycles in CAD technology for the next four or five years. Investment in CAD by these large companies will slow until the next investment cycle begins, bringing down the overall market growth.

Tier-Two Investments

Related to the above assumption, now that these companies have completed their investment cycles, Dataquest expects to see corresponding investment by their supplier bases as a significant driver of the market going forward.

New Software, New Platforms, and New Users

Even though it is still a UNIX-based world, there is a very strong interest in NT-based mechanical design solutions. 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 and are looking to upgrade from their 2-D-based systems. Based on what Dataquest has seen in 1997, we are shifting the peak of our NT-based mechanical CAD/CAM/CAE sales forecast to arrive earlier in our five-year forecast.

Continued Economic Turmoil in Asia/Pacific

The Asia/Pacific region will be a mixed bag of high and low growth over the forecast period, fueled by CAD investments from local and national governments and expansion by multinational companies, but also tempered by economic and political turmoil in southeast Asia. We have lowered our forecast for Asia/Pacific in light of the economic uncertainty in some of that region.

Meeting User Needs beyond Design

For the mechanical CAD/CAM/CAE market to show the high growth it has achieved 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. If they can come up with the "right" solution, Dataquest will be able to raise the forecast significantly.

AEC Forecast Assumptions

The following factors will affect 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.

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.

A More Tailored Focus

If vendors stay focused on not selling generic CAD solutions but rather on selling more tailored solutions to fit different needs in AEC (such as architectural and plant design needs), then Dataquest can begin to elevate the forecast. Over the years, AEC sales have largely been driven by vanilla sales of CAD products. Solutions that meet specific needs of users will help drive the market forward at a faster rate.

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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 affect growth in the worldwide GIS market.

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 leveraged continually 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 expand the user base broadly. Advances in aerial photography, global positioning systems, and satellite imagery 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.

Indispensability of GIS

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.

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 attempts to create compelling new applications and improved investment payoff for customers.

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Electronic Design Automation Forecast Assumptions

The preliminary numbers show that Dataquest missed the percentage growth by 6.5 percent—quite a bit compared to our historical hit rate. Upon investigation, we found that the problem somewhat mimics the issue we had in the early 1990s. The customer base has run out of tools to buy. Power users are waiting impatiently for the tools needed to fill out the new register transfer level (RTL) methodology, and the semiconductor companies are waiting, even less patiently, for the IC CAD tools needed to lay out 0.25-micron silicon. The good news is that the mainstream has become much more of a factor in today's EDA market. This will cause the base EDA business to continue at about 10 percent a year rather than the 2 percent to 3 percent of the early 1990s.

It appears that there has been a shift in the battle between UNIX and NT. The war is all but over in the mainstream, with NT the declared winner. Up until last October Dataquest believed that NT would also win the 64-bit battle because of the introduction of four separate versions of 64-bit UNIX. Since then it has become apparent that the war is really between Sun and Microsoft, as the other UNIX players are rapidly losing position in the EDA market place. Two events have greatly enhanced Sun's chance of maintaining control in the power user market. First has been the continual slip in the delivery date for 64-bit NT, now expected sometime in 1999, and by then the battle could be over. The second event was Bill Gates' performance before Congress. It became evident that the operating system (OS) issue is much more of an emotional issue than an engineering issue. Engineers need an OS they can trust, and Microsoft is losing the "trust me" war.

Electronic CAE

CAE was where the industry saw the slowdown because of the lack of tools to fill the new RTL methodology. The RTL virtual prototype is now almost six months later than expected. Industry growth didn't slow down badly as there has been increased activity by mainstream users. Dataquest is now predicting the CAE market to grow at a 15.7 percent compound annual growth rate (CAGR) over the next five years. A possible upside could be Europe, as we have been conservative because of Europe's past lumpy performance in EDA.

IC Layout

The major hit was in IC CAD. The slowdown was in the United States and in Asia/Pacific. Japan came in 1.7 percent under Dataquest's forecast, and Europe exceeded our forecast by 1.1 percent. The miss came because of the financial situation in Korea and because we were unable to predict the "wall." We had thought that the wall was the point where folks will have to extract inductance along with resistance and capacitance, and this had been predicted to be at 0.18 micron. We even felt better about the forecast when the major semiconductor companies were able to solve their 0.18 micron problems without extracting inductance; that meant the wall wouldn't have come up until 0.13 micron.

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As it turns out, we were wrong: The wall was at 0.25 micron. Yes, the major semiconductor companies can do 0.25 micron. However, "major" nowadays means those companies with an advanced internal CAD group. So far, only 10 semiconductor companies are getting acceptable yields, and they are doing it with new methodologies partially populated with internal tools. The rest of the semiconductor world is in trouble, and until the EDA world can produce the IC CAD tools needed, the other companies will remain on the outside looking in. Because of that, Dataquest has lowered the five-year CAGR to 19.8 percent.

PCB Design

Dataquest missed the PCB design forecast by 7.3 percent, and again the miss was primarily in the United States and Asia/Pacific markets. The culprit this time was the delay in the 100-MHz bus introduction. We have lowered the CAGR to 6.3 percent, but that still is much better than historical growth. Actually, the PCB market is healthier than it has been in a long time.

History and Forecast for All Applications and Operating Systems

Tables 3 and 4 show the history and forecast of all applications.

Table 3
CAD/CAM/CAE/GIS Software Revenue History and Forecast (Millions of Dollars)

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Worldwide, All Operating Systems	**6,214**	**6,994**	**7,754**	**8,703**	**9,653**	**10,838**	**12,029**	**13,400**	**11.6**
Worldwide									
UNIX	4,213	4,700	4,723	4,970	5,201	5,598	6,000	6,511	6.6
Windows NT	336	709	1,391	2,089	2,758	3,487	4,211	5,004	29.2
Personal Computer	1,485	1,433	1,519	1,564	1,638	1,716	1,794	1,869	4.2
Host/Proprietary	181	153	121	79	57	37	24	16	-32.9
All Operating Systems									
North America	2,107	2,482	2,824	3,236	3,624	4,119	4,602	5,179	12.9
Europe	2,004	2,181	2,363	2,623	2,919	3,217	3,531	3,872	10.4
Japan	1,623	1,746	1,893	2,115	2,322	2,618	2,896	3,204	11.1
Asia/Pacific	371	462	534	574	616	693	791	911	11.3
Rest of World	109	124	141	156	172	190	211	234	10.7

Source: Dataquest (May 1998)

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Table 4
CAD/CAM/CAE/GIS Software Revenue Growth Rate History and Forecast (Percent)

	1996	1997	1998	1999	2000	2001	2002
Worldwide, All Operating Systems	**12.5**	**10.9**	**12.2**	**10.9**	**12.3**	**11.0**	**11.4**
Worldwide							
UNIX	11.6	0.5	5.2	4.6	7.6	7.2	8.5
Windows NT	110.8	96.3	50.2	32.0	26.5	20.7	18.8
Personal Computer	-3.5	6.0	3.0	4.7	4.8	4.6	4.1
Host/Proprietary	-15.7	-20.5	-34.5	-28.7	-35.2	-33.4	-32.6
All Operating Systems							
North America	17.8	13.8	14.6	12.0	13.7	11.7	12.5
Europe	8.8	8.4	11.0	11.3	10.2	9.8	9.7
Japan	7.6	8.4	11.7	9.8	12.8	10.6	10.6
Asia/Pacific	24.6	15.7	7.4	7.3	12.6	14.0	15.2
Rest of World	13.7	13.7	10.8	10.3	10.6	10.6	11.0

Source: Dataquest (May 1998)

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.

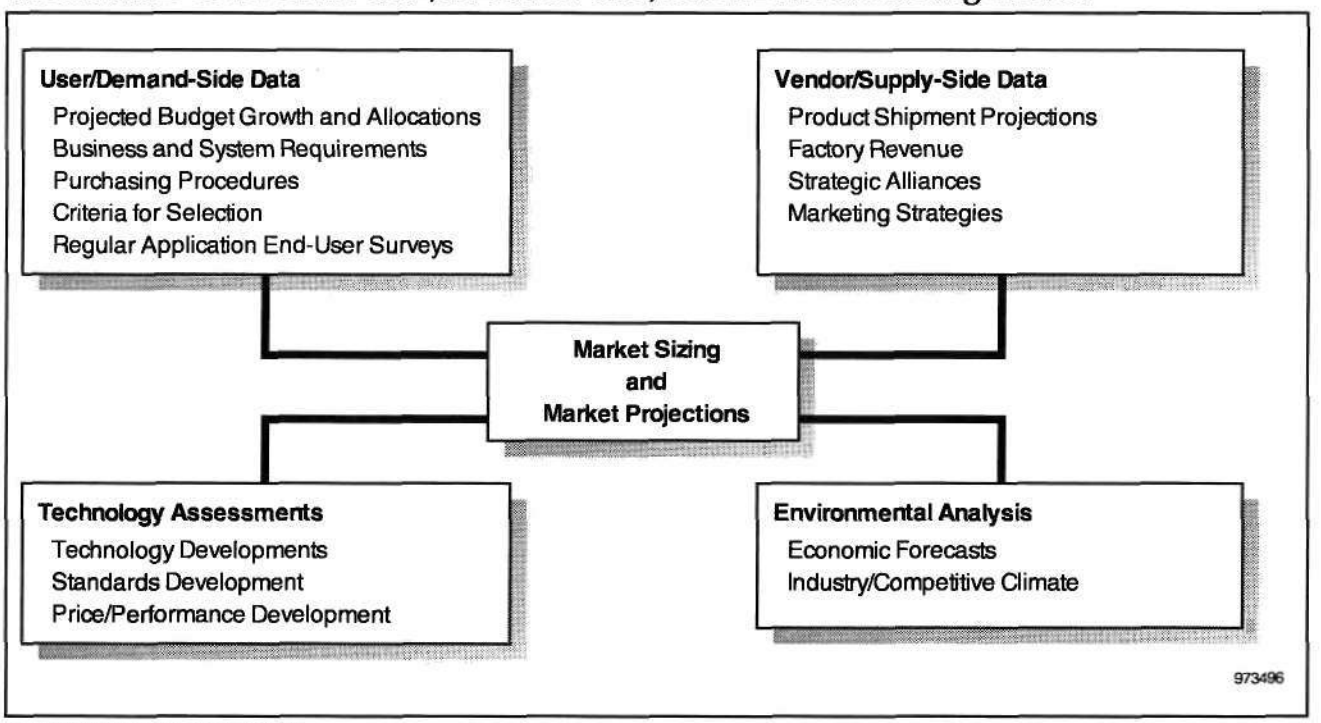
Dataquest also analyzes trends in the macroenvironment, which can have major influences on both supply-side and demand-side forecasting. In addition to demographics, analysts look at gross national product (GNP) growth, interest rate fluctuation, business expectations, and capital spending plans. In the geopolitical arena, the group looks at trade issues, political stability or lack thereof, tariffs, nontariff barriers, and such factors as the effect on Asia and Europe of the events of 1997.

Figure 1 shows the mechanical 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 mechanical 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.

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Figure 1
Mechanical CAD/CAM/CAE, AEC and GIS, and EDA Forecasting Model



Source: Dataquest (May 1998)

- 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.

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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.

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 mechanical 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.

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Regions

The following defines the different regions Dataquest tracks:

- North America:
  - United States: Single-country region
  - Canada: Single-country region
- Europe:
  - Western Europe: Includes Austria, Belgium, France, Germany (including former East Germany), Italy, Luxembourg, Netherlands, Scandinavia (Denmark, Finland, Norway, Sweden), Spain, Switzerland, and the United Kingdom
  - Rest of Western Europe: Includes Andorra, Cyprus, Faroe Islands, Gibraltar, Greenland, Guernsey, Iceland, Isle of Man, Jersey, Liechtenstein, Malta, Monaco, San Marino, and Svalbard
  - Central and Eastern Europe: Includes Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, the Czech Republic, Estonia, Georgia, Hungary, Kazakstan, Kyrgyzstan, Latvia, Lithuania, Macedonia, Moldova, Poland, Romania, Russia, Slovakia, Slovenia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan, and the republics of the former Yugoslavia (Serbia and Montenegro)
- Japan: Single-country region
- Asia/Pacific:
  - Asia/Pacific: Includes China, Hong Kong, South Korea, Singapore, and Taiwan
  - Rest of Asia: Includes Australia, American Samoa, Ashmore and Cartier Islands, Baker Island, Bangladesh, Bhutan, Bouvet Island, Brunei, Cambodia, Christmas Island, Cocos (Keeling) Islands, Cook Islands, Coral Sea Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Howland Island, India, Indonesia, Jarvis Island, Johnston Atoll, Kingman Reef, Kiribati, Laos, Macau, Malaysia, Maldives, Marshall Islands, Midway Islands, Mongolia, Myanmar (Burma), Nauru, Nepal, New Caledonia, New Zealand, Niue, Norfolk Island, Northern Mariana Islands, North Korea, Pakistan, Palau, Palmyra Atoll, Papua New Guinea, Paracel Islands, Philippines, Pitcairn Islands, Solomon Islands, Spratly Islands, Sri Lanka, Thailand, Tokelau, Tonga, Tuvalu, Vanuatu, Vietnam, Wake Island, Wallis and Futuna, and Western Samoa
- Rest of World:
  - Latin America: Includes Anguilla, Antigua and Barbuda, Argentina, Aruba, Bahamas, Barbados, Belize, Bermuda, Bolivia, Brazil, Cayman Islands, Chile, Clipperton Island, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Falkland Islands (Islas Malvinas), French Guiana, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Mexico, Montserrat, Navassa Island, Netherlands Antilles, Nicaragua,

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Panama, Paraguay, Peru, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Tortola (British Virgin Islands), Trinidad and Tobago, Turks and Caicos Islands, Uruguay, Venezuela, and Virgin Islands (St. John, St. Croix, and St. Thomas)

- Middle East/Africa: Includes Afghanistan, Algeria, Angola, Bahrain, Bassas da India, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Cote d'Ivoire, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Europa Island, Gabon, Gambia, Ghana, Glorioso Islands, Guinea, Guinea-Bissau, Iran, Iraq, Israel, Jordan, Juan de Nova Island, Kenya, Kuwait, Lebanon, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mayotte, Morocco, Mozambique, Namibia, Niger, Nigeria, Oman, Qatar, Reunion, Rwanda, Saint Helena, Sao Tome and Principe, Saudi Arabia, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Syria, Tanzania, Togo, Tromelin Island, Tunisia, Turkey, Uganda, United Arab Emirates, Western Sahara, Yemen, Zaire, Zambia, and Zimbabwe

Preliminary Market Forecast Tables

Tables 5 to 15 present Dataquest's preliminary forecast for the mechanical CAD/CAM/CAE market.

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Table 5
Top Level Mechanical Software Forecast, Worldwide, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Software Revenue ($M)									
Worldwide, All Operating Systems	2,939	3,284	3,579	4,004	4,436	4,856	5,253	5,662	9.6
Worldwide									
UNIX	2,166	2,358	2,246	2,309	2,385	2,467	2,531	2,600	3.0
Windows NT	115	294	700	1,084	1,443	1,784	2,113	2,446	28.4
Personal Computer	540	536	540	551	563	575	588	602	2.2
Host/Proprietary	117	97	92	60	45	30	21	14	-31.1
All Operating Systems									
North America	848	983	1,122	1,289	1,449	1,583	1,709	1,830	10.3
Europe	1,014	1,139	1,213	1,343	1,478	1,603	1,735	1,892	9.3
Japan	901	948	987	1,100	1,217	1,349	1,462	1,565	9.7
Asia/Pacific	139	177	216	227	242	265	289	314	7.8
Rest of World	36	36	42	46	50	54	58	62	8.3
Year-to-Year Software Revenue Growth Rate (%)									
Worldwide, All Operating Systems	-	11.7	9.0	11.9	10.8	9.5	8.2	7.8	-
Worldwide									
UNIX	-	8.9	-4.7	2.8	3.3	3.4	2.6	2.7	-
Windows NT	-	154.1	138.6	54.8	33.1	23.7	18.4	15.8	-
Personal Computer	-	-0.9	0.8	2.0	2.2	2.1	2.3	2.4	-
Host/Proprietary	-	-17.2	-4.9	-35.4	-24.8	-33.8	-30.7	-30.1	-
All Operating Systems									
North America	-	15.9	14.1	14.9	12.4	9.3	7.9	7.1	-
Europe	-	12.4	6.4	10.7	10.0	8.5	8.2	9.1	-
Japan	-	5.2	4.1	11.4	10.6	10.9	8.3	7.1	-
Asia/Pacific	-	27.1	22.1	5.1	6.8	9.5	9.0	8.5	-
Rest of World	-	-0.6	15.9	9.5	9.6	8.2	7.5	6.5	-

NA = Not applicable
Source: Dataquest (May 1998)

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Table 6
Detail Mechanical Software Forecast, Worldwide, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	335,416	345,486	403,791	425,700	454,300	469,400	491,600	515,600	5
Seats	344,469	354,812	408,525	427,200	450,700	471,900	493,400	517,000	5
Year-to-Year Increase (%)	16	3	15	5	6	5	5	5	-
Installed Base									
CPUs	890,330	975,916	1,090,737	1,206,700	1,313,600	1,394,800	1,462,600	1,526,000	7
Seats	940,772	1,021,243	1,127,999	1,233,800	1,327,700	1,404,300	1,470,400	1,532,700	6
Year-to-Year Increase (%)	12	9	10	9	8	6	5	4	-
Revenue Data ($M)									
CPU Revenue	3,935	4,030	4,213	4,135	4,283	4,428	4,586	4,774	3
Terminal Revenue	154	136	40	30	21	14	9	5	-33
Peripheral Revenue	342	346	356	311	296	282	267	254	-7
Hardware Revenue	4,431	4,511	4,609	4,477	4,600	4,723	4,862	5,034	2
Year-to-Year Increase (%)	13	2	2	-3	3	3	3	4	-
Software Revenue	2,939	3,284	3,579	4,004	4,436	4,856	5,253	5,662	10
Year-to-Year Increase (%)	23	12	9	12	11	9	8	8	-
Software Service	953	1,251	1,464	1,534	1,698	1,861	2,029	2,179	8
Hardware Service	832	913	940	834	848	868	894	923	0
Service Revenue	1,785	2,164	2,403	2,368	2,546	2,729	2,923	3,102	5
Year-to-Year Increase (%)	11	21	11	-1	8	7	7	6	-
Total Factory Revenue	9,155	9,959	10,591	10,849	11,582	12,308	13,037	13,798	5
Year-to-Year Increase (%)	15	9	6	2	7	6	6	6	-

NA = Not applicable
Source: Dataquest (May 1998)

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Table 7
Detail Mechanical Software Forecast, Worldwide, UNIX

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	125,030	131,991	133,526	121,600	121,100	121,400	122,100	123,000	-2
Seats	125,030	131,991	133,526	121,600	121,100	121,400	122,100	123,000	-2
Year-to-Year Increase (%)	15	6	1	-9	0	0	1	1	-
Installed Base									
CPUs	362,528	409,960	445,340	459,100	462,700	461,000	459,000	458,500	1
Seats	362,528	409,960	445,340	459,100	462,700	461,000	459,000	458,500	1
Year-to-Year Increase (%)	18	13	9	3	1	0	0	0	-
Revenue Data ($M)									
CPU Revenue	2,898	2,876	2,805	2,561	2,568	2,591	2,612	2,622	-1
Terminal Revenue	-	-	-	-	-	-	-	-	NA
Peripheral Revenue	259	254	249	210	196	184	171	158	-9
Hardware Revenue	3,158	3,130	3,054	2,771	2,764	2,775	2,783	2,781	-2
Year-to-Year Increase (%)	19	-1	-2	-9	0	0	0	0	-
Software Revenue	2,166	2,358	2,246	2,309	2,385	2,467	2,531	2,600	3
Year-to-Year Increase (%)	23	9	-5	3	3	3	3	3	-
Software Service	761	995	1,036	1,049	1,085	1,129	1,160	1,194	3
Hardware Service	696	758	779	671	682	698	713	726	-1
Service Revenue	1,457	1,753	1,815	1,720	1,768	1,826	1,873	1,919	1
Year-to-Year Increase (%)	13	20	4	-5	3	3	3	2	-
Total Factory Revenue	6,781	7,241	7,115	6,801	6,916	7,068	7,187	7,300	1
Year-to-Year Increase (%)	19	7	-2	-4	2	2	2	2	-

NA = Not applicable
Source: Dataquest (May 1998)

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Table 8
Detail Mechanical Software Forecast, Worldwide, NT

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	5,981	14,791	44,536	60,500	74,800	85,600	94,900	104,800	19
Seats	5,981	14,791	44,536	60,500	74,800	85,600	94,900	104,800	19
Year-to-Year Increase (%)	163	147	201	36	24	14	11	10	-
Installed Base									
CPUs	7,847	20,777	60,286	110,000	160,100	203,600	239,300	270,000	35
Seats	7,847	20,777	60,286	110,000	160,100	203,600	239,300	270,000	35
Year-to-Year Increase (%)	245	165	190	82	46	27	17	13	-
Revenue Data ($M)									
CPU Revenue	69	167	454	645	822	963	1,112	1,294	23
Terminal Revenue	-	-	-	-	-	-	-	-	NA
Peripheral Revenue	6	10	14	18	22	24	26	29	15
Hardware Revenue	75	178	469	663	843	987	1,138	1,323	23
Year-to-Year Increase (%)	129	138	164	42	27	17	15	16	-
Software Revenue	115	294	700	1,084	1,443	1,784	2,113	2,446	28
Year-to-Year Increase (%)	176	154	139	55	33	24	18	16	-
Software Service	30	76	252	383	516	642	785	907	29
Hardware Service	9	31	45	63	82	97	114	135	25
Service Revenue	39	107	297	446	598	739	899	1,042	29
Year-to-Year Increase (%)	46	176	177	50	34	24	22	16	-
Total Factory Revenue	229	578	1,466	2,193	2,884	3,511	4,150	4,811	27
Year-to-Year Increase (%)	127	153	153	50	31	22	18	16	-

NA = Not applicable
Source: Dataquest (May 1998)

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Table 9
Detail Mechanical Software Forecast, Worldwide, Personal Computer

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	201,671	195,856	223,474	240,600	251,300	262,400	274,600	287,900	5
Seats	201,855	196,156	223,577	240,600	251,300	262,400	274,600	287,900	5
Year-to-Year Increase (%)	17	-3	14	8	4	4	5	5	-
Installed Base									
CPUs	504,078	530,951	572,650	625,800	675,000	717,300	755,600	792,000	7
Seats	504,078	530,951	572,650	625,800	675,000	717,300	755,600	792,000	7
Year-to-Year Increase (%)	10	5	8	9	8	6	5	5	-
Revenue Data ($M)									
CPU Revenue	691	668	684	760	779	802	816	828	4
Terminal Revenue	-	-	-	-	-	-	-	-	NA
Peripheral Revenue	48	44	50	52	54	56	57	58	3
Hardware Revenue	739	713	734	812	832	857	873	886	4
Year-to-Year Increase (%)	15	-4	3	11	2	3	2	2	-
Software Revenue	540	536	540	551	563	575	588	602	2
Year-to-Year Increase (%)	18	-1	1	2	2	2	2	2	-
Software Service	80	90	88	52	53	54	54	55	-9
Hardware Service	31	29	38	52	52	52	53	53	7
Service Revenue	110	118	126	105	105	106	107	109	-3
Year-to-Year Increase (%)	13	7	7	-17	0	1	1	1	-
Total Factory Revenue	1,389	1,366	1,400	1,468	1,500	1,538	1,568	1,597	3
Year-to-Year Increase (%)	16	-2	2	5	2	3	2	2	-

NA = Not applicable
Source: Dataquest (May 1998)

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Table 10
Detail Mechanical Software Forecast, Worldwide, Host/Proprietary

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	2,734	2,848	2,255	3,000	7,100	-	-	-	NA
Seats	11,603	11,874	6,885	4,500	3,500	2,500	1,800	1,400	-28
Year-to-Year Increase (%)	-21	2	-42	-34	-22	-30	-28	-24	-
Installed Base									
CPUs	15,877	14,228	12,462	11,800	15,800	12,700	8,800	5,600	-15
Seats	66,319	59,555	49,724	38,900	29,800	22,200	16,500	12,200	-24
Year-to-Year Increase (%)	-11	-10	-17	-22	-23	-25	-26	-26	-
Revenue Data ($M)									
CPU Revenue	277	318	270	169	115	73	46	29	-36
Terminal Revenue	154	136	40	30	21	14	9	5	-33
Peripheral Revenue	30	37	42	31	24	18	13	9	-26
Hardware Revenue	460	491	352	230	161	104	68	44	-34
Year-to-Year Increase (%)	-25	7	-28	-35	-30	-35	-35	-35	-
Software Revenue	117	97	92	60	45	30	21	14	-31
Year-to-Year Increase (%)	-10	-17	-5	-35	-25	-34	-31	-30	-
Software Service	83	90	88	49	43	37	30	24	-23
Hardware Service	96	95	78	48	33	21	14	8	-36
Service Revenue	179	186	165	97	76	58	44	32	-28
Year-to-Year Increase (%)	-6	4	-11	-41	-22	-24	-24	-26	-
Total Factory Revenue	756	774	609	387	282	191	132	90	-32
Year-to-Year Increase (%)	-19	2	-21	-37	-27	-32	-31	-32	-

NA = Not applicable
Source: Dataquest (May 1998)

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Table 11
Detail Mechanical Software Forecast, North America, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	119,674	118,375	121,967	131,800	140,500	144,800	150,400	156,200	5
Seats	121,380	120,089	123,224	132,100	139,600	145,200	150,700	156,400	5
Year-to-Year Increase (%)	13	-1	3	7	6	4	4	4	-
Installed Base									
CPUs	334,873	356,548	373,326	394,200	418,700	440,100	459,300	476,800	5
Seats	350,716	369,281	383,385	401,200	422,200	442,200	460,800	478,100	5
Year-to-Year Increase (%)	9	5	4	5	5	5	4	4	-
Revenue Data ($M)									
CPU Revenue	1,050	1,115	1,240	1,267	1,329	1,380	1,440	1,502	4
Terminal Revenue	33	27	10	6	3	2	1	1	-37
Peripheral Revenue	32	38	47	39	36	33	32	30	-8
Hardware Revenue	1,115	1,180	1,297	1,313	1,369	1,416	1,473	1,533	3
Year-to-Year Increase (%)	12	6	10	1	4	3	4	4	-
Software Revenue	848	983	1,122	1,289	1,449	1,583	1,709	1,830	10
Year-to-Year Increase (%)	21	16	14	15	12	9	8	7	-
Software Service	252	380	476	527	586	639	693	740	9
Hardware Service	220	259	287	264	271	280	292	304	1
Service Revenue	473	640	762	791	857	919	985	1,044	6
Year-to-Year Increase (%)	9	35	19	4	8	7	7	6	-
Total Factory Revenue	2,436	2,802	3,181	3,393	3,674	3,918	4,167	4,407	7
Year-to-Year Increase (%)	14	15	14	7	8	7	6	6	-

NA = Not applicable
Source: Dataquest (May 1998)

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Table 12
Detail Mechanical Software Forecast, Europe, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	106,955	106,653	106,267	100,200	106,200	105,800	109,300	113,700	1
Seats	110,620	110,278	108,713	101,400	105,000	107,200	110,200	114,300	1
Year-to-Year Increase (%)	14	0	-1	-7	4	2	3	4	-
Installed Base									
CPUs	278,303	293,595	304,095	314,500	327,400	335,700	343,300	351,900	3
Seats	296,268	310,209	318,530	325,900	333,800	340,600	347,500	355,600	2
Year-to-Year Increase (%)	8	5	3	2	2	2	2	2	-
Revenue Data ($M)									
CPU Revenue	1,310	1,351	1,395	1,251	1,278	1,291	1,326	1,384	0
Terminal Revenue	58	49	20	17	13	8	5	3	-32
Peripheral Revenue	91	105	108	86	82	74	69	64	-10
Hardware Revenue	1,459	1,504	1,523	1,355	1,373	1,373	1,399	1,451	-1
Year-to-Year Increase (%)	11	3	1	-11	1	0	2	4	-
Software Revenue	1,014	1,139	1,213	1,343	1,478	1,603	1,735	1,892	9
Year-to-Year Increase (%)	23	12	6	11	10	9	8	9	-
Software Service	324	429	514	495	538	576	619	664	5
Hardware Service	280	312	328	272	274	274	280	289	-3
Service Revenue	604	741	842	767	812	850	898	953	3
Year-to-Year Increase (%)	4	23	14	-9	6	5	6	6	-
Total Factory Revenue	3,078	3,385	3,578	3,464	3,663	3,827	4,033	4,296	4
Year-to-Year Increase (%)	13	10	6	-3	6	4	5	7	-

NA = Not applicable
Source: Dataquest (May 1998)

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Table 13
Detail Mechanical Software Forecast, Japan, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	77,837	88,763	143,240	160,600	173,100	184,100	195,700	207,600	8
Seats	80,628	91,553	143,848	160,500	172,300	184,400	195,800	207,700	8
Year-to-Year Increase (%)	20	14	57	12	7	7	6	6	-
Installed Base									
CPUs	205,535	240,850	319,660	398,700	463,600	512,000	549,800	582,900	13
Seats	218,740	253,038	329,071	405,000	466,700	513,700	550,800	583,600	12
Year-to-Year Increase (%)	18	16	30	23	15	10	7	6	-
Revenue Data ($M)									
CPU Revenue	1,327	1,292	1,270	1,314	1,372	1,444	1,496	1,549	4
Terminal Revenue	48	41	6	3	2	1	1	0	-42
Peripheral Revenue	200	188	184	169	163	160	153	147	-4
Hardware Revenue	1,575	1,520	1,459	1,487	1,537	1,604	1,649	1,696	3
Year-to-Year Increase (%)	11	-3	-4	2	3	4	3	3	-
Software Revenue	901	948	987	1,100	1,217	1,349	1,462	1,565	10
Year-to-Year Increase (%)	21	5	4	11	11	11	8	7	-
Software Service	330	365	376	410	466	529	591	639	11
Hardware Service	282	279	255	236	240	249	254	259	0
Service Revenue	612	644	631	646	706	778	844	898	7
Year-to-Year Increase (%)	20	5	-2	2	9	10	9	6	-
Total Factory Revenue	3,088	3,113	3,077	3,233	3,460	3,732	3,955	4,159	6
Year-to-Year Increase (%)	16	1	-1	5	7	8	6	5	-

NA = Not applicable
Source: Dataquest (May 1998)

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Table 14
Detail Mechanical Software Forecast, Asia/Pacific, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	22,812	24,044	24,589	24,700	25,800	25,600	26,900	28,300	3
Seats	23,577	25,128	24,939	24,900	25,100	26,000	27,200	28,600	3
Year-to-Year Increase (%)	25	7	-1	0	1	4	5	5	-
Installed Base									
CPUs	52,206	63,189	70,671	75,200	78,700	80,800	83,000	85,900	4
Seats	54,552	66,112	73,354	77,200	79,500	81,400	83,800	86,800	3
Year-to-Year Increase (%)	35	21	11	5	3	2	3	4	-
Revenue Data ($M)									
CPU Revenue	201	230	259	252	253	261	272	285	2
Terminal Revenue	14	18	3	3	2	2	1	1	-19
Peripheral Revenue	15	12	14	13	12	11	11	10	-6
Hardware Revenue	230	261	276	268	267	275	284	296	1
Year-to-Year Increase (%)	39	13	6	-3	0	3	3	4	-
Software Revenue	139	177	216	227	242	265	289	314	8
Year-to-Year Increase (%)	40	27	22	5	7	10	9	8	-
Software Service	41	65	84	87	93	101	110	119	7
Hardware Service	41	53	60	54	54	55	57	60	0
Service Revenue	82	119	144	141	146	157	168	179	4
Year-to-Year Increase (%)	32	45	22	-2	4	7	7	7	-
Total Factory Revenue	451	556	636	636	656	697	741	789	4
Year-to-Year Increase (%)	38	23	14	0	3	6	6	6	-

NA = Not applicable
Source: Dataquest (May 1998)

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Table 15
Detail Mechanical Software Forecast, Rest of World, All Operating Systems

	1995	1996	1997	1998	1999	2000	2001	2002	CAGR (%) 1997-2002
Hardware Shipment Data									
Shipments									
CPUs	8,138	7,651	7,729	8,300	8,800	9,000	9,400	9,900	5
Seats	8,264	7,765	7,801	8,400	8,700	9,100	9,500	9,900	5
Year-to-Year Increase (%)	30	-6	0	7	4	4	4	5	-
Installed Base									
CPUs	19,414	21,734	22,985	24,100	25,200	26,200	27,300	28,400	4
Seats	20,497	22,603	23,660	24,600	25,400	26,400	27,400	28,600	4
Year-to-Year Increase (%)	23	10	5	4	4	4	4	4	-
Revenue Data ($M)									
CPU Revenue	47	42	48	49	50	52	53	54	2
Terminal Revenue	1	1	1	1	0	0	0	0	-17
Peripheral Revenue	3	3	4	4	4	3	3	3	-4
Hardware Revenue	52	47	53	54	54	55	56	58	2
Year-to-Year Increase (%)	20	-10	13	2	1	2	2	2	-
Software Revenue	36	36	42	46	50	54	58	62	8
Year-to-Year Increase (%)	30	-1	16	9	10	8	8	7	-
Software Service	7	12	14	14	15	16	17	18	5
Hardware Service	8	8	10	9	10	10	10	11	2
Service Revenue	15	20	24	23	25	26	27	28	4
Year-to-Year Increase (%)	-10	35	18	-2	6	5	5	4	-
Total Factory Revenue	103	103	118	123	129	135	142	148	5
Year-to-Year Increase (%)	17	0	15	4	5	5	5	4	-

NA = Not applicable
Source: Dataquest (May 1998)

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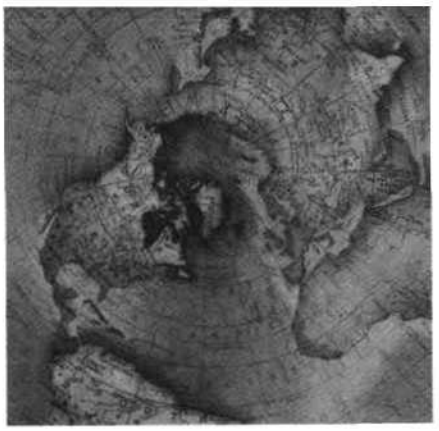
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1997 Mechanical CAD/CAM/CAE Worldwide Market Share

Market Statistics

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1997 Mechanical CAD/CAM/CAE Worldwide Market Share



Market Statistics

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Table of Contents

Page

1. Introduction 1
   - About This Document 3
   - Segmentation Definitions 5
     - Applications 5
     - Regions 6
     - Operating Systems 7
     - Metrics 7
   - Market Share Methodology 12
     - The Audit Process 12
   - Reporting Changes 13
   - A Final Note 14
   - Publishing Schedule 14
2. Market Statistics 15

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List of Figures

Figure Page
1-1 CAD/CAM/CAE, AEC and GIS, and EDA Database 1

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List of Tables

Table		Page
1-1	Market Summary for All CAD Applications, 1996 to 1997,	2
1-2	Companies Renamed In 1997	3
1-3	Companies (or CAD Portions of Companies) Sold/ Merged in 1997	4
1-4	Top 25 Product Software Revenue, Software Companies, Worldwide, All Operating Systems, 10	
1-5	Top 25 Company Software Revenue, Software Companies, Worldwide, All Operating Systems, 11	
A-1	1997 CAD/CAM/CAE/GIS Software Market Share, Top 30 Mechanical Software Companies, Worldwide, All Operating Systems	15
A-2	1997 CAD/CAM/CAE/GIS Software Market Share, Top 30 Mechanical Software Companies, Worldwide, Unix	16
A-3	1997 CAD/CAM/CAE/GIS Software Market Share, Top 30 Mechanical Software Companies, Worldwide, NT	17
A-4	1997 CAD/CAM/CAE/GIS Software Market Share, Top 30 Mechanical Software Companies, Worldwide, Personal Computer	18
A-5	1997 CAD/CAM/CAE/GIS Software Market Share, Top 24 Mechanical Software Companies, Worldwide, Host/Proprietary	19
A-6	1997 CAD/CAM/CAE/GIS Software Market Share, Top 30 Mechanical Software Companies, North America, All Operating Systems	20
A-7	1997 CAD/CAM/CAE/GIS Software Market Share, Top 30 Mechanical Software Companies, North America, Unix	21
A-8	1997 CAD/CAM/CAE/GIS Software Market Share, Top 30 Mechanical Software Companies, North America, NT	22
A-9	1997 CAD/CAM/CAE/GIS Software Market Share, Top 30 Mechanical Software Companies, North America, Personal Computer	23
A-10	1997 CAD/CAM/CAE/GIS Software Market Share, Top 14 Mechanical Software Companies, North America, Host/Proprietary	24
A-11	1997 CAD/CAM/CAE/GIS Software Market Share, Top 30 Mechanical Software Companies, Europe, All Operating Systems	25
A-12	1997 CAD/CAM/CAE/GIS Software Market Share, Top 30 Mechanical Software Companies, Europe, Unix	26
A-13	1997 CAD/CAM/CAE/GIS Software Market Share, Top 30 Mechanical Software Companies, Europe, NT	27
A-14	1997 CAD/CAM/CAE/GIS Software Market Share, Top 30 Mechanical Software Companies, Europe, Personal Computer	28

List of Tables (Continued)

Table		Page
A-15	1997 CAD/CAM/CAE/GIS Software Market Share, Top 14 Mechanical Software Companies, Europe, Host/Proprietary	29
A-16	1997 CAD/CAM/CAE/GIS Software Market Share, Top 30 Mechanical Software Companies, Japan, All Operating Systems	30
A-17	1997 CAD/CAM/CAE/GIS Software Market Share, Top 30 Mechanical Software Companies, Japan, Unix	31
A-18	1997 CAD/CAM/CAE/GIS Software Market Share, Top 30 Mechanical Software Companies, Japan, NT	32
A-19	1997 CAD/CAM/CAE/GIS Software Market Share, Top 30 Mechanical Software Companies, Japan, Personal Computer	33
A-20	1997 CAD/CAM/CAE/GIS Software Market Share, Top 19 Mechanical Software Companies, Japan, Host/Proprietary	34
A-21	1997 CAD/CAM/CAE/GIS Software Market Share, Top 30 Mechanical Software Companies, Asia-Pacific, All Operating Systems	35
A-22	1997 CAD/CAM/CAE/GIS Software Market Share, Top 30 Mechanical Software Companies, Asia-Pacific, Unix	36
A-23	1997 CAD/CAM/CAE/GIS Software Market Share, Top 30 Mechanical Software Companies, Asia-Pacific, NT	37
A-24	1997 CAD/CAM/CAE/GIS Software Market Share, Top 30 Mechanical Software Companies, Asia-Pacific, Personal Computer	38
A-25	1997 CAD/CAM/CAE/GIS Software Market Share, Top 9 Mechanical Software Companies, Asia-Pacific, Host/Proprietary	39
A-26	1997 CAD/CAM/CAE/GIS Software Market Share, Top 30 Mechanical Software Companies, Rest of World, All Operating Systems	40
A-27	1997 CAD/CAM/CAE/GIS Software Market Share, Top 30 Mechanical Software Companies, Rest of World, Unix	41
A-28	1997 CAD/CAM/CAE/GIS Software Market Share, Top 20 Mechanical Software Companies, Rest of World, NT	42
A-29	1997 CAD/CAM/CAE/GIS Software Market Share, Top 30 Mechanical Software Companies, Rest of World, Personal Computer	43
A-30	1997 CAD/CAM/CAE/GIS Software Market Share, Top Seven Mechanical Software Companies, Rest of World, Host/Proprietary	44
B-1	1997 CAD/CAM/CAE/GIS Software Market Share, All Mechanical Software Companies, Worldwide, All Operating Systems	45

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List of Tables (Continued)

Table		Page
C-1	1997 CAD/CAM/CAE/GIS Total Vendor Market Share , Top 30 Mechanical Software Companies, Worldwide, All Operating Systems	49
C-2	1997 CAD/CAM/CAE/GIS Total Vendor Market Share , Top 30 Mechanical Software Companies, Worldwide, Unix	50
C-3	1997 CAD/CAM/CAE/GIS Total Vendor Market Share Table, Top 30 Mechanical Software Companies, Worldwide, NT	51
C-4	1997 CAD/CAM/CAE/GIS Total Vendor Market Share Table, Top 30 Mechanical Software Companies, Worldwide, Personal Computer	52
C-5	1997 CAD/CAM/CAE/GIS Total Vendor Market ShareTable, Top 23 Mechanical Software Companies, Worldwide, Host/Proprietary	53

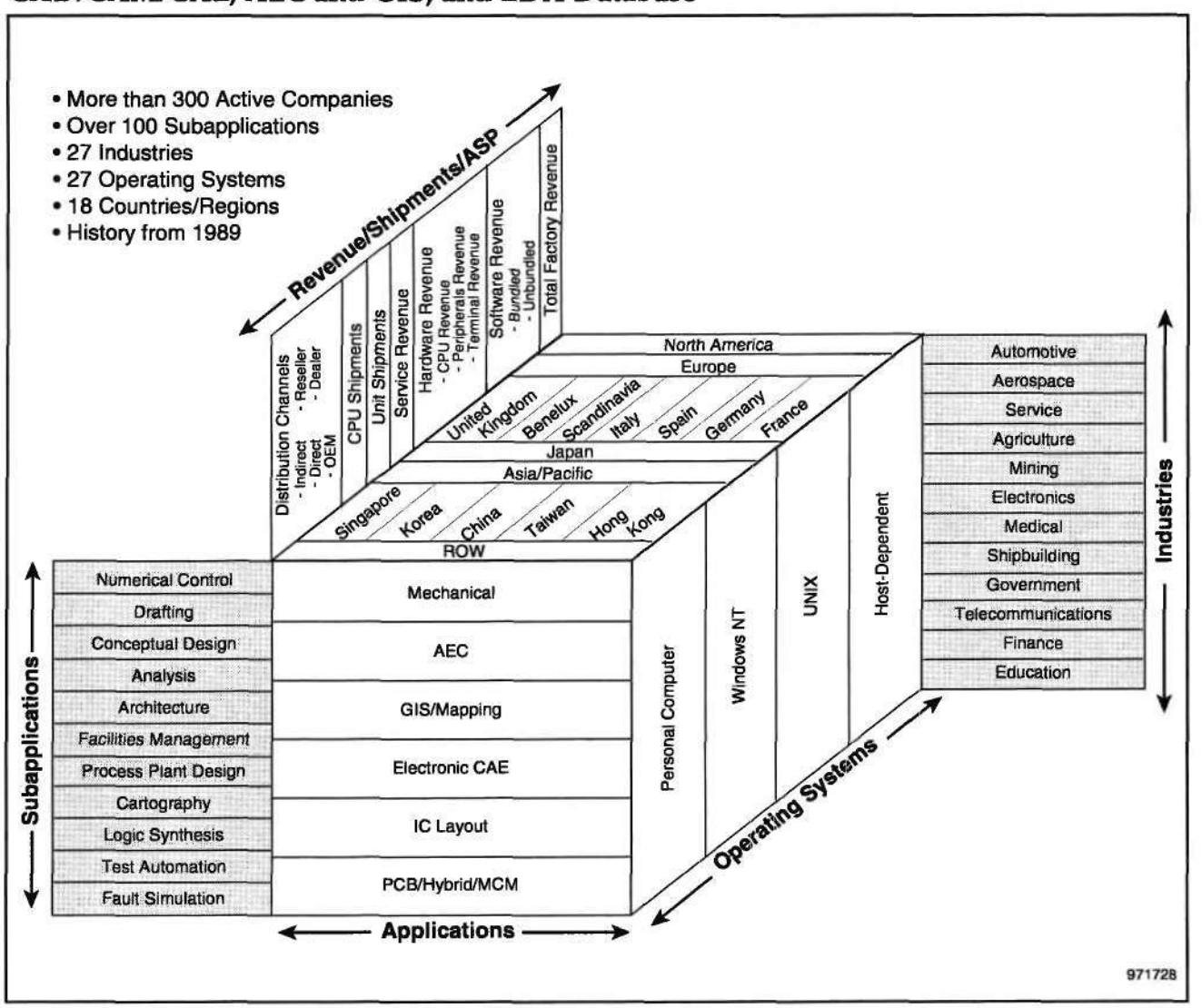
Chapter 1
Introduction

CAD/CAM/CAE, AEC and 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 CAD/CAM/CAE, AEC and GIS, and EDA systems continue to decrease in cost, they become more available and cost-justifiable to new users.

To provide a comprehensive view of the CAD/CAM/CAE, AEC and GIS, and EDA industry, Dataquest's CAD/CAM/CAE, AEC and GIS, and EDA group maintains 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 and GIS, and EDA markets in 1997 versus 1996.

Figure 1-1
CAD/CAM/CAE, AEC and GIS, and EDA Database



Source: Dataquest (March 1998)

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Table 1-1
Market Summary for All CAD Applications, 1996 to 1997 (Revenue in Millions of Dollars)

	Software Revenue			Hardware Revenue			Total Factory Revenue			Seat Shipments		
	1996	1997	1996-1997 Growth (%)	1996	1997	1996-1997 Growth (%)	1996	1997	1996-1997 Growth (%)	1996	1997	1996-1997 Growth (%)
Applications—For the Selected Operating System and Region:												
Mechanical	3,283.84	3,578.53	8.97	4,874.55	4,873.55	(0.02)	10,311.75	10,920.85	5.91	356,294.6	343,996.8	(3.45)
AEC	903.32	943.79	4.48	1,261.55	820.52	(34.96)	2,584.88	2,175.35	(15.84)	223,485.2	84,428.6	(62.22)
GIS/Mapping	908.75	1,023.85	12.67	1,155.72	1,024.71	(11.34)	2,730.90	2,769.93	1.43	128,650.7	79,063.4	(38.54)
Electronic CAE	1,170.69	1,383.23	18.16	1,163.20	1,252.69	7.69	3,260.44	3,662.89	12.34	96,459.6	78,253.0	(18.87)
IC Layout	432.53	524.17	21.19	349.75	375.50	7.36	1,136.66	1,318.24	15.97	16,084.0	16,083.8	(0.00)
PCB/MCM/Hybrid	294.42	299.20	1.62	362.79	309.65	(14.65)	878.99	861.74	(1.96)	29,919.3	16,856.1	(43.66)
EDA	1,897.64	2,206.60	16.28	1,875.75	1,937.85	3.31	5,276.09	5,842.87	10.74	142,463.0	111,192.9	(21.95)
All Applications	6,993.55	7,752.78	10.86	9,167.57	8,656.63	(5.57)	20,903.62	21,709.00	3.85	850,893.5	618,681.8	(27.29)
Region—For All Applications in the selected Operating System:												
North America	2,481.55	2,823.60	13.78	2,964.35	2,838.61	(4.24)	7,249.98	7,686.02	6.01	328,734.1	186,127.4	(43.38)
Europe	2,180.75	2,362.94	8.35	2,978.46	2,783.76	(6.54)	6,585.36	6,774.33	2.87	278,873.2	166,113.6	(40.43)
Japan	1,745.84	1,892.92	8.42	2,632.97	2,575.09	(2.20)	5,547.03	5,734.63	3.38	160,427.8	232,551.9	44.96
Asia/Pacific	463.06	534.35	15.40	454.72	346.99	(23.69)	1,189.44	1,183.24	(0.52)	60,686.5	24,845.6	(59.06)
Rest of World	123.76	140.73	13.71	139.47	112.59	(19.27)	335.46	334.09	(0.41)	22,237.8	9,044.8	(59.33)
Worldwide	6,993.55	7,752.78	10.86	9,167.57	8,656.63	(5.57)	20,903.62	21,709.00	3.85	850,893.5	618,681.8	(27.29)
Operating System—For All Applications in the Selected Region:												
UNIX	4,698.53	4,723.03	0.52	6,241.82	6,430.96	3.03	14,698.13	15,148.61	3.06	264,963.1	279,795.6	5.60
Host/Proprietary	152.56	121.31	(20.48)	661.36	464.80	(29.72)	1,081.37	797.02	(26.29)	5,489.1	3,703.1	(32.54)
NT/Hybrid	708.57	1,389.60	96.11	524.60	699.29	33.30	1,638.31	2,827.62	72.59	40,712.5	58,334.8	43.28
Personal Computer	1,433.89	1,518.84	5.92	1,739.80	1,061.58	(38.98)	3,485.81	2,935.75	(15.78)	539,728.7	276,848.4	(48.71)
All Operating Systems	6,993.55	7,752.78	10.86	9,167.57	8,656.63	(5.57)	20,903.62	21,709.00	3.85	850,893.5	618,681.8	(27.29)

Source: Dataquest (March 1998)

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About This Document

This document contains Dataquest's detailed market share information on the mechanical CAD/CAM/CAE industry. Numbers presented in this book represent Dataquest's best estimate of the CAD/CAM/CAE, AEC and GIS, and EDA 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 1-2 and 1-3 for changes in the companies tracked from our 1996 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. Dataquest has added GIS data companies.
- Electronic design automation (EDA) 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

Dataquest no longer publishes top-level market statistics for the entire CAD/CAM/CAE, AEC and GIS, and EDA industries. This data is available by calling Daya Nadamuni at (408) 468-8290 or by e-mail at daya.nadamuni@dataquest.com. More detailed data on these markets may be requested through our client inquiry service.

Table 1-2
Companies Renamed In 1997

Original Company Name	New Company Name
Harris EDA	Xynetix
VLSI Libraries	Artisan Components

Source: Dataquest (March 1998)

Table 1-3
Companies (or CAD Portions of Companies) Sold/Merged in 1997

Original Company Name	Acquired by/Merged with
Cimtel Ltd.	Concurrent Engineering
Clemessy Geocity	Network Management Tools
Compact Software	Ansoft
Compass Design Automation	Avant!
Cooper & Chyan Technology	Cadence
Deneb Robotics	Dassault Systemes
Eagle Design Automation	Synopsys
EPIC Design Technology	Synopsys
Framasoft	ESI Group
Simulation Technology	Summit Design
Softdesk	Autodesk
SolidWorks	Dassault Systemes
SpeedSim	Quickturn Systems Design
Viewlogic Systems	Synopsys

Source: Dataquest (March 1998)

Companies deleted from our database in 1997 are as follows:

- Actel
- Altera
- Xilinx

Companies added to our database in 1997 are as follows:

- AMBIT Design Systems
- Camcentre
- CoreLogic
- DSP Group
- Flomerics
- Gambit Automated Design
- Innovative Semiconductors
- Modultek Oy
- Open Mind
- Precedence
- Simplex
- Western Design Center

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 it includes government and education. Common design applications include conceptual design, industrial design, structural or thermal analysis, detail design, and electro-mechanical 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.

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Regions

The following paragraphs define the regions.

- North America:
  - United States: Single-country region
  - Canada: Single-country region
- Europe:
  - Western Europe: Includes Austria, Belgium, France, Germany (including former East Germany), Italy, Luxembourg, Netherlands, Scandinavia (Denmark, Finland, Norway, Sweden), Spain, Switzerland, and the United Kingdom
  - Rest of Western Europe: Includes Andorra, Cyprus, Faroe Islands, Gibraltar, Greenland, Guernsey, Iceland, Isle of Man, Jersey, Liechtenstein, Malta, Monaco, San Marino, and Svalbard
  - Central and Eastern Europe: Includes Albania, Armenia, Azerbaijan, Belarus, Bosnia and Herzegovina, Bulgaria, Croatia, the Czech Republic, Estonia, Georgia, Hungary, Kazakstan, Kyrgyzstan, Latvia, Lithuania, Macedonia, Moldova, Poland, Romania, Russia, Slovakia, Slovenia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan, and the republics of the former Yugoslavia (Serbia and Montenegro)
- Japan: Single-country region
- Asia/Pacific:
  - **Asia/Pacific:** Includes China, Hong Kong, Korea, Singapore, and Taiwan
  - **Rest of Asia:** Includes Australia, American Samoa, Ashmore and Cartier Islands, Baker Island, Bangladesh, Bhutan, Bouvet Island, Brunei, Cambodia, Christmas Island, Cocos (Keeling) Islands, Cook Islands, Coral Sea Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Howland Island, India, Indonesia, Jarvis Island, Johnston Atoll, Kingman Reef, Kiribati, Laos, Macau, Malaysia, Maldives, Marshall Islands, Midway Islands, Mongolia, Myanmar (Burma), Nauru, Nepal, New Caledonia, New Zealand, Niue, Norfolk Island, Northern Mariana Islands, North Korea, Pakistan, Palau, Palmyra Atoll, Papua New Guinea, Paracel Islands, Philippines, Pitcairn Islands, Solomon Islands, Spratly Islands, Sri Lanka, Thailand, Tokelau, Tonga, Tuvalu, Vanuatu, Vietnam, Wake Island, Wallis and Futuna, and Western Samoa
- Rest of World:
  - **Latin America:** Includes Anguilla, Antigua and Barbuda, Argentina, Aruba, Bahamas, Barbados, Belize, Bermuda, Bolivia, Brazil, Cayman Islands, Chile, Clipperton Island, Colombia, Costa Rica, Cuba, Dominica, Dominican Republic, Ecuador, El Salvador, Falkland Islands (Islas Malvinas), French Guiana, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Mexico, Montserrat, Navassa Island, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Tortola (British Virgin Islands), Trinidad and Tobago, Turks and Caicos Islands, Uruguay, Venezuela, and Virgin Islands (St. John, St. Croix and St. Thomas)

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- **Middle East/Africa:** Includes Afghanistan, Algeria, Angola, Bahrain, Bassas da India, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo, Cote d'Ivoire, Djibouti, Egypt, Equatorial Guinea, Eritrea, Ethiopia, Europa Island, Gabon, Gambia, Ghana, Glorioso Islands, Guinea, Guinea-Bissau, Iran, Iraq, Israel, Jordan, Juan de Nova Island, Kenya, Kuwait, Lebanon, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mayotte, Morocco, Mozambique, Namibia, Niger, Nigeria, Oman, Qatar, Reunion, Rwanda, Saint Helena, Sao Tome and Principe, Saudi Arabia, Senegal, Seychelles, Sierra Leone, Somalia, South Africa, Sudan, Swaziland, Syria, Tanzania, Togo, Tromelin Island, Tunisia, Turkey, Uganda, United Arab Emirates, Western Sahara, Yemen, Zaire, Zambia, and Zimbabwe

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, AEC and GIS, and EDA 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, AEC and 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 for a specific customer who pays for the design and development of new customized CAD/CAM/CAE, AEC and 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 and GIS, and 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—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 made directly 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 and 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.

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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 as follows:

- 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. 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 the following:

- 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 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-a-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.

Table 1-4
Top 25 Product Software Revenue, Software Companies, Worldwide, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	IBM	464.0	518.6	619.5	19.5	8.0
2	Parametric Technology	321.2	495.0	605.9	22.4	7.8
3	Autodesk	551.6	505.0	600.0	18.8	7.7
4	Cadence	283.0	411.5	522.3	26.9	6.7
5	Synopsys	283.6	361.0	465.5	29.0	6.0
6	Intergraph	292.5	282.9	318.7	12.7	4.1
7	ESRI	124.1	184.9	222.7	20.5	2.9
8	Mentor Graphics	183.3	205.9	218.5	6.1	2.8
9	EDS Unigraphics	133.4	161.4	208.0	28.8	2.7
10	Fujitsu	151.4	160.5	198.9	23.9	2.6
11	Structural Dynamics Research Corporation	144.9	164.3	170.7	3.9	2.2
12	MICROCADAM	129.2	152.0	156.8	3.1	2.0
13	Bentley Systems	89.4	100.8	140.6	39.4	1.8
14	AVANT!	103.1	125.8	126.3	0.4	1.6
15	Quickturn Design Systems	72.0	89.3	104.6	17.2	1.3
16	NEC	110.0	94.9	104.4	10.0	1.3
17	Landmark Graphics	89.9	98.3	102.8	4.5	1.3
18	CoCreate	79.0	86.8	99.2	14.4	1.3
19	MacNeal-Schwendler	117.6	109.0	99.2	-9.0	1.3
20	Hitachi	94.5	85.0	85.9	1.1	1.1
21	Matra Datavision	87.4	91.8	85.3	-7.1	1.1
22	Siemens Nixdorf Info systeme	93.2	75.2	83.5	10.9	1.1
23	Nihon Unisys	77.1	79.3	79.1	-0.3	1.0
24	Toshiba	88.5	78.0	74.7	-4.2	1.0
25	Computervision	163.7	191.7	73.3	-61.7	0.9
	All North American Companies	4,583.9	5,327.4	5,980.4	12.3	77.1
	All European Companies	753.8	793.2	829.2	4.5	10.7
	All Asian Companies	879.5	873.0	943.2	8.0	12.2
	All Companies	**6,217.3**	**6,993.5**	**7,752.8**	**10.9**	**100.0**

Note: All numbers shown are Dataquest's best estimates.
Source: Dataquest (March 1998)

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Table 1-5
Top 25 Company Software Revenue, Software Companies, Worldwide, All Operating Systems (Revenue in Millions of Dollars)

Rank	Company	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	IBM	530.6	618.7	697.2	12.7	9.0
2	Parametric Technology	321.2	495.0	605.9	22.4	7.8
3	Autodesk	556.8	509.7	605.7	18.8	7.8
4	Cadence	293.9	421.7	529.6	25.6	6.8
5	Synopsys	295.3	367.2	473.9	29.1	6.1
6	Intergraph	342.3	315.6	355.7	12.7	4.6
7	Dassault Systemes	203.7	248.6	296.5	19.3	3.8
8	ESRI	124.1	184.9	222.7	20.5	2.9
9	Mentor Graphics	185.0	208.1	220.2	5.8	2.8
10	EDS Unigraphics	133.4	161.4	208.0	28.8	2.7
11	Fujitsu	210.8	225.0	198.9	-11.6	2.6
12	Structural Dynamics Research Corporation	144.8	164.3	170.7	3.9	2.2
13	MICROCADAM	129.2	152.0	156.8	3.1	2.0
14	Bentley Systems	89.4	100.8	140.6	39.4	1.8
15	AVANT!	106.0	128.6	128.0	-0.5	1.7
16	Info. Services Int'l. Dentsu	85.2	117.2	127.1	8.5	1.6
17	Quickturn Design Systems	72.0	89.3	104.6	17.2	1.3
18	NEC	110.0	94.9	104.4	10.0	1.3
19	Landmark Graphics	89.9	98.3	102.8	4.5	1.3
20	CoCreate	79.0	86.8	99.2	14.4	1.3
21	MacNeal-Schwendler	117.6	109.0	99.2	-9.0	1.3
22	Hitachi	94.5	85.0	85.9	1.1	1.1
23	Matra Datavision	87.4	91.8	85.3	-7.1	1.1
24	Siemens Nixdorf Info systeme	93.2	75.2	83.5	11.0	1.1
25	Toshiba	97.3	85.7	82.9	-3.2	1.1
	All North American Companies	4,583.9	5,327.4	5,980.4	12.3	77.1
	All European Companies	753.8	793.2	829.2	4.5	10.7
	All Asian Companies	879.5	873.0	943.2	8.0	12.2
	All Companies	**6,217.3**	**6,993.5**	**7,752.8**	**10.9**	**100.0**

Note: All numbers shown are Dataquest's best estimates.
Source: Dataquest (March 1998)

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, AEC and GIS, and EDA 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

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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.

The company statistics published by Dataquest are estimated based on the data supplied by vendors along with the numerous sources listed above. 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 and 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 and 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 our March 4, 1996, publication, Dataquest 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, AEC and 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 we choose to publish in statistics books are those Dataquest believes to be the most 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, AEC and GIS, and EDA market, worldwide, and we welcome your 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. Our annual delivery schedule is as follows:

- Market share 1997 is presented in this report.
- A five-year forecast for CAD/CAM/CAE, AEC and GIS, and EDA will be available to clients by April 30.
- 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 1997 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.
- Dataquest will provide complete final forecast tables by September 30. These tables take into consideration changes in the market share during the previous six months.

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Chapter 2
Market Statistics

Table A-1
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top 30 Mechanical Software Companies, Worldwide, All Operating Systems

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	IBM	494.5	579.7	656.4	13.2	18.3
2	Parametric Technology	321.2	495.0	605.9	22.4	16.9
3	Dassault Systemes	199.9	244.0	290.9	19.2	8.1
4	Autodesk	190.5	176.5	218.1	23.6	6.1
5	EDS Unigraphics	133.4	161.4	208.0	28.8	5.8
6	Structural Dynamics Research Corporation	144.8	164.3	170.7	3.9	4.8
7	MICROCADAM	129.2	152.0	156.8	3.1	4.4
8	Info. Services Int'l. Dentsu	85.2	117.2	127.1	8.5	3.6
9	Fujitsu	97.0	107.3	104.4	-2.7	2.9
10	CoCreate	79.0	86.8	99.2	14.4	2.8
11	MacNeal-Schwendler	114.0	109.0	99.2	-9.0	2.8
12	Matra Datavision	87.4	91.8	85.3	-7.1	2.4
13	NEC	72.9	62.9	70.9	12.7	2.0
14	Hitachi	70.9	63.7	68.7	7.8	1.9
15	Computervision	149.0	174.4	66.7	-61.7	1.9
16	Toshiba	66.7	62.5	60.5	-3.2	1.7
17	Nihon Unisys	52.8	54.4	55.1	1.2	1.5
18	Hitachi Zosen Info Systems	38.7	39.3	43.2	9.9	1.2
19	Tecnomatix Technology	20.1	26.3	34.4	31.0	1.0
20	C. Itoh Techno-Science	30.8	30.8	32.5	5.5	0.9
21	Ansys	32.6	37.0	32.2	-13.0	0.9
22	Sherpa Corp.	20.6	26.2	27.5	4.8	0.8
23	Delcam Plc	16.7	21.9	27.0	23.7	0.8
24	Intergraph	54.0	27.1	25.8	-5.0	0.7
25	Marubeni Hytech	19.9	23.0	24.9	8.5	0.7
26	Applicon	21.5	21.8	24.0	10.4	0.7
27	Sumisho Electronics	18.8	21.6	23.4	8.4	0.7
28	ISD Software	14.5	22.7	22.8	0.7	0.6
29	MARC	18.2	19.5	21.8	11.7	0.6
30	Tokyo Electron	17.4	20.0	21.8	8.5	0.6
	All N.A. Companies	2,124.0	2,458.2	2,673.1	8.7	74.7
	All European Companies	334.9	350.3	366.4	4.6	10.2
	All Asian Companies	481.5	475.4	539.1	13.4	15.1
	All Companies	**2,940.4**	**3,283.8**	**3,578.5**	**9.0**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table A-2
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top 30 Mechanical Software Companies, Worldwide, UNIX

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	IBM	405.2	509.1	577.0	13.3	25.7
2	Parametric Technology	269.8	386.1	454.4	17.7	20.2
3	Dassault Systemes	155.6	209.5	250.9	19.8	11.2
4	EDS Unigraphics	133.4	145.3	145.6	0.2	6.5
5	Structural Dynamics Research Corporation	136.6	156.4	144.6	-7.5	6.4
6	Info. Services Int'l. Dentsu	80.9	111.3	120.8	8.5	5.4
7	MacNeal-Schwendler	86.6	80.1	78.6	-1.9	3.5
8	Computervision	142.4	166.7	63.8	-61.7	2.8
9	Matra Datavision	75.5	79.2	63.5	-19.8	2.8
10	Nihon Unisys	51.8	53.6	54.1	1.0	2.4
11	CoCreate	59.3	58.2	42.0	-27.8	1.9
12	NEC	43.7	37.7	40.9	8.5	1.8
13	Hitachi Zosen Info Systems	38.7	39.3	38.8	-1.1	1.7
14	Tecnomatix Technology	20.1	26.3	34.4	31.0	1.5
15	MICROCADAM	51.7	45.6	31.4	-31.3	1.4
16	C. Itoh Techno-Science	28.4	28.4	30.8	8.5	1.4
17	Sherpa Corp.	20.4	26.0	27.4	5.3	1.2
18	Toshiba	50.0	42.5	27.2	-36.0	1.2
19	Marubeni Hytech	19.9	23.0	24.9	8.5	1.1
20	Delcam Plc	16.0	20.8	23.2	11.8	1.0
21	Tokyo Electron	17.4	20.0	21.8	8.5	1.0
22	Ansys	24.5	27.8	20.0	-28.1	0.9
23	Fujitsu	65.0	72.7	19.8	-72.7	0.9
24	Intergraph	52.2	20.2	19.2	-5.0	0.9
25	MARC	18.2	17.7	18.9	6.7	0.8
26	Alias Research	17.3	17.3	18.6	7.9	0.8
27	ICEM Technologies	17.6	19.6	18.5	-5.9	0.8
28	Sumisho Electronics	14.2	16.4	17.8	8.5	0.8
29	Mitsui Engineering	13.5	15.5	16.9	8.5	0.8
30	Gerber Systems	13.1	14.9	16.2	8.8	0.7
	All N.A. Companies	1,553.6	1,782.7	1,765.8	-0.9	78.6
	All European Companies	237.9	219.2	204.6	-6.7	9.1
	All Asian Companies	374.5	356.0	275.6	-22.6	12.3
	All Companies	**2,166.0**	**2,357.8**	**2,245.9**	**-4.7**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table A-3
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top 30 Mechanical Software Companies, Worldwide, NT

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	Parametric Technology	51.4	108.9	151.5	39.1	21.6
2	Autodesk	-	29.1	109.0	274.5	15.6
3	EDS Unigraphics	-	16.1	62.4	286.5	8.9
4	Fujitsu	-	-	56.4	NA	8.1
5	CoCreate	3.2	7.5	40.2	439.0	5.7
6	MICROCADAM	6.4	18.2	39.2	115.0	5.6
7	Structural Dynamics Research Corporation	4.8	6.6	24.8	276.8	3.5
8	ISD Software	-	12.3	17.0	37.5	2.4
9	Matra Datavision	9.6	10.1	14.1	39.9	2.0
10	Wacom	4.9	7.1	12.0	70.0	1.7
11	CAD Lab	0.7	5.2	10.5	102.9	1.5
12	Ansys	3.9	4.8	10.3	114.1	1.5
13	ADRA Systems	-	-	10.2	NA	1.5
14	Omron	5.8	5.8	10.1	74.1	1.4
15	Bentley Systems	5.1	6.4	9.0	39.4	1.3
16	Graphtec Engineering	-	2.6	8.7	238.1	1.2
17	Radan Computational	-	5.1	8.7	72.0	1.2
18	NEC	5.2	4.5	7.6	70.0	1.1
19	Applicon	-	-	7.4	NA	1.1
20	CAD Distribution	3.5	4.8	7.4	53.5	1.1
21	Intergraph	1.8	6.9	6.6	-5.0	0.9
22	Dassault Systemes	-	6.3	6.3	-	0.9
23	Hitachi	-	-	6.1	NA	0.9
24	Toshiba	-	-	6.1	NA	0.9
25	Seiko	-	-	5.9	NA	0.8
26	Agile Software	1.0	0.6	5.7	876.2	0.8
27	ASCAD	0.9	1.0	5.7	461.5	0.8
28	Toshiba Engineering	-	2.5	4.3	70.0	0.6
29	Hitachi Zosen Info Systems	-	-	4.3	NA	0.6
30	BCT GmbH	0.4	2.5	3.9	56.0	0.6
	All N.A. Companies	84.6	225.9	512.5	126.9	73.2
	All European Companies	15.0	45.4	71.0	56.3	10.1
	All Asian Companies	15.9	22.2	116.9	426.5	16.7
	All Companies	**115.5**	**293.5**	**700.3**	**138.6**	**100.0**

NA = Not Available
Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table A-4
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top 30 Mechanical Software Companies, Worldwide, Personal Computer

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	Autodesk	180.7	142.3	107.1	-24.7	19.8
2	MICROCADAM	71.1	88.2	86.2	-2.2	16.0
3	Hitachi	10.2	9.2	48.6	428.9	9.0
4	Toshiba	16.7	20.0	27.2	36.1	5.0
5	Fujitsu	24.2	26.9	26.1	-3.0	4.8
6	NEC	24.0	20.8	22.4	8.0	4.2
7	Andor	15.9	17.8	19.2	8.0	3.6
8	CoCreate	16.5	21.1	17.0	-19.4	3.2
9	Design Automation	11.6	13.3	14.1	6.6	2.6
10	Cimatron	9.3	13.0	12.9	-0.4	2.4
11	Investronica SA	11.1	10.6	10.3	-3.2	1.9
12	CNC Software	8.4	8.7	8.8	1.8	1.6
13	Bentley Systems	7.2	6.0	8.4	39.4	1.6
14	Tebis	8.0	8.9	8.0	-9.5	1.5
15	Ashlar	5.7	5.9	6.9	16.5	1.3
16	Baystate Technologies	1.3	4.1	6.5	58.9	1.2
17	Surfware	5.0	5.4	6.5	20.0	1.2
18	Info. Services Int'l. Dentsu	4.3	5.9	6.4	8.5	1.2
19	Formtek	5.7	6.2	6.2	0.5	1.2
20	Matra Datavision	2.3	2.5	6.0	139.1	1.1
21	Viagrafix	5.6	5.4	5.6	2.6	1.0
22	Sumisho Electronics	4.6	5.1	5.6	8.0	1.0
23	Pathtrace Engineering Systems	3.2	4.2	5.3	28.1	1.0
24	PAFEC	2.4	5.3	5.2	-1.2	1.0
25	Serbi	5.9	5.6	5.0	-10.8	0.9
26	Applicon	4.2	4.6	5.0	9.1	0.9
27	Algor Interactive Systems	6.0	6.3	5.0	-21.1	0.9
28	Wiechers Datentechnik	4.5	4.8	4.8	1.2	0.9
29	Whessoe Computing Systems	4.1	4.2	4.2	-0.4	0.8
30	BCT GmbH	3.8	4.7	4.2	-10.4	0.8
	All N.A. Companies	383.5	366.1	311.3	-15.0	57.6
	All European Companies	78.9	83.5	87.1	4.3	16.1
	All Asian Companies	79.2	85.9	141.6	64.8	26.2
	All Companies	**541.6**	**535.5**	**540.0**	**0.8**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table A-5
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top 24 Mechanical Software Companies, Worldwide, Host/Proprietary

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	IBM	89.3	69.6	78.3	12.6	84.8
2	Dassault Systemes	44.2	27.4	33.0	20.2	35.7
3	MacNeal-Schwendler	25.1	23.8	14.8	-37.9	16.0
4	Fujitsu	7.8	7.7	2.1	-72.8	2.3
5	Matra Datavision	-	-	1.7	NA	1.8
6	C. Itoh Techno-Science	2.4	2.4	1.7	-30.0	1.8
7	Hitachi	3.3	3.0	1.6	-45.5	1.8
8	Exapt	4.5	1.3	0.9	-25.1	1.0
9	Mitsubishi Electric	1.2	0.9	0.6	-30.0	0.6
10	Toyo Information Systems	0.8	0.6	0.4	-30.0	0.4
11	Nihon Unisys	1.1	0.8	0.4	-51.4	0.4
12	Kubota Computer	0.8	0.5	0.3	-32.3	0.4
13	Ansys	1.3	1.1	0.3	-71.0	0.3
14	Whessoe Computing Systems	0.5	0.4	0.3	-19.2	0.3
15	Computational Mechanics	0.5	0.3	0.2	-25.4	0.3
16	Mechanical Dynamics	1.9	1.5	0.2	-88.8	0.2
17	Century Research Center	0.3	0.2	0.1	-30.0	0.2
18	Sherpa Corp.	0.2	0.2	0.1	-40.1	0.2
19	Altair Computing	-	0.2	0.1	-45.1	0.1
20	ESI Group	0.4	0.2	0.1	-49.7	0.1
21	debis Systemhaus	0.2	0.2	0	-79.5	0.1
22	Technodia	0	0.0	0	-30.0	0
23	Access Corp.	0.4	0.2	-	-100.0	-
24	CIMTEK	0.1	0.1	-	-100.0	-
	All N.A. Companies	102.3	83.6	83.6	-0.0	90.5
	All European Companies	3.1	2.2	3.7	71.8	4.0
	All Asian Companies	11.9	11.3	5.0	-55.5	5.4
	All Companies	**117.2**	**97.0**	**92.3**	**-4.9**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table A-6
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top 30 Mechanical Software Companies, North America, All Operating Systems

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	Parametric Technology	160.6	217.8	285.4	31.0	25.4
2	IBM	95.1	123.9	165.8	33.8	14.8
3	EDS Unigraphics	80.1	95.2	122.7	28.8	10.9
4	Autodesk	84.3	73.2	91.6	25.1	8.2
5	Dassault Systemes	54.1	74.3	87.4	17.7	7.8
6	Structural Dynamics Research Corporation	68.3	73.3	82.6	12.8	7.4
7	MacNeal-Schwendler	50.0	48.0	43.5	-9.2	3.9
8	Computervision	48.1	64.0	25.3	-60.5	2.3
9	CoCreate	11.9	15.6	19.8	27.1	1.8
10	Sherpa Corp.	13.4	15.7	17.1	8.4	1.5
11	Ansys	15.4	18.7	15.1	-19.2	1.3
12	Intergraph	24.8	14.1	13.4	-5.0	1.2
13	Formtek	10.0	10.5	11.3	7.1	1.0
14	MICROCADAM	9.0	10.6	11.0	3.1	1.0
15	Altair Computing	6.0	10.0	10.8	8.3	1.0
16	Tecnomatix Technology	7.4	8.6	10.8	24.5	1.0
17	Gerber Systems	8.3	9.4	10.2	9.0	0.9
18	Applicon	8.3	8.8	10.1	15.0	0.9
19	Alias Research	8.6	8.6	9.4	9.0	0.8
20	Algor Interactive Systems	9.7	9.0	8.6	-5.2	0.8
21	Matra Datavision	4.4	5.5	8.5	54.9	0.8
22	Bentley Systems	6.0	5.8	8.1	39.4	0.7
23	Mechanical Dynamics	4.7	5.5	7.2	32.4	0.6
24	ADRA Systems	8.1	9.2	6.9	-25.8	0.6
25	CGTech	5.5	5.8	6.6	14.1	0.6
26	Agile Software	1.4	0.8	6.3	650.0	0.6
27	Ashlar	3.0	3.1	6.2	97.8	0.6
28	DP Technology	3.8	4.8	6.1	26.4	0.5
29	ICEM Technologies	6.2	7.4	5.9	-19.2	0.5
30	CNC Software	5.6	5.8	5.9	2.5	0.5
	All N.A. Companies	818.4	942.0	1,075.4	14.2	95.9
	All European Companies	28.4	39.5	43.8	11.0	3.9
	All Asian Companies	1.6	1.8	2.3	30.8	0.2
	All Companies	**848.4**	**983.3**	**1,121.6**	**14.1**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table A-7
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top 30 Mechanical Software Companies, North America, UNIX

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	Parametric Technology	134.9	169.9	214.0	26.0	28.7
2	IBM	77.2	109.4	146.3	33.8	19.6
3	EDS Unigraphics	80.1	85.7	85.9	0.2	11.5
4	Dassault Systemes	43.1	61.6	73.3	18.9	9.8
5	Structural Dynamics Research Corporation	63.2	69.7	70.0	0.4	9.4
6	MacNeal-Schwendler	38.0	35.2	34.5	-2.1	4.6
7	Computervision	46.0	61.2	24.2	-60.5	3.2
8	Sherpa Corp.	13.3	15.6	17.0	9.0	2.3
9	Tecnomatix Technology	7.4	8.6	10.8	24.5	1.4
10	Altair Computing	5.9	9.5	10.3	9.0	1.4
11	Gerber Systems	8.3	9.4	10.2	9.0	1.4
12	Intergraph	24.0	10.5	10.0	-5.0	1.3
13	Alias Research	8.6	8.6	9.4	9.0	1.3
14	Ansys	11.6	14.0	9.4	-33.2	1.3
15	CoCreate	8.9	10.5	8.4	-19.7	1.1
16	Formtek	7.0	7.4	8.0	9.0	1.1
17	Matra Datavision	3.8	4.8	6.4	33.7	0.9
18	Mechanical Dynamics	3.8	4.2	5.9	41.0	0.8
19	ICEM Technologies	6.2	7.1	5.5	-22.4	0.7
20	Applicon	6.6	6.9	4.9	-29.6	0.7
21	CGTech	3.9	4.0	4.3	7.5	0.6
22	Concentra	8.0	12.0	4.3	-64.5	0.6
23	Cadis Software	1.1	3.3	3.8	15.0	0.5
24	CIMLINC	3.4	3.4	3.8	9.0	0.5
25	First Cadcam Inc.	2.6	3.0	3.4	11.2	0.5
26	Adina R&D	2.7	3.1	3.3	9.0	0.4
27	MARC	2.6	2.8	3.1	9.0	0.4
28	CSAR Corp.	1.7	2.6	3.0	17.1	0.4
29	Auto-Trol	3.7	2.6	2.8	7.2	0.4
30	Delcam Plc	3.2	2.5	2.8	11.8	0.4
	All N.A. Companies	596.7	686.0	713.9	4.1	95.8
	All European Companies	24.2	27.8	29.6	6.7	4.0
	All Asian Companies	1.4	1.6	1.8	7.7	0.2
	All Companies	**622.3**	**715.4**	**745.2**	**4.2**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

Table A-8
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top 30 Mechanical Software Companies, North America, NT

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	Parametric Technology	25.7	47.9	71.3	48.9	31.5
2	Autodesk	-	12.1	45.8	279.0	20.2
3	EDS Unigraphics	-	9.5	36.8	286.5	16.3
4	Structural Dynamics Research Corporation	3.0	2.9	12.0	308.9	5.3
5	CoCreate	0.5	1.3	8.0	498.9	3.6
6	Agile Software	1.0	0.6	5.2	778.6	2.3
7	Ansys	1.9	2.4	4.8	98.9	2.1
8	Dassault Systemes	-	4.7	4.7	-	2.1
9	ADRA Systems	-	-	4.4	NA	1.9
10	Bentley Systems	2.3	2.9	4.0	39.4	1.8
11	Intergraph	0.8	3.6	3.4	-5.0	1.5
12	Applicon	-	-	3.1	NA	1.4
13	3D/Eye, Inc.	-	1.8	3.0	72.0	1.3
14	Algor Interactive Systems	-	-	3.0	NA	1.3
15	MICROCADAM	0.5	1.3	2.7	114.8	1.2
16	DP Technology	0.8	1.5	2.6	72.0	1.2
17	Matra Datavision	0.5	0.6	1.4	133.1	0.6
18	CGTech	0.6	0.6	1.3	107.4	0.6
19	MacNeal-Schwendler	0.5	0.5	1.1	137.7	0.5
20	Mechanical Dynamics	-	0.4	0.9	115.2	0.4
21	Gibbs and Assoc.	-	0.4	0.9	118.5	0.4
22	Spatial Technology	-	0.4	0.8	96.7	0.3
23	NOVASOFT Systems	0.2	0.5	0.7	49.3	0.3
24	Auto-Trol	-	0.1	0.7	409.1	0.3
25	Delcam Plc	-	0.1	0.5	260.5	0.2
26	SRAC	0.4	0.4	0.4	10.1	0.2
27	MARC	-	0.2	0.4	72.0	0.2
28	ICEM Technologies	-	0.2	0.4	89.9	0.2
29	B.A. Intelligence Networks	0.2	0.4	0.3	-24.3	0.1
30	CAD Lab	-	-	0.3	NA	0.1
	All N.A. Companies	39.2	94.1	218.4	132.2	96.6
	All European Companies	0.5	5.9	7.5	27.0	3.3
	All Asian Companies	-	-	0.3	NA	0.1
	All Companies	**39.7**	**100.0**	**226.2**	**126.3**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table A-9
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top 30 Mechanical Software Companies, North America, Personal Computer

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	Autodesk	79.3	58.9	44.9	-23.9	35.5
2	Ashlar	3.0	3.1	6.2	97.8	4.9
3	MICROCADAM	5.0	6.2	6.0	-2.2	4.8
4	CNC Software	5.6	5.8	5.9	2.5	4.7
5	Viagrafix	5.0	5.1	5.3	2.5	4.2
6	Baystate Technologies	1.1	3.5	4.9	41.8	3.9
7	Surfware	3.6	3.8	4.5	20.0	3.6
8	Algor Interactive Systems	5.8	5.4	3.9	-28.9	3.1
9	Bentley Systems	3.3	2.7	3.7	39.4	3.0
10	CoCreate	2.5	3.8	3.4	-10.5	2.7
11	Formtek	3.0	3.2	3.2	2.5	2.6
12	SRAC	1.5	2.2	2.4	10.1	1.9
13	Applicon	1.7	1.8	2.1	13.6	1.7
14	Cimatron	0.9	2.0	2.0	2.5	1.6
15	DP Technology	1.9	2.0	2.0	2.5	1.6
16	Gibbs and Assoc.	2.2	1.6	2.0	27.4	1.6
17	Pathtrace Engineering Systems	1.5	2.0	1.8	-7.3	1.4
18	3D/Eye, Inc.	-	1.8	1.8	2.5	1.4
19	MacNeal-Schwendler	0.6	1.8	1.4	-18.3	1.1
20	Variation Systems Analysis	1.3	1.3	1.3	2.5	1.1
21	Agile Software	0.4	0.3	1.1	350.0	0.9
22	Computervision	2.1	2.8	1.1	-60.5	0.9
23	Engineering Mechanics	1.0	1.1	1.1	2.5	0.9
24	ADRA Systems	2.2	2.5	1.1	-57.0	0.8
25	Workgroup Tech.	1.8	2.2	1.1	-52.3	0.8
26	Boothroyd Dewhurst	1.0	1.0	1.0	2.5	0.8
27	CGTech	1.1	1.2	1.0	-14.4	0.8
28	NOVASOFT Systems	1.0	1.0	1.0	-2.9	0.8
29	Diehl Graphsoft	1.0	1.1	0.8	-20.0	0.7
30	Consensys	0.5	0.8	0.8	2.5	0.6
	All N.A. Companies	154.8	138.2	119.7	-13.4	94.8
	All European Companies	3.5	5.8	6.4	11.2	5.1
	All Asian Companies	0.1	0.1	0.2	281.1	0.2
	All Companies	**158.4**	**144.0**	**126.3**	**-12.3**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table A-10
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top 14 Mechanical Software Companies, North America, Host/Proprietary

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	IBM	17.9	14.3	19.2	33.9	80.2
2	Dassault Systemes	11.1	7.4	8.9	20.2	37.3
3	MacNeal-Schwendler	11.0	10.5	6.5	-38.1	27.2
4	Matra Datavision	-	-	0.2	NA	0.7
5	Ansys	0.6	0.6	0.2	-73.1	0.6
6	Altair Computing	-	0.2	0.1	-50.0	0.4
7	Sherpa Corp.	0.1	0.1	0.1	-50.0	0.3
8	Mechanical Dynamics	0.7	0.6	0.1	-88.0	0.3
9	Kubota Computer	0.1	0.1	0	-50.0	0.1
10	Computational Mechanics	0.2	0	0.0	-50.0	0.1
11	Fujitsu	-	-	0	NA	0
12	debis Systemhaus	-	0	0.0	-93.2	0
13	ESI Group	-	0	0.0	-43.7	0
14	Access Corp.	0.4	0.2	-	-100.0	-
	All N.A. Companies	27.7	23.7	23.5	-0.9	98.5
	All European Companies	0.2	0.1	0.3	434.8	1.4
	All Asian Companies	0.1	0.1	0	-32.3	0.2
	All Companies	**28.0**	**23.9**	**23.9**	**0.1**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table A-11
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top 30 Mechanical Software Companies, Europe, All Operating Systems

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	IBM	249.5	298.5	347.5	16.4	28.7
2	Parametric Technology	109.2	173.3	209.6	21.0	17.3
3	Dassault Systemes	112.4	133.3	160.1	20.1	13.2
4	Autodesk	60.7	55.2	67.6	22.5	5.6
5	EDS Unigraphics	37.4	46.8	60.3	28.8	5.0
6	Matra Datavision	70.0	68.8	55.4	-19.5	4.6
7	Structural Dynamics Research Corporation	38.7	54.3	48.5	-10.7	4.0
8	CoCreate	43.5	40.8	47.6	16.8	3.9
9	Computervision	73.6	81.1	29.3	-63.9	2.4
10	MacNeal-Schwendler	32.0	31.6	27.0	-14.6	2.2
11	ISD Software	14.5	22.4	22.6	0.7	1.9
12	Tecnomatix Technology	11.6	16.3	20.8	27.8	1.7
13	ASCAD	14.9	16.5	16.0	-3.0	1.3
14	Delcam Plc	7.7	12.9	15.4	19.4	1.3
15	CAD Lab	13.6	12.8	14.0	8.9	1.2
16	Tebis	12.5	14.0	13.1	-6.4	1.1
17	Applicon	12.4	12.1	13.0	7.0	1.1
18	Radan Computational	7.6	8.2	11.8	43.5	1.0
19	ICEM Technologies	10.4	11.9	11.7	-1.9	1.0
20	MICROCADAM	10.3	12.2	11.0	-9.8	0.9
21	Sherpa Corp.	7.2	10.5	10.4	-0.6	0.9
22	Ansys	10.1	11.1	10.3	-7.2	0.8
23	Bentley Systems	6.2	5.9	8.2	39.4	0.7
24	Investronica SA	6.0	8.6	8.2	-5.0	0.7
25	BCT GmbH	4.2	7.2	8.1	12.8	0.7
26	Straessle Informationssysteme	12.0	10.3	8.0	-21.6	0.7
27	CAD Distribution	5.8	5.1	7.6	50.2	0.6
28	ADRA Systems	6.8	7.8	7.5	-4.1	0.6
29	Sescoi	6.0	7.5	7.1	-5.2	0.6
30	PROCAD GmbH & Co KG	5.8	6.5	6.8	5.3	0.6
	All N.A. Companies	752.5	875.4	945.0	7.9	77.9
	All European Companies	261.4	264.1	267.8	1.4	22.1
	All Asian Companies	-	-	-	NA	-
	All Companies	**1,013.9**	**1,139.5**	**1,212.8**	**6.4**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table A-12
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top 30 Mechanical Software Companies, Europe, UNIX

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	IBM	206.0	263.5	306.8	16.4	37.5
2	Parametric Technology	91.7	135.1	157.2	16.3	19.2
3	Dassault Systemes	86.7	116.5	140.0	20.2	17.1
4	EDS Unigraphics	37.4	42.1	42.2	0.2	5.2
5	Matra Datavision	60.4	59.4	41.3	-30.5	5.0
6	Structural Dynamics Research Corporation	37.0	51.7	41.1	-20.5	5.0
7	Computervision	70.4	77.5	28.0	-63.9	3.4
8	MacNeal-Schwendler	24.3	23.2	21.4	-8.0	2.6
9	Tecnomatix Technology	11.6	16.3	20.8	27.8	2.5
10	CoCreate	32.6	27.3	20.2	-26.2	2.5
11	Delcam Plc	7.4	12.3	13.2	8.0	1.6
12	ICEM Technologies	10.4	11.5	10.9	-4.9	1.3
13	Sherpa Corp.	7.1	10.4	10.4	-0.3	1.3
14	ASCAD	12.8	14.1	9.6	-32.3	1.2
15	Straessle Informationssysteme	12.0	10.3	8.0	-21.6	1.0
16	Eigner + Partner	6.3	6.8	6.7	-1.9	0.8
17	Ansys	7.6	8.3	6.4	-23.3	0.8
18	Han Dataport	7.8	6.5	6.3	-2.5	0.8
19	Applicon	10.0	9.6	6.3	-34.5	0.8
20	Sescoi	4.8	6.0	5.8	-3.5	0.7
21	Open Mind	-	-	5.7	NA	0.7
22	PROCAD GmbH & Co KG	5.2	5.7	5.6	-1.9	0.7
23	ESI Group	6.5	5.5	5.4	-0.5	0.7
24	MARC	4.5	5.3	5.4	0.6	0.7
25	Tebis	4.6	5.3	5.2	-1.0	0.6
26	debis Systemhaus	3.0	3.2	4.7	48.1	0.6
27	Intergraph	19.1	4.8	4.6	-5.0	0.6
28	Alias Research	4.3	4.3	4.3	0.6	0.5
29	Mechanical Dynamics	3.0	3.7	4.3	15.1	0.5
30	CAD Lab	7.5	6.4	4.2	-34.7	0.5
	All N.A. Companies	580.1	680.1	674.0	-0.9	82.4
	All European Companies	184.9	162.6	143.7	-11.6	17.6
	All Asian Companies	-	-	-	NA	-
	All Companies	**765.0**	**842.6**	**817.7**	**-3.0**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table A-13
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top 30 Mechanical Software Companies, Europe, NT

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	Parametric Technology	17.5	38.1	52.4	37.5	23.8
2	Autodesk	-	9.1	33.8	271.5	15.3
3	CoCreate	1.8	3.5	19.3	450.5	8.7
4	EDS Unigraphics	-	4.7	18.1	286.5	8.2
5	ISD Software	-	12.2	16.8	37.4	7.6
6	CAD Lab	0.7	5.1	9.8	90.6	4.4
7	Matra Datavision	7.7	7.5	9.1	21.2	4.1
8	Radan Computational	-	4.5	7.8	72.2	3.5
9	CAD Distribution	3.5	4.8	7.4	53.5	3.3
10	Structural Dynamics Research Corporation	1.0	2.2	7.0	223.9	3.2
11	ASCAD	0.9	1.0	5.7	461.5	2.6
12	Bentley Systems	2.3	2.9	4.0	39.4	1.8
13	Applicon	-	-	4.0	NA	1.8
14	BCT GmbH	0.4	2.5	3.9	56.0	1.8
15	ADRA Systems	-	-	3.6	NA	1.6
16	Ansys	1.2	1.4	3.3	128.4	1.5
17	MICROCADAM	0.5	1.5	2.7	88.0	1.2
18	Vero International Software	-	1.3	2.2	71.2	1.0
19	Delcam Plc	-	0.6	2.2	235.8	1.0
20	Intergraph	0.6	1.7	1.6	-5.0	0.7
21	PROCAD GmbH & Co KG	0.6	0.8	1.3	55.9	0.6
22	Modultek Oy	-	-	0.9	NA	0.4
23	Dassault Systemes	-	0.9	0.9	-	0.4
24	ICEM Technologies	-	0.4	0.8	75.0	0.4
25	Catalpa groupe Missler	-	0.5	0.8	73.7	0.4
26	MARC	-	0.5	0.7	60.0	0.3
27	MacNeal-Schwendler	0.3	0.3	0.7	123.5	0.3
28	Mechanical Dynamics	-	0.4	0.7	75.6	0.3
29	CIMTEK	-	-	0.7	NA	0.3
30	IBM	-	0.5	0.6	17.1	0.3
	All N.A. Companies	27.0	73.0	164.6	125.5	74.6
	All European Companies	13.1	35.1	55.9	59.5	25.4
	All Asian Companies	-	-	-	NA	-
	All Companies	**40.1**	**108.1**	**220.5**	**104.1**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table A-14
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top 30 Mechanical Software Companies, Europe, Personal Computer

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	Autodesk	58.4	44.4	33.1	-25.4	25.0
2	CoCreate	9.1	9.9	8.2	-17.7	6.2
3	Investronica SA	6.0	8.6	8.2	-5.0	6.1
4	Tebis	7.9	8.8	7.9	-9.6	6.0
5	MICROCADAM	5.7	7.1	6.0	-14.4	4.5
6	Serbi	5.9	5.6	5.0	-10.8	3.8
7	Wiechers Datentechnik	4.5	4.6	4.6	0.2	3.5
8	BCT GmbH	3.8	4.7	4.2	-10.4	3.2
9	Ziegler Informatics	3.3	4.6	4.1	-10.2	3.1
10	Cimatron	3.4	4.4	4.1	-7.5	3.1
11	Matra Datavision	1.8	1.9	3.9	107.2	2.9
12	Whessoe Computing Systems	3.8	3.9	3.8	-0.5	2.9
13	Bentley Systems	3.3	2.7	3.8	39.4	2.9
14	PAFEC	-	3.7	3.6	-3.0	2.7
15	CADdy Spain	1.4	1.4	3.1	119.3	2.3
16	Pathtrace Engineering Systems	1.6	2.1	2.7	28.1	2.0
17	Applicon	2.4	2.6	2.7	5.7	2.0
18	Anilam Electronics	2.6	2.7	2.7	-1.2	2.0
19	ISD Software	4.0	2.6	2.6	-3.7	1.9
20	Just In Time Systems	2.5	2.1	1.9	-10.5	1.4
21	RoboCAD Solutions	1.9	1.6	1.5	-4.1	1.1
22	Formtek	1.4	1.5	1.4	-7.6	1.1
23	ADRA Systems	1.8	2.1	1.4	-35.6	1.0
24	Sescoi	1.2	1.5	1.3	-12.0	1.0
25	Computervision	3.2	3.6	1.3	-63.9	1.0
26	Vero International Software	1.7	1.2	1.2	-4.4	0.9
27	CNC Software	1.3	1.2	1.1	-3.9	0.9
28	B.A. Intelligence Networks	0.8	0.7	1.1	54.1	0.9
29	Superdraft	1.2	1.1	1.1	-3.5	0.8
30	Softronics	2.0	1.0	1.0	2.7	0.8
	All N.A. Companies	101.6	86.5	67.2	-22.3	50.7
	All European Companies	60.8	64.5	65.4	1.5	49.3
	All Asian Companies	-	-	-	NA	-
	All Companies	**162.4**	**151.0**	**132.6**	**-12.1**	**100.0**

NA = Not Available
Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table A-15
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top 14 Mechanical Software Companies, Europe, Host/Proprietary

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	IBM	43.6	34.5	40.2	16.4	95.8
2	Dassault Systemes	25.6	15.9	19.1	20.2	45.5
3	MacNeal-Schwendler	7.0	6.9	4.0	-41.8	9.6
4	Matra Datavision	-	-	1.1	NA	2.6
5	Exapt	3.0	1.3	0.9	-25.1	2.3
6	Whessoe Computing Systems	0.3	0.3	0.2	-18.6	0.5
7	Computational Mechanics	0.2	0.2	0.2	-21.2	0.4
8	Ansys	0.4	0.3	0.1	-69.1	0.2
9	ESI Group	0.4	0.1	0.1	-45.8	0.2
10	Sherpa Corp.	0.1	0.1	0.1	-25.2	0.2
11	Mechanical Dynamics	0.6	0.5	0.1	-90.2	0.1
12	debis Systemhaus	0.2	0.2	0	-78.6	0.1
13	CIMTEK	0.1	0.1	-	-100.0	-
14	Access Corp.	0	0.0	-	-100.0	-
	All N.A. Companies	43.8	35.9	39.1	9.0	93.4
	All European Companies	2.6	2.0	2.8	42.0	6.6
	All Asian Companies	-	-	-	NA	-
	All Companies	**46.4**	**37.9**	**41.9**	**10.7**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table A-16
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top 30 Mechanical Software Companies, Japan, All Operating Systems

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	MICROCADAM	104.7	123.1	128.5	4.4	13.0
2	Info. Services Int'l. Dentsu	85.2	117.2	127.1	8.5	12.9
3	Fujitsu	97.0	107.3	103.4	-3.7	10.5
4	IBM	106.0	109.8	86.8	-20.9	8.8
5	NEC	72.9	62.9	70.9	12.7	7.2
6	Hitachi	70.9	63.7	68.7	7.8	7.0
7	Toshiba	66.7	62.5	60.5	-3.2	6.1
8	Parametric Technology	41.8	71.1	58.2	-18.2	5.9
9	Nihon Unisys	52.8	54.4	55.1	1.2	5.6
10	Hitachi Zosen Info Systems	38.3	38.9	42.7	9.9	4.3
11	C. Itoh Techno-Science	30.8	30.8	32.5	5.5	3.3
12	CoCreate	22.9	30.4	28.8	-5.2	2.9
13	Structural Dynamics Research Corporation	31.3	25.9	28.0	8.2	2.8
14	Dassault Systemes	20.0	21.4	25.5	19.2	2.6
15	Marubeni Hytech	19.9	23.0	24.9	8.5	2.5
16	Autodesk	19.0	19.8	24.0	20.8	2.4
17	Sumisho Electronics	18.8	21.6	23.4	8.4	2.4
18	Tokyo Electron	17.4	20.0	21.8	8.5	2.2
19	MacNeal-Schwendler	29.6	21.8	21.3	-2.2	2.2
20	Seiko	19.7	19.0	21.3	12.1	2.2
21	Andor	15.9	17.8	19.2	8.0	1.9
22	Mitsui Engineering	14.0	16.1	17.5	8.5	1.8
23	Wacom	6.0	8.4	13.5	60.1	1.4
24	Design Automation	10.0	11.5	12.2	6.6	1.2
25	Omron	7.8	7.7	12.0	55.4	1.2
26	Matra Datavision	5.2	11.9	11.9	0.1	1.2
27	MARC	11.1	9.8	11.1	13.4	1.1
28	Graphtec Engineering	8.6	8.6	10.9	26.5	1.1
29	Mutoh Industries	13.1	9.3	10.6	14.5	1.1
30	Toyo Information Systems	8.1	9.0	9.5	6.0	1.0
	All N.A. Companies	406.8	454.0	427.5	-5.9	43.3
	All European Companies	18.8	24.4	26.9	10.3	2.7
	All Asian Companies	475.8	469.8	532.3	13.3	53.9
	All Companies	**901.4**	**948.3**	**986.7**	**4.1**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table A-17
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top 30 Mechanical Software Companies, Japan, UNIX

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	Info. Services Int'l. Dentsu	80.9	111.3	120.8	8.5	23.1
2	IBM	86.1	95.5	75.6	-20.9	14.4
3	Nihon Unisys	51.8	53.6	54.1	1.0	10.3
4	Parametric Technology	35.1	55.4	43.6	-21.3	8.3
5	NEC	43.7	37.7	40.9	8.5	7.8
6	Hitachi Zosen Info Systems	38.3	38.9	38.4	-1.1	7.3
7	C. Itoh Techno-Science	28.4	28.4	30.8	8.5	5.9
8	Toshiba	50.0	42.5	27.2	-36.0	5.2
9	MICROCADAM	41.9	36.9	25.7	-30.4	4.9
10	Marubeni Hytech	19.9	23.0	24.9	8.5	4.8
11	Structural Dynamics Research Corporation	30.6	24.6	23.7	-3.7	4.5
12	Dassault Systemes	15.6	18.6	22.2	19.5	4.2
13	Tokyo Electron	17.4	20.0	21.8	8.5	4.2
14	Fujitsu	65.0	72.7	19.6	-73.0	3.8
15	Sumisho Electronics	14.2	16.4	17.8	8.5	3.4
16	MacNeal-Schwendler	22.5	16.0	16.9	5.4	3.2
17	Mitsui Engineering	13.5	15.5	16.9	8.5	3.2
18	Seiko	19.7	19.0	15.4	-19.1	2.9
19	Hitachi	57.3	51.6	12.4	-76.0	2.4
20	CoCreate	17.2	20.4	12.2	-40.1	2.3
21	MARC	11.1	8.9	9.6	8.5	1.8
22	Toyo Information Systems	7.3	8.4	9.1	8.5	1.7
23	Matra Datavision	4.5	10.3	8.9	-13.6	1.7
24	Adam Net	7.2	7.7	8.4	8.5	1.6
25	Kubota Computer	6.6	7.6	8.2	8.5	1.6
26	Sharp	8.3	7.5	7.6	1.1	1.4
27	Nihon Itek	5.5	6.4	6.9	8.5	1.3
28	Computervision	13.4	15.0	5.7	-61.7	1.1
29	Adina R&D	4.1	4.7	5.1	8.5	1.0
30	Technodia	3.9	4.4	4.8	8.5	0.9
	All N.A. Companies	279.1	291.4	236.3	-18.9	45.1
	All European Companies	13.7	16.5	15.7	-4.8	3.0
	All Asian Companies	370.2	352.0	271.4	-22.9	51.9
	All Companies	**663.0**	**660.0**	**523.4**	**-20.7**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table A-18
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top 30 Mechanical Software Companies, Japan, NT

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	Fujitsu	-	-	55.8	NA	27.3
2	MICROCADAM	5.2	14.8	32.1	117.5	15.7
3	Parametric Technology	6.7	15.6	14.5	-7.0	7.1
4	Wacom	4.9	7.1	12.0	70.0	5.9
5	Autodesk	-	3.3	12.0	266.2	5.9
6	CoCreate	0.9	2.6	11.7	346.6	5.7
7	Omron	5.8	5.8	10.1	74.1	4.9
8	Graphtec Engineering	-	2.6	8.7	238.1	4.3
9	NEC	5.2	4.5	7.6	70.0	3.7
10	Hitachi	-	-	6.1	NA	3.0
11	Toshiba	-	-	6.1	NA	3.0
12	Seiko	-	-	5.9	NA	2.9
13	Toshiba Engineering	-	2.5	4.3	70.0	2.1
14	Hitachi Zosen Info Systems	-	-	4.3	NA	2.1
15	Structural Dynamics Research Corporation	0.4	1.0	4.1	292.2	2.0
16	Mutoh Industries	2.3	2.4	3.0	22.8	1.5
17	Kozo Keikaku Engineering	-	-	2.8	NA	1.4
18	Matra Datavision	0.6	1.3	2.0	50.6	1.0
19	EDS Unigraphics	-	0.5	1.9	286.5	0.9
20	Ricoh	-	-	1.7	NA	0.8
21	ADRA Systems	-	-	1.6	NA	0.8
22	Ansys	0.5	0.6	1.5	147.1	0.8
23	MARC	-	0.8	1.3	70.0	0.6
24	Vero International Software	-	0.6	0.9	60.9	0.5
25	Radan Computational	-	0.4	0.7	70.0	0.3
26	MacNeal-Schwendler	0.3	0.2	0.6	156.2	0.3
27	CGTech	0.2	0.2	0.5	107.4	0.2
28	Mechanical Dynamics	-	0.2	0.4	87.6	0.2
29	Dassault Systemes	-	0.4	0.4	-	0.2
30	Intergraph	0.1	0.3	0.3	-5.0	0.2
	All N.A. Companies	14.5	40.7	83.6	105.6	40.9
	All European Companies	0.6	2.8	4.4	58.3	2.2
	All Asian Companies	15.9	22.2	116.3	423.8	56.9
	All Companies	**31.0**	**65.7**	**204.3**	**211.1**	**100.0**

NA = Not Available
Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table A-19
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top 30 Mechanical Software Companies, Japan, Personal Computer

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	MICROCADAM	57.6	71.4	70.7	-1.0	29.4
2	Hitachi	10.2	9.2	48.6	428.9	20.2
3	Toshiba	16.7	20.0	27.2	36.1	11.3
4	Fujitsu	24.2	26.9	25.8	-3.9	10.7
5	NEC	24.0	20.8	22.4	8.0	9.3
6	Andor	15.9	17.8	19.2	8.0	8.0
7	Design Automation	10.0	11.5	12.2	6.6	5.1
8	Autodesk	18.0	16.2	12.0	-25.9	5.0
9	Info. Services Int'l. Dentsu	4.3	5.9	6.4	8.5	2.6
10	Sumisho Electronics	4.6	5.1	5.6	8.0	2.3
11	CoCreate	4.8	7.4	4.9	-33.3	2.1
12	Mutoh Industries	3.5	3.6	3.9	8.6	1.6
13	Argo Graphics	2.0	2.3	2.4	8.0	1.0
14	Kozo Keikaku Engineering	3.3	4.2	2.4	-43.8	1.0
15	Mitsubishi Electric	1.7	1.9	2.0	8.0	0.8
16	Cimatron	0.7	1.8	2.0	8.0	0.8
17	Wacom	1.1	1.3	1.4	8.0	0.6
18	Anilam Electronics	1.2	1.3	1.4	8.0	0.6
19	Graphtec Engineering	-	2.6	1.1	-58.6	0.4
20	Surfware	0.3	0.8	1.0	20.0	0.4
21	Matra Datavision	0.1	0.3	0.8	157.5	0.3
22	Adam Net	0.2	0.8	0.8	8.0	0.3
23	Investronica SA	-	0.7	0.7	8.0	0.3
24	MacNeal-Schwendler	0.3	0.8	0.7	-12.0	0.3
25	Formtek	0.9	0.6	0.7	8.0	0.3
26	Mitsui Engineering	0.5	0.6	0.6	8.0	0.3
27	Pathtrace Engineering Systems	0	0.0	0.6	1437.6	0.3
28	Nihon Unisys	-	-	0.6	NA	0.2
29	CADIX	-	-	0.5	NA	0.2
30	Uchida Yoko	0.8	1.3	0.5	-61.8	0.2
	All N.A. Companies	89.6	105.3	94.7	-10.1	39.3
	All European Companies	4.4	5.0	6.4	28.4	2.7
	All Asian Companies	77.9	84.3	139.6	65.5	58.0
	All Companies	**172.0**	**194.7**	**240.7**	**23.7**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table A-20
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top 19 Mechanical Software Companies, Japan, Host/Proprietary

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	IBM	20.0	14.1	11.1	-20.9	61.0
2	MacNeal-Schwendler	6.5	4.8	3.2	-33.3	17.4
3	Dassault Systemes	4.4	2.4	2.9	20.2	15.7
4	Fujitsu	7.8	7.7	2.1	-73.1	11.3
5	C. Itoh Techno-Science	2.4	2.4	1.7	-30.0	9.3
6	Hitachi	3.3	3.0	1.6	-45.5	8.9
7	Mitsubishi Electric	1.2	0.9	0.6	-30.0	3.3
8	Toyo Information Systems	0.8	0.6	0.4	-30.0	2.2
9	Nihon Unisys	1.1	0.8	0.4	-51.4	2.2
10	Kubota Computer	0.6	0.4	0.3	-30.0	1.7
11	Matra Datavision	-	-	0.2	NA	1.3
12	Century Research Center	0.3	0.2	0.1	-30.0	0.8
13	Ansys	0.2	0.1	0	-66.5	0.3
14	Whessoe Computing Systems	0.1	0.1	0	-30.0	0.2
15	Mechanical Dynamics	0.5	0.3	0	-89.5	0.2
16	Altair Computing	-	0	0.0	-30.0	0.1
17	Technodia	0	0.0	0	-30.0	0.1
18	Computational Mechanics	0	0.0	0	-30.0	0.1
19	ESI Group	0	0.0	0	-93.4	0
	All N.A. Companies	23.6	16.7	12.9	-22.3	71.0
	All European Companies	0.1	0.1	0.3	311.0	1.8
	All Asian Companies	11.7	11.2	5.0	-55.7	27.2
	All Companies	**35.4**	**28.0**	**18.2**	**-34.8**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table A-21
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top 30 Mechanical Software Companies, Asia/Pacific, All Operating Systems

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	Parametric Technology	9.6	32.9	52.7	60.4	24.4
2	IBM	38.8	42.3	48.2	13.9	22.3
3	Autodesk	20.9	22.9	28.3	23.6	13.1
4	EDS Unigraphics	13.3	14.5	18.7	28.8	8.7
5	Dassault Systemes	13.3	15.0	17.9	19.7	8.3
6	Structural Dynamics Research Corporation	6.5	10.9	11.6	7.1	5.4
7	Matra Datavision	7.0	4.6	8.5	85.9	4.0
8	MacNeal-Schwendler	2.4	6.5	6.2	-4.4	2.9
9	MICROCADAM	3.9	4.6	4.7	3.1	2.2
10	Computervision	10.3	10.1	4.3	-57.1	2.0
11	Delcam Plc	2.8	3.1	4.1	32.6	1.9
12	Intergraph	2.1	2.8	2.6	-5.0	1.2
13	Formtek	0.8	2.1	2.3	10.0	1.1
14	Alias Research	1.7	1.7	2.1	20.0	1.0
15	Cimatron	1.7	1.8	1.9	3.9	0.9
16	Sharp	2.1	1.9	1.9	1.1	0.9
17	Design Automation	1.6	1.8	1.9	6.6	0.9
18	Gerber Systems	1.2	1.5	1.8	18.5	0.8
19	Mechanical Dynamics	1.0	0.9	1.5	65.6	0.7
20	ADRA Systems	1.1	1.3	1.3	2.1	0.6
21	Ansys	2.0	1.9	1.3	-30.4	0.6
22	Bentley Systems	0.9	0.9	1.3	39.4	0.6
23	Tecnomatix Technology	-	-	1.3	NA	0.6
24	MARC	-	0.8	1.0	30.5	0.5
25	PAFEC	-	1.0	1.0	5.2	0.5
26	Investronica SA	3.9	0.8	0.8	2.8	0.4
27	DP Technology	0.3	0.5	0.7	53.7	0.3
28	CNC Software	0.6	0.7	0.7	2.4	0.3
29	Altair Computing	0.4	0.6	0.7	14.0	0.3
30	Concentra	0.3	1.2	0.7	-43.7	0.3
	All N.A. Companies	118.6	158.9	192.1	20.9	89.0
	All European Companies	17.8	14.1	19.3	36.3	8.9
	All Asian Companies	4.1	3.8	4.5	18.0	2.1
	All Companies	**140.4**	**176.8**	**215.8**	**22.1**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table A-22
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top 30 Mechanical Software Companies, Asia/Pacific, UNIX

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	IBM	31.9	36.4	41.4	13.9	29.8
2	Parametric Technology	8.1	25.6	39.5	54.2	28.5
3	Dassault Systemes	10.2	12.9	15.5	20.2	11.1
4	EDS Unigraphics	13.3	13.1	13.1	0.2	9.4
5	Structural Dynamics Research Corporation	5.7	10.3	9.9	-4.7	7.1
6	Matra Datavision	6.0	4.0	6.4	60.4	4.6
7	MacNeal-Schwendler	1.8	4.8	4.9	3.0	3.6
8	Computervision	9.8	9.7	4.1	-57.1	3.0
9	Delcam Plc	2.7	2.9	3.5	19.8	2.5
10	Alias Research	1.7	1.7	2.1	20.0	1.5
11	Intergraph	2.0	2.1	2.0	-5.0	1.4
12	Sharp	2.1	1.9	1.9	1.1	1.4
13	Gerber Systems	1.2	1.5	1.8	18.5	1.3
14	Formtek	0.5	1.4	1.6	13.2	1.2
15	Tecnomatix Technology	-	-	1.3	NA	0.9
16	Mechanical Dynamics	0.8	0.7	1.2	76.3	0.9
17	MICROCADAM	1.6	1.4	0.9	-31.3	0.7
18	MARC	-	0.7	0.9	20.0	0.6
19	Ansys	1.5	1.4	0.8	-42.5	0.6
20	Concentra	0.3	1.2	0.7	-43.7	0.5
21	Straessle Informationssysteme	1.6	1.4	0.7	-52.0	0.5
22	Altair Computing	0.4	0.6	0.6	13.2	0.5
23	Pacific Numerix	-	0.1	0.6	537.0	0.4
24	ICEM Technologies	0.1	-	0.6	NA	0.4
25	ADRA Systems	0.8	1.0	0.5	-49.5	0.3
26	Hitachi Zosen Info Systems	0.4	0.4	0.4	-1.1	0.3
27	PAFEC	-	0.3	0.4	10.4	0.3
28	CIMLINC	0.3	0.3	0.3	12.1	0.2
29	Autodesk	1.3	0.7	0.3	-58.8	0.2
30	CSAR Corp.	0.2	0.2	0.3	17.1	0.2
	All N.A. Companies	81.3	109.9	124.5	13.3	89.7
	All European Companies	10.8	8.7	11.9	37.6	8.6
	All Asian Companies	2.8	2.3	2.4	5.1	1.7
	All Companies	**95.0**	**120.8**	**138.8**	**14.9**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table A-23
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top 30 Mechanical Software Companies, Asia/Pacific, NT

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	Autodesk	-	3.8	14.2	274.5	33.3
2	Parametric Technology	1.5	7.2	13.2	82.2	31.0
3	EDS Unigraphics	-	1.5	5.6	286.5	13.2
4	Structural Dynamics Research Corporation	0.4	0.4	1.7	288.1	4.0
5	Matra Datavision	0.8	0.5	1.4	179.7	3.3
6	MICROCADAM	0.2	0.5	1.2	114.8	2.8
7	Intergraph	0.1	0.7	0.7	-5.0	1.6
8	Bentley Systems	0.4	0.4	0.6	39.4	1.5
9	ADRA Systems	-	-	0.6	NA	1.4
10	Delcam Plc	-	0.1	0.6	286.2	1.3
11	Ansys	0.2	0.2	0.4	71.3	1.0
12	DP Technology	0.1	0.2	0.4	137.3	1.0
13	Dassault Systemes	-	0.3	0.3	-	0.7
14	Vero International Software	-	0.4	0.3	-22.7	0.7
15	Fujitsu	-	-	0.3	NA	0.7
16	CAD Lab	-	0.1	0.2	305.8	0.5
17	Mechanical Dynamics	-	0.1	0.2	169.0	0.4
18	MacNeal-Schwendler	0	0.1	0.2	150.2	0.4
19	MARC	-	0.1	0.2	150.0	0.4
20	B.A. Intelligence Networks	0.1	0.3	0.1	-53.4	0.3
21	IBM	-	0.1	0.1	14.5	0.2
22	Spatial Technology	-	0	0.1	96.7	0.2
23	Algor Interactive Systems	-	-	0.1	NA	0.2
24	Applicon	-	-	0.1	NA	0.2
25	Gibbs and Assoc.	-	0	0.1	130.8	0.1
26	Hitachi Zosen Info Systems	-	-	0	NA	0.1
27	Ricoh	-	-	0	NA	0.1
28	ICEM Technologies	-	-	0	NA	0.1
29	IMSI	-	0	0.0	48.0	0.1
30	CGTech	0	0.0	0	406.0	0.1
	All N.A. Companies	3.3	16.0	39.6	147.2	93.1
	All European Companies	0.8	1.4	2.6	87.0	6.1
	All Asian Companies	-	-	0.3	NA	0.8
	All Companies	**4.0**	**17.4**	**42.5**	**144.2**	**100.0**

NA = Not Available
Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table A-24
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top 30 Mechanical Software Companies, Asia/Pacific, Personal Computer

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	Autodesk	19.6	18.5	13.9	-24.8	50.6
2	MICROCADAM	2.1	2.6	2.6	-2.2	9.4
3	Design Automation	1.6	1.8	1.9	6.6	6.9
4	Cimatron	1.4	1.7	1.7	2.8	6.3
5	Investronica SA	3.9	0.8	0.8	2.8	3.0
6	CNC Software	0.6	0.7	0.7	2.4	2.5
7	PAFEC	-	0.6	0.7	2.7	2.4
8	Formtek	0.2	0.6	0.6	2.7	2.3
9	Matra Datavision	0.2	0.1	0.6	378.2	2.2
10	Bentley Systems	0.5	0.4	0.6	39.4	2.1
11	Baystate Technologies	-	-	0.5	NA	1.9
12	Just In Time Systems	-	0.4	0.4	2.5	1.4
13	B.A. Intelligence Networks	0.2	0.3	0.3	5.9	1.1
14	Surfware	0.5	0.2	0.3	20.0	0.9
15	ADRA Systems	0.3	0.4	0.2	-31.9	0.9
16	MacNeal-Schwendler	0	0.2	0.2	-14.0	0.8
17	DP Technology	0.2	0.2	0.2	2.6	0.7
18	Computervision	0.5	0.4	0.2	-57.1	0.7
19	Vero International Software	0.3	0.3	0.1	-56.8	0.5
20	Gibbs and Assoc.	-	0.1	0.1	34.6	0.5
21	Research Engineers—Civilsoft	0.1	0.1	0.1	27.4	0.5
22	Fujitsu	-	-	0.1	NA	0.5
23	Pathtrace Engineering Systems	0	0.0	0.1	156.3	0.4
24	Algor Interactive Systems	0	0.1	0.1	57.8	0.4
25	SRAC	-	0.2	0.1	-50.9	0.4
26	IMSI	0.1	0.1	0.1	4.4	0.4
27	Structural Dynamics Research Corporation	0.3	0.1	0.1	7.1	0.3
28	Spatial Technology	0.3	0.1	0.1	-43.8	0.3
29	Drawbase Software	0.1	0.1	0.1	37.3	0.3
30	Ansys	0.2	0.2	0.1	-61.3	0.2
	All N.A. Companies	27.5	26.7	21.2	-20.5	77.2
	All European Companies	6.1	4.1	4.5	11.2	16.4
	All Asian Companies	1.2	1.5	1.8	15.2	6.4
	All Companies	**34.9**	**32.3**	**27.5**	**-14.8**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table A-25
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top 9 Mechanical Software Companies, Asia/Pacific, Host/Proprietary

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	IBM	6.9	5.9	6.7	13.9	95.6
2	Dassault Systemes	3.1	1.8	2.1	20.2	30.2
3	MacNeal-Schwendler	0.5	1.4	0.9	-34.8	13.3
4	Matra Datavision	-	-	0.2	NA	2.4
5	Mechanical Dynamics	0.2	0.1	0	-84.9	0.2
6	Ansys	0.1	0.1	0	-76.8	0.2
7	Altair Computing	-	0	0.0	0.7	0.2
8	Fujitsu	-	-	0	NA	0.1
9	ESI Group	0	0.0	0	-76.8	0
	All N.A. Companies	6.4	6.4	6.8	6.5	97.0
	All European Companies	0	0.0	0.2	12198.9	2.9
	All Asian Companies	-	-	0	NA	0.1
	All Companies	**6.4**	**6.4**	**7.0**	**9.8**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table A-26
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top 30 Mechanical Software Companies, Rest of World, All Operating Systems

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	IBM	5.0	5.2	8.1	55.6	19.4
2	Autodesk	5.7	5.3	6.5	23.6	15.7
3	Engineering Mechanics	4.5	5.2	5.3	0.3	12.6
4	Cimatron	3.5	3.4	3.4	0.9	8.2
5	CoCreate	-	-	3.0	NA	7.1
6	Delcam Plc	2.2	2.2	2.7	23.8	6.5
7	Intergraph	4.9	2.4	2.3	-5.0	5.6
8	Computervision	3.0	3.5	1.8	-48.3	4.3
9	MICROCADAM	1.3	1.5	1.6	3.7	3.8
10	NOVASOFT Systems	1.0	1.1	1.3	19.7	3.2
11	MacNeal-Schwendler	-	1.1	1.1	0.1	2.6
12	Matra Datavision	0.9	0.9	0.9	-7.1	2.0
13	Formtek	0.8	0.8	0.8	0.3	2.0
14	Ansys	0.7	0.5	0.6	24.3	1.5
15	Investronica SA	0.5	0.6	0.6	1.0	1.4
16	CNC Software	0.5	0.5	0.5	1.0	1.3
17	Whessoe Computing Systems	0.5	0.5	0.5	-0.2	1.1
18	Algor Interactive Systems	0.1	0.2	0.4	110.4	1.1
19	Baystate Technologies	0	0.2	0.3	66.9	0.6
20	DP Technology	0.1	0.2	0.2	23.0	0.5
21	Straessle Informationssysteme	0.3	0.3	0.2	-34.3	0.5
22	Bentley Systems	0.1	0.1	0.2	39.4	0.4
23	Viagrafix	0.2	0.2	0.2	1.0	0.4
24	B.A. Intelligence Networks	0.1	0.2	0.2	6.0	0.4
25	Camcentre	-	-	0.2	NA	0.4
26	Tebis	0.1	0.1	0.1	0.6	0.3
27	Computational Mechanics	0.1	0.1	0.1	-1.9	0.3
28	Surfware	0.1	0.1	0.1	20.0	0.3
29	CGTech	0.1	0.1	0.1	22.0	0.3
30	SRAC	0.1	0.1	0.1	6.4	0.3
	All N.A. Companies	27.7	27.8	33.1	19.0	79.4
	All European Companies	8.5	8.2	8.6	5.3	20.6
	All Asian Companies	-	-	-	NA	-
	All Companies	**36.2**	**36.0**	**41.7**	**15.9**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table A-27
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top 30 Mechanical Software Companies, Rest of World, UNIX

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	IBM	4.1	4.4	6.9	57.6	33.1
2	Engineering Mechanics	3.0	3.6	3.6	-	17.3
3	Delcam Plc	2.1	2.1	2.3	11.8	11.2
4	Intergraph	4.7	1.8	1.7	-5.0	8.3
5	Computervision	2.8	3.3	1.7	-48.3	8.3
6	CoCreate	-	-	1.3	NA	6.1
7	MacNeal-Schwendler	-	0.8	0.9	7.9	4.2
8	NOVASOFT Systems	0.5	0.6	0.7	14.9	3.2
9	Matra Datavision	0.8	0.8	0.6	-19.8	3.1
10	Formtek	0.5	0.6	0.6	-	2.8
11	Ansys	0.5	0.4	0.4	2.7	1.9
12	MICROCADAM	0.5	0.5	0.3	-31.3	1.5
13	Cimatron	0.6	0.3	0.3	-	1.5
14	Straessle Informationssysteme	0.3	0.3	0.2	-34.3	0.9
15	Camcentre	-	-	0.1	NA	0.7
16	Computational Mechanics	0.1	0.1	0.1	-	0.4
17	Algor Interactive Systems	0	0.1	0.1	5.2	0.4
18	CGTech	0.1	0.1	0.1	7.5	0.4
19	Autodesk	0.3	0.2	0.1	-59.2	0.3
20	Whessoe Computing Systems	0	0.1	0.1	-	0.3
21	Tebis	0	0.1	0.1	-	0.3
22	DP Technology	0	0.1	0.1	-	0.2
23	First Cadcam Inc.	0	0.0	0	11.2	0.2
24	SRAC	0	0.0	0	-1.8	0.2
25	B.A. Intelligence Networks	0	0.0	0	1.1	0.1
26	ESI Group	-	-	0	NA	0.1
27	Bentley Systems	0	0.0	0	39.4	0
28	MCS	0	0.1	-	-100.0	-
29	Cadcentre	0	0.1	-	-100.0	-
30	ADRA Systems	0.1	0.1	-	-100.0	-
	All N.A. Companies	16.4	15.3	17.1	11.7	82.2
	All European Companies	4.3	3.7	3.7	0.9	17.8
	All Asian Companies	-	-	-	NA	-
	All Companies	**20.6**	**19.0**	**20.8**	**9.6**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table A-28
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top 20 Mechanical Software Companies, Rest of World, NT

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	Autodesk	-	0.9	3.3	274.5	48.0
2	CoCreate	-	-	1.2	NA	17.7
3	Intergraph	0.2	0.6	0.6	-5.0	8.7
4	MICROCADAM	0.1	0.2	0.4	126.2	5.8
5	Delcam Plc	-	0.1	0.4	260.5	5.6
6	NOVASOFT Systems	0.1	0.1	0.3	127.8	4.2
7	Ansys	0.1	0.1	0.2	205.9	3.0
8	Algor Interactive Systems	-	-	0.2	NA	2.3
9	Matra Datavision	0.1	0.1	0.1	39.9	2.1
10	Bentley Systems	0.1	0.1	0.1	39.4	1.3
11	DP Technology	0	0.0	0.1	100.0	1.1
12	B.A. Intelligence Networks	0	0.0	0	-6.7	0.6
13	MacNeal-Schwendler	-	0	0.0	162.1	0.4
14	CGTech	-	0	0.0	406.0	0.3
15	IBM	-	-	0	NA	0.2
16	SRAC	0	0.0	0	227.4	0.2
17	IMSI	-	0	0.0	48.0	0.2
18	Research Engineers—Civilsoft	-	0	0.0	61.1	0.1
19	MCS	-	0.2	-	-100.0	-
20	Vero International Software	-	0	-	-100.0	-
	All N.A. Companies	0.6	2.2	6.3	188.5	92.5
	All European Companies	0.1	0.2	0.5	119.6	7.5
	All Asian Companies	-	-	-	NA	-
	All Companies	**0.7**	**2.4**	**6.8**	**181.8**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table A-29
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top 30 Mechanical Software Companies, Rest of World, Personal Computer

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	Autodesk	5.4	4.3	3.2	-24.8	25.0
2	Cimatron	2.9	3.1	3.1	1.0	24.4
3	Engineering Mechanics	1.5	1.6	1.7	1.0	13.0
4	MICROCADAM	0.7	0.9	0.9	-2.2	6.7
5	Investronica SA	0.5	0.6	0.6	1.0	4.4
6	CNC Software	0.5	0.5	0.5	1.0	4.2
7	CoCreate	-	-	0.5	NA	4.0
8	NOVASOFT Systems	0.4	0.4	0.4	-6.4	3.0
9	Whessoe Computing Systems	0.3	0.4	0.4	1.0	2.9
10	Baystate Technologies	0	0.2	0.3	66.9	2.0
11	Formtek	0.2	0.2	0.2	1.0	1.9
12	Algor Interactive Systems	0	0.1	0.2	57.8	1.5
13	Viagrafix	0.2	0.2	0.2	1.0	1.4
14	Surfware	0.1	0.1	0.1	20.0	1.0
15	B.A. Intelligence Networks	0.1	0.1	0.1	13.9	0.8
16	Tebis	0.1	0.1	0.1	1.0	0.7
17	Bentley Systems	0.1	0.1	0.1	39.4	0.7
18	Computervision	0.1	0.2	0.1	-48.4	0.6
19	DP Technology	0.1	0.1	0.1	1.0	0.6
20	SRAC	0.1	0.1	0.1	-1.8	0.5
21	Matra Datavision	0	0.0	0.1	139.1	0.5
22	Pathtrace Engineering Systems	0	-	0.1	NA	0.4
23	IMSI	0	0.0	0	4.4	0.4
24	Ziegler Informatics	0	0.0	0	1.0	0.4
25	Superdraft	0	0.0	0	1.0	0.3
26	MacNeal-Schwendler	–	0	0.0	-10.0	0.3
27	Engineered Software	-	0	0.0	1.0	0.3
28	Ansys	0.1	0	0.0	-31.0	0.3
29	Research Engineers—Civilsoft	0	0.0	0	34.9	0.2
30	Diehl Graphsoft	0	0.0	0	-18.4	0.2
	All N.A. Companies	10.0	9.4	8.5	-9.4	66.5
	All European Companies	4.1	4.2	4.3	2.6	33.5
	All Asian Companies	-	-	-	NA	-
	All Companies	**14.0**	**13.6**	**12.8**	**-5.7**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table A-30
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
Top Seven Mechanical Software Companies, Rest of World, Host/Proprietary

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	IBM	0.9	0.8	1.2	42.9	93.6
2	MacNeal-Schwendler	-	0.2	0.2	-31.7	12.8
3	Whessoe Computing Systems	0.1	0	0.0	-10.0	3.4
4	Computational Mechanics	0	0.0	0	-10.0	2.0
5	Matra Datavision	-	-	0	NA	1.3
6	Ansys	0	0.0	0	-58.6	0.5
7	ESI Group	-	-	0	NA	0
	All N.A. Companies	0.8	0.9	1.2	29.0	94.6
	All European Companies	0.1	0.1	0.1	20.8	5.4
	All Asian Companies	-	-	-	NA	-
	All Companies	**0.9**	**1.0**	**1.3**	**28.5**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table B-1
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
All Mechanical Software Companies, Worldwide, All Operating Systems

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
1	3D/Eye, Inc.	-	3.5	4.8	37.3	0.1
2	Access Corp.	0.6	0.5	-	-100.0	-
3	Adam Net	7.5	8.5	9.2	8.5	0.3
4	Adina R&D	9.0	10.3	11.1	7.0	0.3
5	ADRA Systems	19.0	21.8	18.3	-16.1	0.5
6	Agile Software	1.4	0.8	7.0	733.3	0.2
7	Algor Interactive Systems	10.0	10.5	11.0	5.2	0.3
8	Alias Research	17.3	17.3	18.6	7.9	0.5
9	Altair Computing	8.0	12.0	13.0	8.6	0.4
10	Andor	15.9	17.8	19.2	8.0	0.5
11	Anilam Electronics	3.8	4.1	4.1	1.8	0.1
12	Ansys	32.6	37.0	32.2	-13.0	0.9
13	Applicon	21.5	21.8	24.0	10.4	0.7
14	Argo Graphics	3.8	4.3	4.7	8.2	0.1
15	ASCAD	14.9	16.5	16.0	-3.0	0.4
16	Ashlar	5.7	5.9	6.9	16.5	0.2
17	Auto-Trol	4.1	4.2	5.0	18.2	0.1
18	Autodesk	190.5	176.5	218.1	23.6	6.1
19	B.A. Intelligence Networks	2.7	3.3	3.9	18.5	0.1
20	Baystate Technologies	1.3	4.1	6.5	58.9	0.2
21	BCT GmbH	4.2	7.2	8.1	12.8	0.2
22	Bentley Systems	13.4	13.1	18.3	39.4	0.5
23	Boothroyd Dewhurst	1.6	1.6	1.6	4.7	0
24	C. Itoh Techno-Science	30.8	30.8	32.5	5.5	0.9
25	CAD Distribution	5.8	5.1	7.6	50.2	0.2
26	CAD Lab	13.6	13.0	15.0	15.9	0.4
27	Cadcentre	0.9	1.5	-	-100.0	-
28	CADdy Spain	1.4	1.4	3.1	119.3	0.1
29	Cadis Software	1.2	3.3	3.8	15.0	0.1
30	CADIX	4.7	7.3	5.3	-26.9	0.1
31	CADSI	3.1	3.2	3.8	18.8	0.1
32	Camcentre	-	-	1.9	NA	0.1
33	Catalpa groupe Missler	1.5	1.3	1.5	17.2	0
34	Century Research Center	1.1	1.1	1.1	1.0	0
35	CGTech	10.0	10.4	11.9	14.2	0.3
36	Cimatron	11.3	14.3	14.3	0.1	0.4
37	CIMLINC	5.8	5.9	6.4	8.4	0.2
38	CIMTEK	1.2	1.6	2.0	23.1	0.1

Table B-1 (Continued)
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
All Mechanical Software Companies, Worldwide, All Operating Systems

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
39	CMstat	0.7	1.9	2.1	9.0	0.1
40	CNC Software	8.4	8.7	8.8	1.8	0.2
41	CoCreate	79.0	86.8	99.2	14.4	2.8
42	Computational Mechanics	2.1	2.1	2.1	0.6	0.1
43	Computervision	149.0	174.4	66.7	-61.7	1.9
44	Concentra	12.7	19.6	7.3	-62.7	0.2
45	Concurrent Engineering	1.0	1.0	0.8	-22.0	0
46	Consensys	0.6	1.0	1.1	14.1	0
47	CSAR Corp.	3.4	5.2	6.1	17.1	0.2
48	Dassault Systemes	199.9	244.0	290.9	19.2	8.1
49	Database Applications	0.5	0.7	-	-100.0	-
50	debis Systemhaus	3.5	4.0	4.9	23.2	0.1
51	Delcam Plc	16.7	21.9	27.0	23.7	0.8
52	Design Automation	11.6	13.3	14.1	6.6	0.4
53	Diehl Graphsoft	1.5	1.5	1.2	-19.5	0
54	DP Technology	4.8	6.0	7.6	27.2	0.2
55	Drawbase Software	0.2	0.1	0.1	29.5	0
56	EDS Unigraphics	133.4	161.4	208.0	28.8	5.8
57	Eigner + Partner	6.3	7.0	6.9	-1.6	0.2
58	Engineered Software	0.6	0.6	0.6	0.5	0
59	Engineering Mechanics	7.6	8.6	8.8	2.9	0.2
60	ESI Group	9.2	7.9	7.8	-1.5	0.2
61	Exapt	5.7	2.6	2.3	-12.6	0.1
62	FHECOR	0.6	0.6	0.6	2.7	0
63	First Cadcam Inc.	3.7	3.8	4.3	11.2	0.1
64	Formtek	18.9	20.6	21.7	5.1	0.6
65	Fujitsu	97.0	107.3	104.4	-2.7	2.9
66	Gerber Systems	13.1	14.9	16.2	8.8	0.5
67	Gibbs and Assoc.	2.2	2.6	4.0	53.8	0.1
68	Graphtec Engineering	8.6	8.6	10.9	26.5	0.3
69	Hakuto	29.8	0.2	0.2	-3.6	0
70	Han Dataport	7.8	6.5	6.3	-2.5	0.2
71	Hitachi	70.9	63.7	68.7	7.8	1.9
72	Hitachi Zosen Info Systems	38.7	39.3	43.2	9.9	1.2
73	IBM	494.5	579.7	656.4	13.2	18.3
74	ICEM Technologies	17.6	20.3	19.8	-2.6	0.6
75	IMSI	1.0	1.4	1.5	11.0	0
76	Info. Services Int'l. Dentsu	85.2	117.2	127.1	8.5	3.6

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Table B-1 (Continued)
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
All Mechanical Software Companies, Worldwide, All Operating Systems

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
77	Intergraph	54.0	27.1	25.8	-5.0	0.7
78	Investronica SA	11.1	10.6	10.3	-3.2	0.3
79	ISD Software	14.5	22.7	22.8	0.7	0.6
80	ISKA	1.1	1.2	1.2	-1.5	0
81	Just In Time Systems	2.5	2.4	2.2	-8.5	0.1
82	Kozo Keikaku Engineering	7.3	8.4	5.1	-39.0	0.1
83	Kubota Computer	8.9	9.8	10.5	6.4	0.3
84	Livermore Software Tech.	1.6	1.5	1.6	6.1	0
85	MacNeal-Schwendler	114.0	109.0	99.2	-9.0	2.8
86	MARC	18.2	19.5	21.8	11.7	0.6
87	Marubeni Hytech	19.9	23.0	24.9	8.5	0.7
88	Matra Datavision	87.4	91.8	85.3	-7.1	2.4
89	MCS	13.6	14.7	-	-100.0	-
90	Mechanical Dynamics	12.6	14.0	17.2	22.7	0.5
91	MICROCADAM	129.2	152.0	156.8	3.1	4.4
92	Mitsubishi Electric	6.3	6.7	6.9	3.4	0.2
93	Mitsui Engineering	14.0	16.1	17.5	8.5	0.5
94	Modultek Oy	-	-	2.0	NA	0.1
95	Mutoh Industries	13.1	9.3	10.6	14.5	0.3
96	NEC	72.9	62.9	70.9	12.7	2.0
97	Nihon Itek	5.5	6.4	6.9	8.5	0.2
98	Nihon Unisys	52.8	54.4	55.1	1.2	1.5
99	NOVASOFT Systems	4.8	3.9	4.7	18.8	0.1
100	Omron	7.8	7.7	12.0	55.4	0.3
101	Open Mind	-	-	5.7	NA	0.2
102	Pacific Numerix	-	0.3	2.5	696.2	0.1
103	PAFEC	6.0	7.9	8.1	1.6	0.2
104	Parametric Technology	321.2	495.0	605.9	22.4	16.9
105	Pathtrace Engineering Systems	3.2	4.2	5.3	28.1	0.1
106	PROCAD GmbH & Co KG	5.8	6.5	6.8	5.3	0.2
107	Radan Computational	8.2	9.2	13.2	43.4	0.4
108	Research Engineers—Civilsoft	0.6	0.9	1.1	29.4	0
109	Ricoh	4.8	3.9	3.5	-12.0	0.1
110	RoboCAD Solutions	1.9	1.6	1.6	-4.0	0
111	Seiko	19.7	19.0	21.3	12.1	0.6
112	Serbi	5.9	5.6	5.0	-10.8	0.1
113	Sescoi	8.0	10.0	9.8	-2.0	0.3

Table B-1 (Continued)
1997 CAD/CAM/CAE/GIS Software Market Share (Revenue in Millions of Dollars)
All Mechanical Software Companies, Worldwide, All Operating Systems

Rank	Company Name	1995	1996	1997	1996-1997 Growth (%)	1997 Market Share (%)
114	Sharp	10.4	9.4	9.5	1.1	0.3
115	Sherpa Corp.	20.6	26.2	27.5	4.8	0.8
116	Softronics	2.0	1.0	1.0	2.7	0
117	Spatial Technology	3.9	3.7	3.2	-12.6	0.1
118	SRAC	4.8	5.6	5.5	-1.6	0.2
119	Straessle Informationssysteme	16.4	14.1	9.9	-29.4	0.3
120	Structural Dynamics Research Corporation	144.8	164.3	170.7	3.9	4.8
121	Sumisho Electronics	18.8	21.6	23.4	8.4	0.7
122	Superdraft	1.4	1.3	1.2	-2.5	0
123	Surfware	5.0	5.4	6.5	20.0	0.2
124	Tebis	12.6	14.2	13.3	-6.3	0.4
125	Technodia	3.9	4.5	4.8	8.3	0.1
126	Tecnomatix Technology	20.1	26.3	34.4	31.0	1.0
127	Tokyo Electron	17.4	20.0	21.8	8.5	0.6
128	Toshiba	66.7	62.5	60.5	-3.2	1.7
129	Toshiba Engineering	11.8	4.2	6.2	45.4	0.2
130	Toyo Information Systems	8.1	9.0	9.5	6.0	0.3
131	Uchida Yoko	1.4	2.2	2.5	14.6	0.1
132	Variation Systems Analysis	2.6	2.8	3.0	5.8	0.1
133	Vero International Software	2.1	4.5	5.5	22.2	0.2
134	Viagrafix	5.6	5.4	5.6	2.6	0.2
135	Wacom	6.0	8.4	13.5	60.1	0.4
136	Whessoe Computing Systems	5.4	5.5	5.5	-0.2	0.2
137	Wiechers Datentechnik	5.0	4.8	4.8	1.2	0.1
138	Workgroup Tech.	6.3	7.8	3.7	-52.3	0.1
139	Yokogawa Digital Computer	0.2	0.2	0.2	-6.6	0
140	Ziegler Informatics	3.3	4.6	4.1	-10.1	0.1
	All N.A. Companies	2,124.0	2,458.2	2,673.1	8.7	74.7
	All European Companies	334.9	350.3	366.4	4.6	10.2
	All Asian Companies	481.5	475.4	539.1	13.4	15.1
	All Companies	**2,940.4**	**3,283.8**	**3,578.5**	**9.0**	**100.0**

NA = Not available
Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table C-1
1997 CAD/CAM/CAE/GIS Total Vendor Market Share
(Revenue in Millions of Dollars, Actual Units)
Top 30 Mechanical Software Companies, Worldwide, All Operating Systems

Rank	Company Name	CPU Shipments	Software Revenue	CPU Revenue	Service Revenue	Total Distribution Revenue	1997 Market Share (%)
1	IBM	82,429	656.4	1,027.7	434.5	2,299.4	21.1
2	Hewlett-Packard	54,662	-	1,130.5	277.1	1,407.6	12.9
3	Sun Microsystems	50,565	-	1,027.3	281.4	1,308.7	12.0
4	Parametric Technology	-	605.9	-	242.5	848.3	7.8
5	Silicon Graphics	26,708	-	564.3	62.7	627.0	5.7
6	Digital Equipment	37,430	-	514.6	81.3	595.8	5.5
7	Fujitsu	14,279	104.4	154.2	145.2	403.8	3.7
8	Structural Dynamics Research Corporation	-	170.7	-	180.6	351.3	3.2
9	Dassault Systemes	-	290.9	-	45.3	339.2	3.1
10	EDS Unigraphics	6,285	208.0	85.5	38.2	331.6	3.0
11	NEC	18,241	70.9	127.4	32.9	285.0	2.6
12	Autodesk	-	218.1	-	1.6	219.6	2.0
13	Nihon Unisys	1,491	55.1	65.5	26.5	177.0	1.6
14	MICROCADAM	-	156.8	-	-	156.8	1.4
15	Info. Services Int'l. Dentsu	3,697	127.1	23.1	-	150.3	1.4
16	Argo Graphics	1,847	4.7	72.0	-	147.7	1.4
17	Computervision	-	66.7	-	79.0	145.7	1.3
18	Hitachi	60,518	68.7	50.5	4.8	138.8	1.3
19	Sumisho Electronics	1,416	23.4	43.2	-	138.4	1.3
20	CoCreate	-	99.2	-	37.5	136.7	1.3
21	Toshiba	-	60.5	75.2	-	135.7	1.2
22	MacNeal-Schwendler	-	99.2	-	28.5	127.7	1.2
23	Intergraph	1,877	25.8	41.0	51.2	127.2	1.2
24	Matra Datavision	1,380	85.3	20.3	13.7	119.3	1.1
25	Mitsubishi Electric	1,156	6.9	44.3	-	116.4	1.1
26	Hitachi Zosen Info Systems	8,005	43.2	38.2	14.3	104.6	1.0
27	Technodia	335	4.8	25.3	13.6	79.8	0.7
28	Mitsui Engineering	216	17.5	8.9	27.3	62.5	0.6
29	Delcam Plc	721	27.0	15.2	12.2	56.6	0.5
30	C. Itoh Techno-Science	823	32.5	15.6	5.3	56.4	0.5
	All N.A. Companies	213,219	2,673.1	3,485.0	1,982.6	8,342.9	76.4
	All European Companies	11,935	366.4	128.9	168.0	688.9	6.3
	All Asian Companies	118,843	539.1	870.0	318.2	1,889.1	17.3
	All Companies	**343,997**	**3,578.5**	**4,483.9**	**2,468.8**	**10,920.9**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table C-2
1997 CAD/CAM/CAE/GIS Total Vendor Market Share
(Revenue in Millions of Dollars, Actual Units)
Top 30 Mechanical Software Companies, Worldwide, UNIX

Rank	Company Name	CPU Shipments	Software Revenue	CPU Revenue	Service Revenue	Total Distribution Revenue	1997 Market Share (%)
1	IBM	32,030	577.0	687.6	324.9	1,691.2	21.8
2	Hewlett-Packard	33,251	-	1,065.9	265.7	1,331.6	17.1
3	Sun Microsystems	50,565	-	1,027.3	281.4	1,308.7	16.8
4	Parametric Technology	-	454.4	-	181.8	636.2	8.2
5	Silicon Graphics	26,708	-	564.3	62.7	627.0	8.1
6	Structural Dynamics Research Corporation	-	144.6	-	152.9	297.6	3.8
7	Dassault Systemes	-	250.9	-	40.1	291.0	3.7
8	EDS Unigraphics	6,285	145.6	59.9	26.7	232.1	3.0
9	Digital Equipment	11,847	-	179.4	29.2	208.5	2.7
10	Nihon Unisys	1,489	54.1	65.1	18.5	160.9	2.1
11	NEC	3,765	40.9	53.3	18.1	148.7	1.9
12	Info. Services Int'l. Dentsu	2,646	120.8	22.0	-	142.7	1.8
13	Computervision	-	63.8	-	75.5	139.3	1.8
14	Sumisho Electronics	223	17.8	33.4	-	108.7	1.4
15	Mitsubishi Electric	578	4.3	40.1	-	103.2	1.3
16	MacNeal-Schwendler	-	78.6	-	22.6	101.1	1.3
17	Intergraph	1,217	19.2	31.9	35.4	94.1	1.2
18	Hitachi Zosen Info Systems	8,005	38.8	34.4	12.9	94.1	1.2
19	Matra Datavision	1,138	63.5	15.1	10.2	88.8	1.1
20	Fujitsu	1,067	19.8	35.5	28.0	83.3	1.1
21	Technodia	335	4.8	25.3	13.6	79.8	1.0
22	Argo Graphics	340	2.2	35.5	-	74.1	1.0
23	CoCreate	-	42.0	-	19.5	61.5	0.8
24	Toshiba	-	27.2	33.8	-	61.1	0.8
25	Mitsui Engineering	158	16.9	8.1	27.0	59.9	0.8
26	Tecnomatix Technology	289	34.4	5.5	13.3	53.2	0.7
27	C. Itoh Techno-Science	764	30.8	14.5	4.8	52.9	0.7
28	Delcam Plc	721	23.2	12.8	10.2	48.1	0.6
29	Tokyo Electron	179	21.8	9.9	10.2	43.9	0.6
30	Gerber Systems	502	16.2	13.2	8.8	40.2	0.5
	All N.A. Companies	121,625	1,765.8	2,818.9	1,609.0	6,313.6	81.3
	All European Companies	3,980	204.6	75.5	115.3	400.7	5.2
	All Asian Companies	31,281	275.6	498.7	161.6	1,054.4	13.6
	All Companies	**156,886**	**2,245.9**	**3,393.1**	**1,885.8**	**7,768.7**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table C-3
1997 CAD/CAM/CAE/GIS Total Vendor Market Share
(Revenue in Millions of Dollars, Actual Units)
Top 30 Mechanical Software Companies, Worldwide, NT

Rank	Company Name	CPU Shipments	Software Revenue	CPU Revenue	Service Revenue	Total Distribution Revenue	1997 Market Share (%)
1	Fujitsu	8,327	56.4	83.3	78.4	218.1	16.8
2	Parametric Technology	-	151.5	-	60.6	212.1	16.3
3	Autodesk	-	109.0	-	0.8	109.8	8.4
4	Digital Equipment	8,673	-	87.7	14.8	102.5	7.9
5	EDS Unigraphics	-	62.4	25.7	11.4	99.5	7.6
6	CoCreate	-	40.2	-	14.5	54.7	4.2
7	Structural Dynamics Research Corporation	-	24.8	-	26.2	50.9	3.9
8	MICROCADAM	-	39.2	-	-	39.2	3.0
9	Intergraph	660	6.6	9.1	15.8	33.1	2.5
10	ISD Software	1,136	17.0	3.1	6.9	28.7	2.2
11	CAD Lab	-	10.5	4.4	5.7	21.9	1.7
12	NEC	1,638	7.6	9.2	2.1	20.8	1.6
13	ADRA Systems	-	10.2	0.2	10.4	20.8	1.6
14	Matra Datavision	148	14.1	3.3	2.3	19.7	1.5
15	ASCAD	349	5.7	10.4	2.8	19.0	1.5
16	Radan Computational	362	8.7	5.7	3.4	18.2	1.4
17	Graphtec Engineering	155	8.7	6.8	0.8	18.0	1.4
18	Omron	342	10.1	5.7	-	17.5	1.3
19	Ansys	-	10.3	-	4.5	14.8	1.1
20	Toshiba	-	6.1	7.5	-	13.6	1.0
21	Wacom	-	12.0	-	1.1	13.1	1.0
22	Hitachi	6,046	6.1	4.4	0.3	12.1	0.9
23	Applicon	-	7.4	-	4.6	12.0	0.9
24	Hitachi Zosen Info Systems	-	4.3	3.8	1.4	10.5	0.8
25	Bentley Systems	-	9.0	-	1.1	10.0	0.8
26	Toshiba Engineering	290	4.3	3.5	1.7	9.6	0.7
27	Dassault Systemes	-	6.3	-	-	9.0	0.7
28	Delcam Plc	-	3.8	2.4	2.0	8.5	0.7
29	Seiko	-	5.9	2.0	2.1	8.4	0.6
30	Agile Software	-	5.7	-	2.5	8.2	0.6
	All N.A. Companies	9,903	512.5	133.4	184.5	833.4	64.1
	All European Companies	2,119	71.0	28.0	20.7	122.8	9.4
	All Asian Companies	17,040	116.9	129.8	90.4	344.8	26.5
	All Companies	**29,061**	**700.3**	**291.2**	**295.6**	**1,300.9**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table C-4
1997 CAD/CAM/CAE/GIS Total Vendor Market Share
(Revenue in Millions of Dollars, Actual Units)
Top 30 Mechanical Software Companies, Worldwide, Personal Computer

Rank	Company Name	CPU Shipments	Software Revenue	CPU Revenue	Service Revenue	Total Distribution Revenue	1997 Market Share (%)
1	IBM	49,750	-	188.7	-	188.7	15.2
2	NEC	12,838	22.4	64.9	12.7	115.5	9.3
3	Autodesk	-	107.1	-	0.8	107.9	8.7
4	Fujitsu	4,885	26.1	35.5	36.1	97.7	7.9
5	Hitachi	46,145	48.6	35.0	2.8	97.0	7.8
6	MICROCADAM	-	86.2	-	-	86.2	6.9
7	Argo Graphics	1,507	2.4	36.5	-	73.5	5.9
8	Hewlett-Packard	20,841	-	58.6	10.3	69.0	5.6
9	Toshiba	-	27.2	33.8	-	61.1	4.9
10	Investronica SA	4,183	10.3	12.5	9.0	45.4	3.7
11	Digital Equipment	14,478	-	33.3	1.2	34.6	2.8
12	Andor	545	19.2	5.8	-	30.1	2.4
13	Sumisho Electronics	1,193	5.6	9.8	-	29.7	2.4
14	CoCreate	-	17.0	-	3.5	20.5	1.7
15	Design Automation	614	14.1	3.7	0.3	18.2	1.5
16	Tebis	180	8.0	2.5	5.2	17.4	1.4
17	Cimatron	-	12.9	-	3.9	16.8	1.4
18	Mutoh Industries	382	3.9	4.0	0.3	9.9	0.8
19	Mitsubishi Electric	569	2.0	3.1	-	9.4	0.8
20	Bentley Systems	-	8.4	-	1.0	9.4	0.8
21	CNC Software	-	8.8	-	-	8.8	0.7
22	Matra Datavision	63	6.0	1.4	1.0	8.3	0.7
23	Nihon Unisys	-	0.6	0.2	4.0	8.0	0.6
24	Formtek	120	6.2	0	1.8	8.0	0.6
25	Info. Services Int'l. Dentsu	1,051	6.4	1.2	-	7.5	0.6
26	Wiechers Datentechnik	74	4.8	1.4	1.3	7.5	0.6
27	Surfware	-	6.5	-	1.0	7.4	0.6
28	Pathtrace Engineering Systems	-	5.3	-	1.6	6.9	0.6
29	Ashlar	-	6.9	-	-	6.9	0.6
30	Serbi	530	5.0	1.6	-	6.6	0.5
	All N.A. Companies	79,874	311.3	269.8	38.7	619.8	49.9
	All European Companies	5,765	87.1	23.9	25.6	152.7	12.3
	All Asian Companies	70,156	141.6	236.2	58.0	469.6	37.8
	All Companies	**155,794**	**540.0**	**529.9**	**122.2**	**1,242.0**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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Table C-5
1997 CAD/CAM/CAE/GIS Total Vendor Market Share
(Revenue in Millions of Dollars, Actual Units)
Top 23 Mechanical Software Companies, Worldwide, Host/Proprietary

Rank	Company Name	CPU Shipments	Software Revenue	CPU Revenue	Service Revenue	Total Distribution Revenue	1997 Market Share (%)
1	IBM	649	78.3	151.3	109.6	418.3	68.7
2	Digital Equipment	2,432	-	214.2	36.1	250.3	41.1
3	Dassault Systemes	-	33.0	-	5.2	38.2	6.3
4	MacNeal-Schwendler	-	14.8	-	4.2	19.0	3.1
5	Nihon Unisys	2	0.4	0.2	4.0	8.0	1.3
6	Fujitsu	-	2.1	-	2.7	4.8	0.8
7	Hitachi	286	1.6	1.9	0.5	4.1	0.7
8	Mitsubishi Electric	9	0.6	1.1	-	3.8	0.6
9	Exapt	41	0.9	0.9	0.6	3.7	0.6
10	C. Itoh Techno-Science	59	1.7	1.1	0.5	3.6	0.6
11	Matra Datavision	31	1.7	0.4	0.3	2.4	0.4
12	Toyo Information Systems	9	0.4	0.7	0.2	1.6	0.3
13	Century Research Center	1	0.1	0.1	0.1	0.6	0.1
14	Kubota Computer	-	0.3	-	0.2	0.6	0.1
15	Ansys	-	0.3	-	0.1	0.5	0.1
16	Altair Computing	-	0.1	-	0.2	0.4	0.1
17	debis Systemhaus	-	0	0.1	0.2	0.3	0.1
18	Whessoe Computing Systems	-	0.3	-	-	0.3	0.1
19	Mechanical Dynamics	-	0.2	-	0.1	0.3	0
20	Computational Mechanics	-	0.2	-	-	0.2	0
21	Sherpa Corp.	-	0.1	-	0.1	0.2	0
22	ESI Group	0	0.1	0	0.1	0.2	0
23	Technodia	-	0	-	-	0	0
	All N.A. Companies	1,817	83.6	262.9	150.5	576.1	94.6
	All European Companies	71	3.7	1.5	6.4	12.8	2.1
	All Asian Companies	366	5.0	5.3	8.2	20.3	3.3
	All Companies	**2,255**	**92.3**	**269.6**	**165.1**	**609.1**	**100.0**

Notes: All numbers shown are Dataquest's best estimates.
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 (March 1998)

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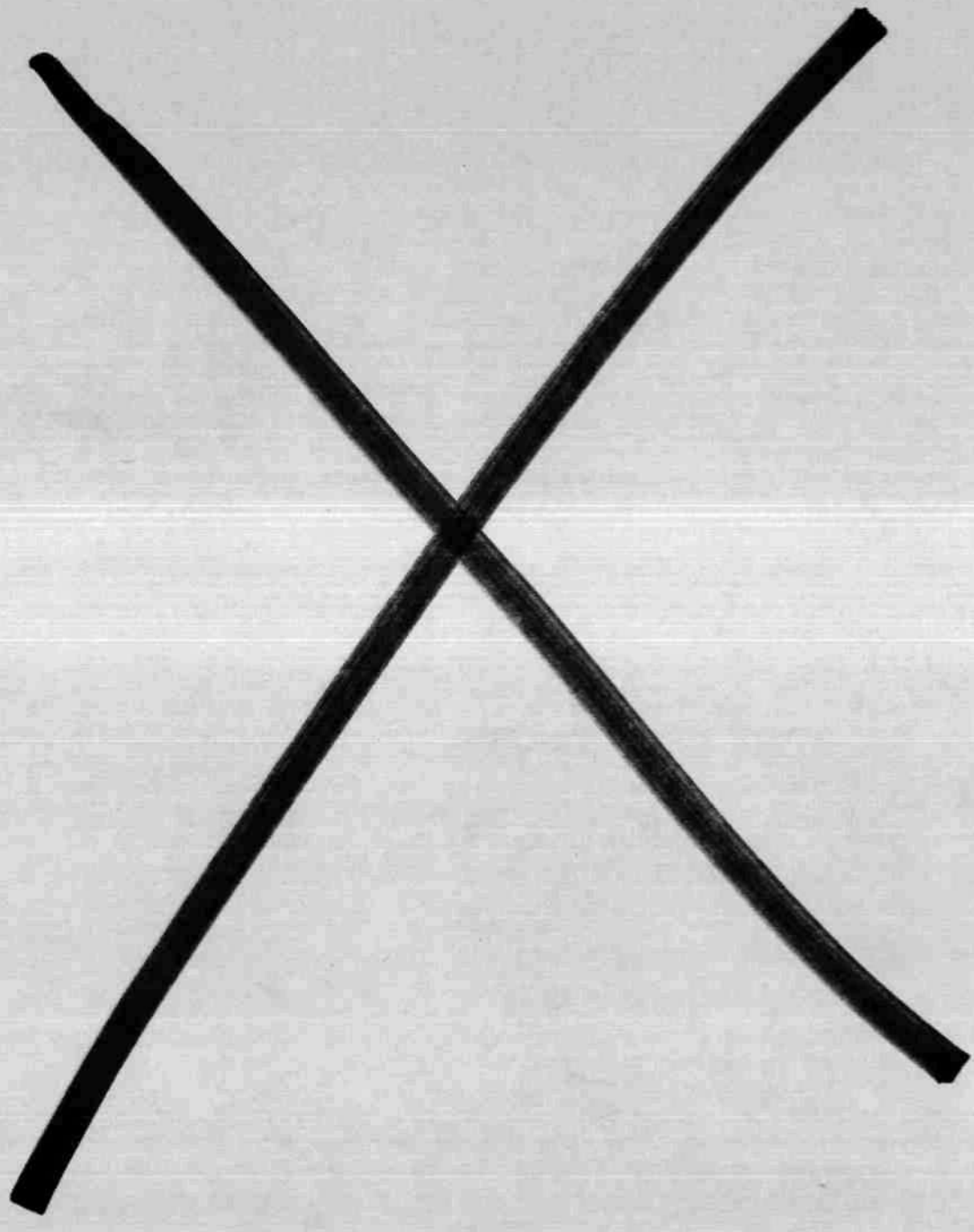
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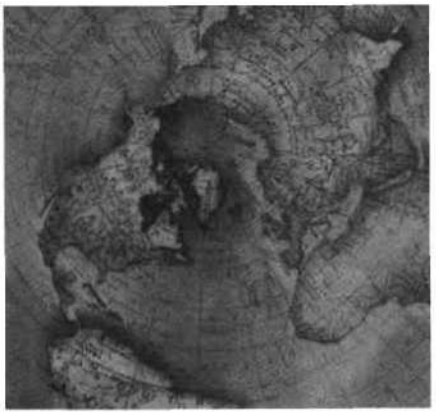
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The European Mechanical Designer



User Wants and Needs

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Program: Mechanical CAD/CAM/CAE Worldwide
Product Code: CMEC-WW-UW-9801
Publication Date: July 6, 1998
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The European Mechanical Designer



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Table of Contents

Page

1. Executive Summary 1
   - Introduction 1
   - Study Objectives 1
   - Key Survey Highlights 1
   - Dataquest Perspective and Recommendations 2
2. Study Foundations and Methodology 5
   - Survey Methodology 5
     - Sample Criteria 5
     - Interviewing Procedures 5
     - Definitions 5
   - Structure of the Document 6
   - Respondent Demographics 6
     - By Country 6
     - By Industry 7
     - By Company Size 7
     - By Job Title 7
     - By CAD Experience 7
3. CAD Design in Europe 11
   - Familiarity with CAD Software Packages 11
   - Is Mechanical CAD Reaching Saturation? 12
   - Customization and Integration 12
   - New Designs or Modifications 14
   - Designing in 2-D or 3-D? 14
     - Reasons for Staying with 2-D 15
   - CAD File Types 17
   - Methods for Transferring Design Files 18
   - The STEP Standard 18
4. Future CAD/CAM/CAE Plans 21
   - Level of System Operation 21
   - Migration Plans to NT 22
     - What Is Driving the NT Decision 24
   - CAD Purchasing Decisions 24
   - CAD/CAM/CAE Seat Counts 25
   - CAD Software Retirements 27
   - CAD Spending Plans 29
   - Plotters and Printers 30
5. Mechanical Application Perceptions 33
   - Is CAD/CAM/CAE Technology Helping to Meet Business Goals? 33
   - Mechanical CAD/CAM/CAE Applications—What Users Think 34
   - Design-Related Tools and Technologies—What Users Want 35
   - Characterizing the Ideal Software Solution and CAD Vendor 37

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List of Figures

Figure		Page
2-1	Respondents by Country	8
2-2	Respondents by Industry	8
2-3	Respondents by Company Size	9
2-4	Experience Base of Respondents	9
3-1	Number of Mechanical Software Applications Used	11
3-2	CAD Penetration by Country and Industry	13
3-3	Customization of CAD/CAM/CAE Systems	14
3-4	2-D or 3-D in 2000?	16
3-5	Reasons for Staying with 2-D Design	16
3-6	Data Files Stored by Type	17
3-7	Main Method for Transferring Design Files	19
3-8	STEP Plans	20
3-9	STEP Plans by Country	20
4-1	Level of System Operation	21
4-2	Future Operating System Plans Based on Survey Responses	23
4-3	Reasons to Move to NT, All Respondents	25
4-4	Reasons to Move to NT, UNIX Respondents	26
4-5	Reasons to Not Move to NT, All Respondents	27
4-6	Reasons to Not Move to NT, UNIX Respondents	28
4-7	CAD Purchasing Decision Drivers	28
4-8	Anticipated Seat Count Changes by Country and Industry	29
4-9	Planned Plotter and Printer Purchases over Next Two Years	32
5-1	CAD Perceptions, Weighted Average of Responses	34
5-2	Importance/Satisfaction Gap Analysis of Mechanical Applications	36
5-3	Importance/Satisfaction Gap Analysis of CAD-Related Technologies	38
5-4	Importance/Satisfaction Gap Analysis of an Ideal CAD Solution	40

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List of Tables

Table		Page
3-1	Is 3-D Design the Main Method of Design?	15
4-1	Adoption of Windows NT by Country and Industry	23
4-2	Anticipated Spending Patterns for Mechanical CAD/CAM/CAE Technology	31
4-3	Plotter Technology	32
5-1	Importance/Satisfaction Gap Analysis of Mechanical Applications	36
5-2	Importance/Satisfaction Gap Analysis of CAD-Related Technologies	38
5-3	Importance/Satisfaction Gap Analysis of an Ideal CAD Solution	40

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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 customer base. Our research of mechanical engineers, designers, and engineering CAD managers provides us with an insightful look into their preferences, application satisfaction, and spending plans. In particular, this year's survey focuses on those mechanical CAD/CAM/CAE users in Europe.

Study Objectives

This study examines European-based users of mechanical CAD/CAM/CAE systems in France, Germany, Italy, and the United Kingdom. This report is based on the results of a May 1998 telephone survey of 324 European-based engineering professionals involved in the mechanical design process. The specific objectives of this study are the following:

- To characterize European-based mechanical designers and managers, their CAD working environments, and their spending plans
- To compare and contrast how individual European countries and industries differ in their mechanical CAD/CAM/CAE usage and attitudes
- To advance the understanding of what these users need to be successful

Key Survey Highlights

Major findings of our survey include the following:

- Mechanical CAD/CAM/CAE technology is a mature technology in Europe. In some industries, mechanical CAD/CAM/CAE technology is now facing the prospect of saturation and growth by replacement seats instead of completely new sales.
- While 3-D design methods are pervasive throughout Europe, there is still plenty of 2-D design work being done. Those survey respondents not planning to move to 3-D over the next few years overwhelmingly cite that 2-D CAD is enough to meet their design needs. Data is most commonly stored as 2-D files.
- Standard for Exchange of Product Data (STEP) still has many years to go until it is widely accepted, understood, and used. It is quite apparent that awareness of the STEP standard varies greatly by country. We can characterize the French and German respondents in our survey as having the most awareness of STEP, and the Italian and U.K. respondents as having the least awareness.

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- According to our European survey respondents, UNIX will indeed cede ground to Windows NT in mechanical CAD/CAM/CAE. In 2000 and 2002, slightly over one-half of our survey respondents expect Windows NT to be their primary operating system. The two top user-cited reasons to move to NT were the prospects of easier system/networking maintenance and reduced hardware costs. Each European country and industry will adopt the NT operating system at very different rates.
- European CAD users, on the whole, are expecting the total number of CAD/CAM/CAE seats at their site to increase or remain the same from 1998 to 2000, with little variation seen by country or industry. Retirement rates for existing software modules are also expected to be high. User responses to our questions about planned spending/budget changes for CAD/CAM/CAE technology bode well for nearly everyone involved in CAD deployment: software developers, hardware vendors, and consultants.
- Despite the maturity of the technology, European users are still not completely satisfied with their mechanical CAD/CAM/CAE solutions. Satisfaction ratings are still lower than importance ratings for all basic CAD/CAM/CAE software functions, such as assembly design and product data management.
- European designers and engineers want a lot of performance from their CAD solutions—tight integration among modules (especially CAD to CAM integration), good graphics, and design optimization capabilities. Survey respondents show an interest in sharing design files via the Internet or intranet and in project Web sites, but such capabilities aren't at the top of user importance rankings.
- There is still plenty of real dissatisfaction with CAD/CAM/CAE solutions among European end users, when it comes to such basic issues as bug-free, stable software, vendor service and support, and software cost per seat.

Dataquest Perspective and Recommendations

While design automation has become indispensable to many European manufacturing companies, European designers and engineers are looking beyond CAD and into such things as integration issues, data exchange and management, and larger IT investment strategies. End-user experiences are still not flawless, because satisfaction ratings are lower than importance ratings for basic CAD/CAM/CAE software functions. There are still large gaps on the wish lists of system characteristics.

The prospects for increased mechanical CAD/CAM/CAE sales in Europe are indeed healthy, as users in our survey reveal plans for increased CAD spending, high software retirement rates, and significant changes in operating systems. There is a clear indication that the European manufacturing industry is going through a major transformation to remain competitive in an increasingly global economy. High labor costs have forced European industries to radically change and increase productivity. This change in the structure of the European manufacturing industry is one of the factors behind the large CAD and IT investments we expect to see in the near future.

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Opportunities exist for those vendors willing to address issues outside of purely design, and for those vendors who recognize that there are clear differences among the countries in Europe. It is not sufficient to lump all of the European designers and engineers into one category called "Europe;" instead, vendors need to examine how CAD technology usage and CAD buying habits in Germany differ from those in France. Indeed, European mechanical designers and engineers will keep vendors on their toes for many years to come.

Project Analyst: Sharon Tan

Primary Research Manager: Simon Bradford

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 130 questions. The end-user data was gathered via a telephone survey conducted in May 1998. The results were entered into a statistical analysis package for analysis of the data. In total, 324 surveys were completed. Countries surveyed included France, Germany, Italy, and the United Kingdom.

All of the percentages in this report are estimates and are subject to the usual limitations of survey research. The characteristics of noncontacted and noncooperating sites could have changed the survey results.

Any data point collected in the survey can form the basis of a cross-tabulation. Because of the scope and length of the survey, this report does not examine every single data point collected. Special cuts of the data (for example by operating system 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 mechanical CAD/CAM/CAE system in development or in place) to qualify. 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 in each country's native language by trained interviewers at Dataquest's primary research facilities in Europe. 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.

Definitions

Some questions asked respondents to evaluate opinion-based statements on the extent of agreement with certain statements or software vendor attributes in terms of importance and satisfaction. These questions asked the individual to respond using a five-point scale. The following rating system was used:

- 1 = Strongly disagree and 5 = Strongly agree
- 1 = Not at all important and 5 = Very important
- 1 = Not at all satisfied and 5 = Very satisfied

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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

Throughout this document, we analyze the data by European country and European industry, where appropriate. While the tendency is to lump all European designers into one category called "Europe," we find that each country in Europe has very distinct CAD/CAM/CAE technology usage and buying habits. Readers should keep this in mind. The remainder of this document is organized as follows:

- Chapter 3, "CAD Design in Europe," characterizes the European mechanical designer today. We begin by examining the use of CAD/CAM/CAE within a company, including CAD penetration rates 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, "Future CAD/CAM/CAE Plans," characterizes the CAD/CAM/CAE spending plans at the respondents' companies. We discuss expected CAD seat count changes and anticipated future budgets for CAD-related hardware, software, and service. We also examine operating system plans for the future.
- 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.

Respondent Demographics

By Country

As we stated earlier, our survey focused specifically on mechanical CAD/CAM/CAE users in France, Germany, Italy, and the United Kingdom. A breakdown of survey respondents by country is shown in Figure 2-1. Our decision to focus on these countries was driven largely by the fact that these countries are the biggest purchasers of mechanical CAD/CAM/CAE systems in Europe. Many of the analyses in this report will use country as a metric for comparison among respondents.

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By Industry

Figure 2-2 gives the respondent breakdown by industry. Because many of the mechanical CAD/CAM/CAE software and hardware purchases are made by a few key industries, we consequently focused on those industries, specifically aerospace, automotive, electrical/electronic machinery, fabricated metal, and industrial machinery, in this survey. While some may argue that our focus on specific industries may skew the results, our aim in conducting the survey is to understand users and decision makers involved in the mechanical design process in key industries. The category "others" in Figure 2-2 consists of those respondents in services/design/consulting, telecommunications, government, and education. Many of the analyses in this report will use industry as a metric for comparison among respondents.

By Company Size

Respondent company size varied from fewer than 10 employees to more than 10,000 employees in that country (see Figure 2-3). About 55 percent of the respondents came from small to medium-size companies with fewer than 500 employees in that country. Further, the category "200 to 499 employees" was identified by 44 percent of our respondents.

By Job Title

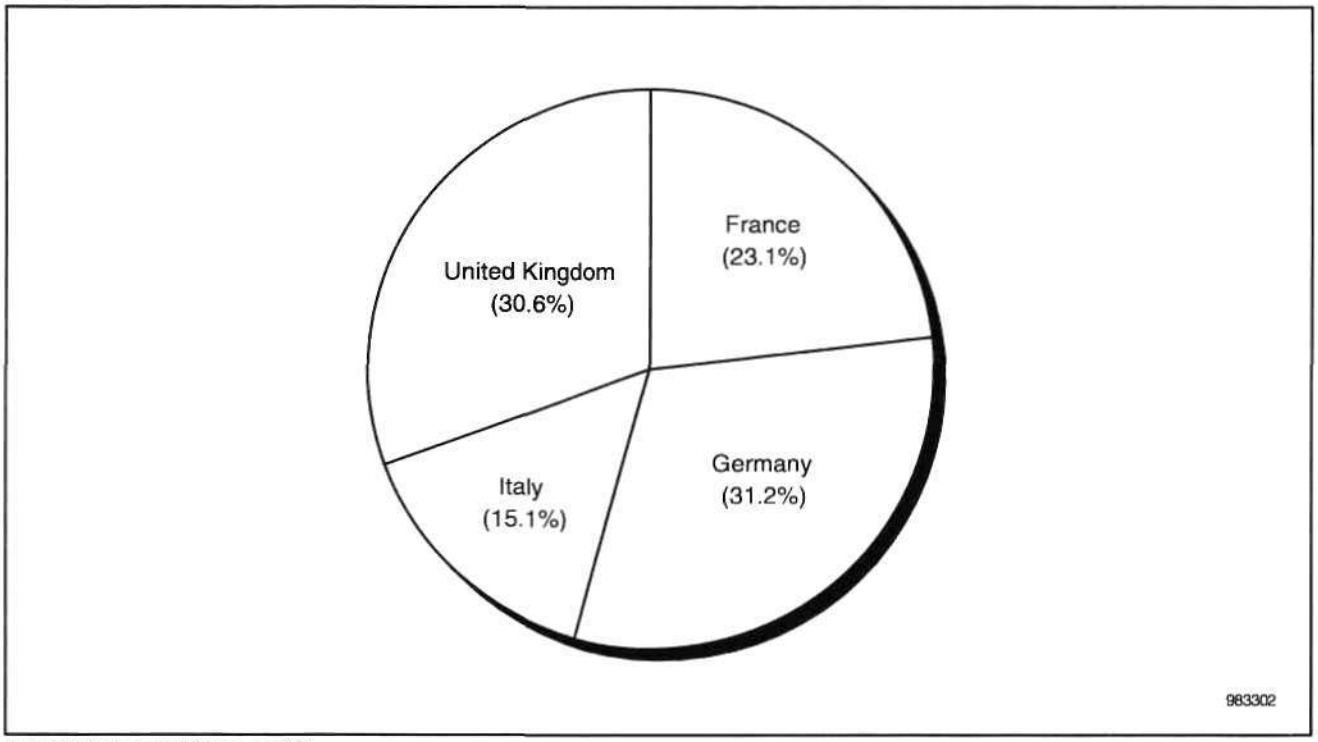
Our survey had a high proportion of engineers and designers who use CAD/CAM/CAE tools in their daily jobs as well as CAD and information technology (IT) managers and supervisors. Again, the focus was to survey users who either use mechanical design software or are involved in mechanical CAD/CAM/CAE system purchases. We will not be showing survey results by job titles, as each job title may have a different meaning and associated responsibilities, depending on the country in which the respondent resides.

By CAD Experience

The respondent group as a whole is well experienced with several years of hands-on use (see Figure 2-4). The experience base of survey respondents was, on average, 9.8 years, with about 38 percent of the respondents having eight to 10 years of experience with mechanical CAD/CAM/CAE systems. Little variation was seen by industry. The median for years of experience was 10 years; the maximum was 30 years.

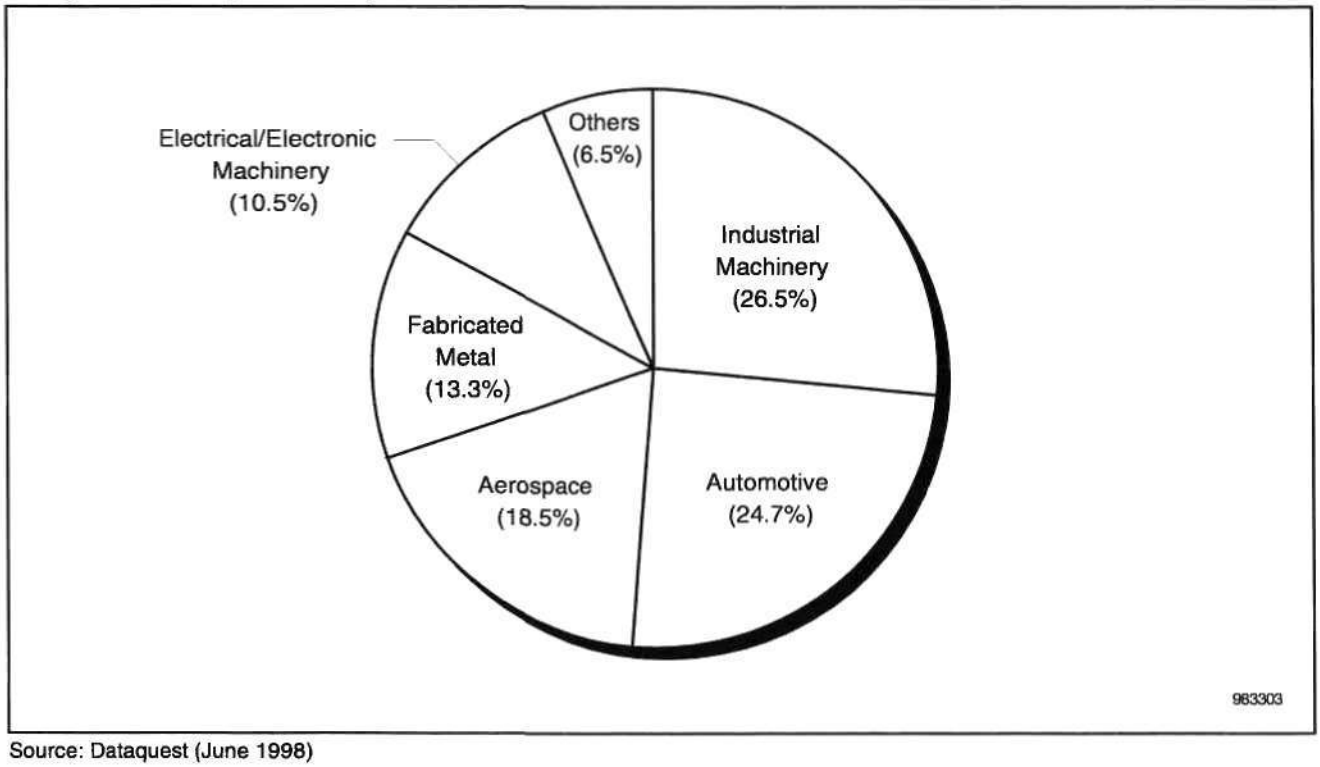
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Figure 2-1
Respondents by Country



Source: Dataquest (June 1998)

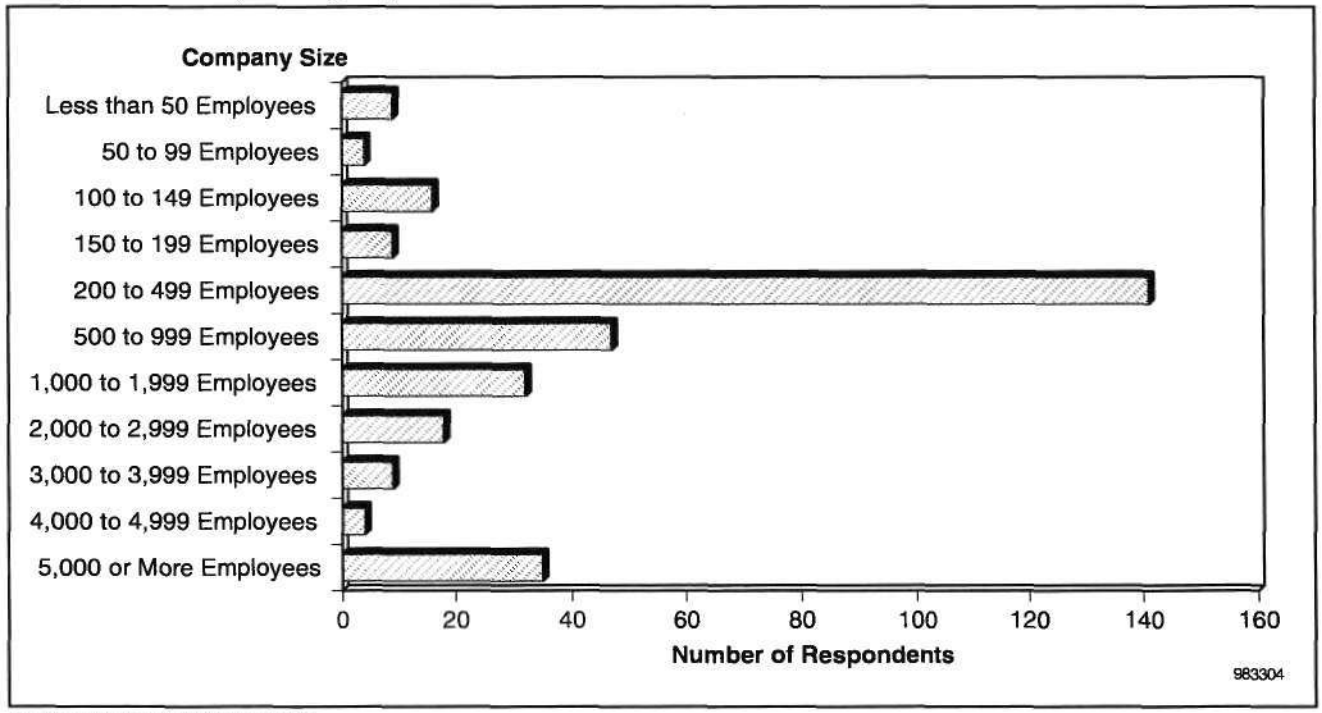
Figure 2-2
Respondents by Industry



Source: Dataquest (June 1998)

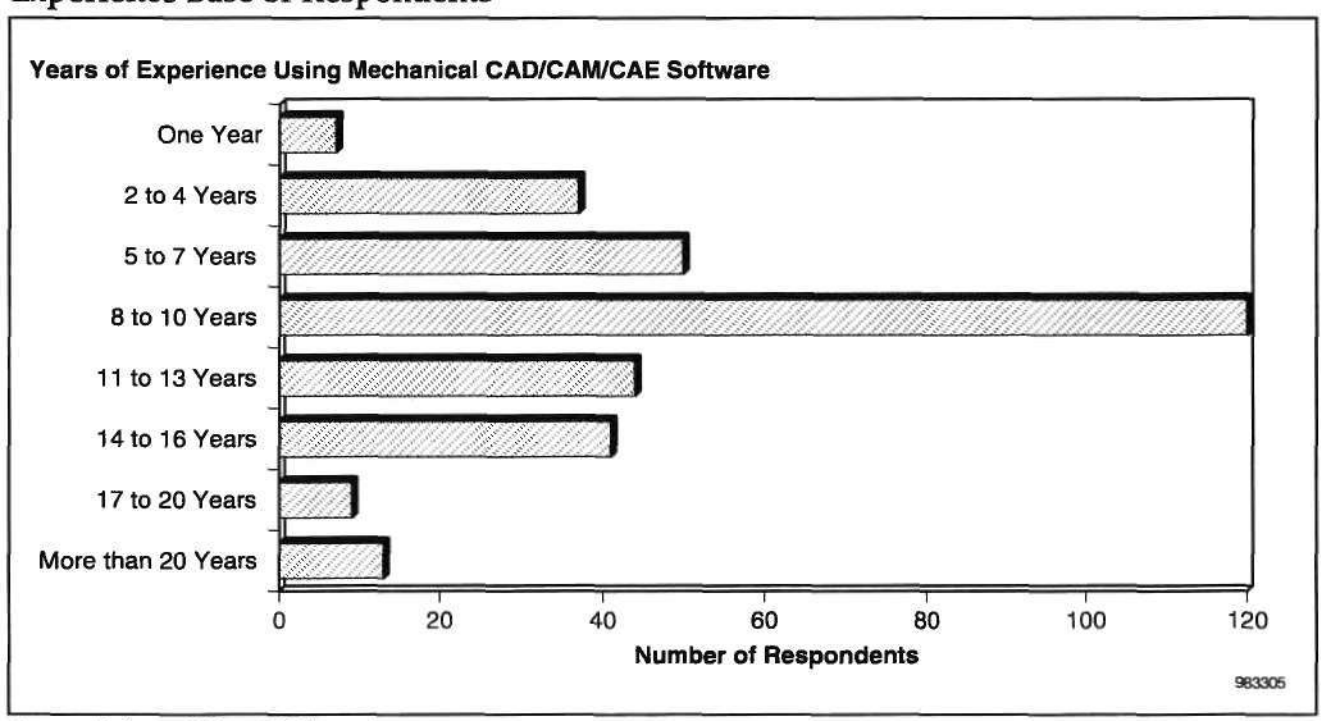
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Figure 2-3
Respondents by Company Size



Source: Dataquest (June 1998)

Figure 2-4
Experience Base of Respondents



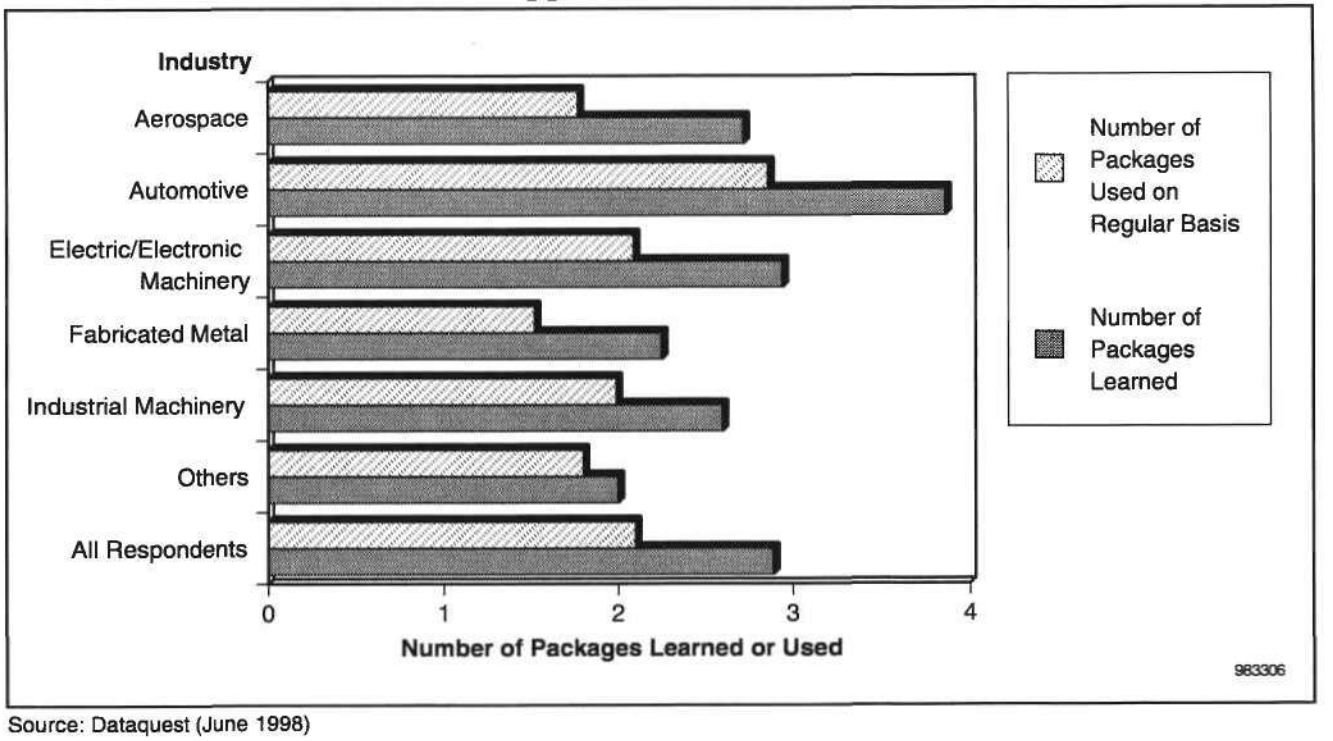
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Chapter 3
CAD Design in Europe

Familiarity with CAD Software Packages

We asked respondents how many CAD/CAM/CAE 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 2.9 mechanical CAD packages (with respondents in automotive having learned the most). Respondents regularly use 2.1 packages, again with those in automotive using the most, followed by those in electrical/electronic machinery. The higher-than-average number of mechanical CAD/CAM/CAE software applications used by respondents in those two industries reflects the nature of design work in those two industries—designers often have to deal with both mechanical and electrical/electronic design problems (such as cabling and signal analysis). Little variation was seen by country in terms of either the number of packages learned or used, though German respondents tended to have learned and use more CAD/CAM/CAE software than their European counterparts.

Figure 3-1
Number of Mechanical Software Applications Used



Source: Dataquest (June 1998)

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Is Mechanical CAD Reaching Saturation?

No doubt, mechanical CAD/CAM/CAE is a mature technology that is now facing the prospect of growth by replacement seats instead of new sales. The difference between the number of people currently working on a CAD/CAM/CAE system at a site and the number who would ideally (that is, where budgets and/or training are not issues) work on the system is indicative of just how close CAD is to reaching its saturation point. Dataquest asked respondents how many people 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, by country and industry, are summarized in Figure 3-2.

For all respondents, the average number of professionals working on a CAD/CAM/CAE system at a given site was 54 professionals, and the ideal number was somewhat higher at 66 professionals. These two numbers imply that, among our sample respondents, there is some, but not much, room for deploying additional CAD/CAM/CAE seats. However, the total number of technical professionals for all respondents was 96 professionals at a site, nearly 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.

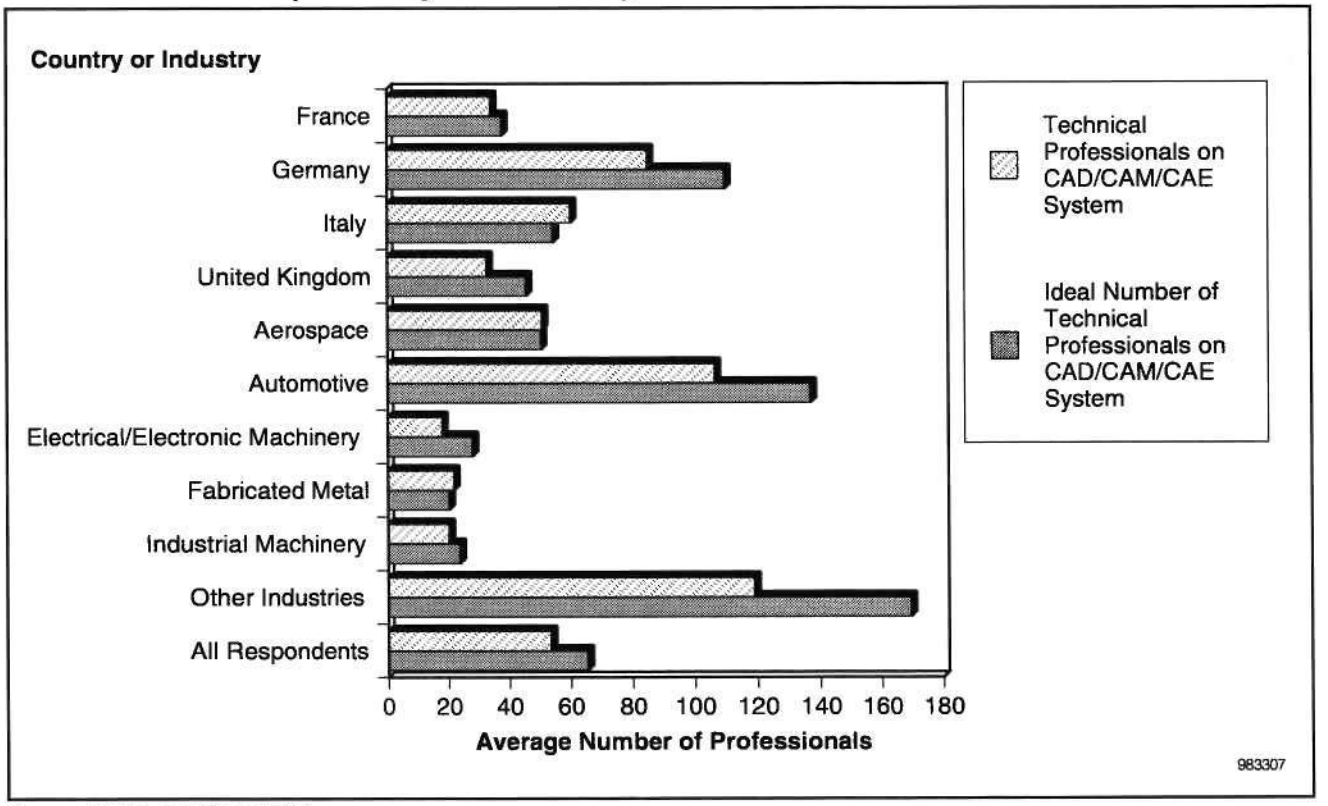
Interestingly, the data from this survey hints at CAD saturation levels in France and Italy, and in the industries aerospace, fabricated metal, and industrial machinery. Here, these respondents indicated that the ideal number of people working on a CAD system would be fewer than are currently working on the system. In contrast, the data reveals significant growth opportunities in Germany and the United Kingdom, and in the industries automotive and electrical/electronic machinery, where there are fewer people currently working on a CAD system than would occur under ideal circumstances.

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—22 percent of respondents said that they do "a lot" of customization and 48 percent said they do "some" customization. In contrast to North American designer responses from earlier surveys, European designers appear more likely to use systems off the shelf, with no customization. Here, in this survey, 30 percent of our European respondents said they do no customization, versus 18 percent of North American respondents in our 1997 survey. Results by country and industry are shown in Figure 3-3.

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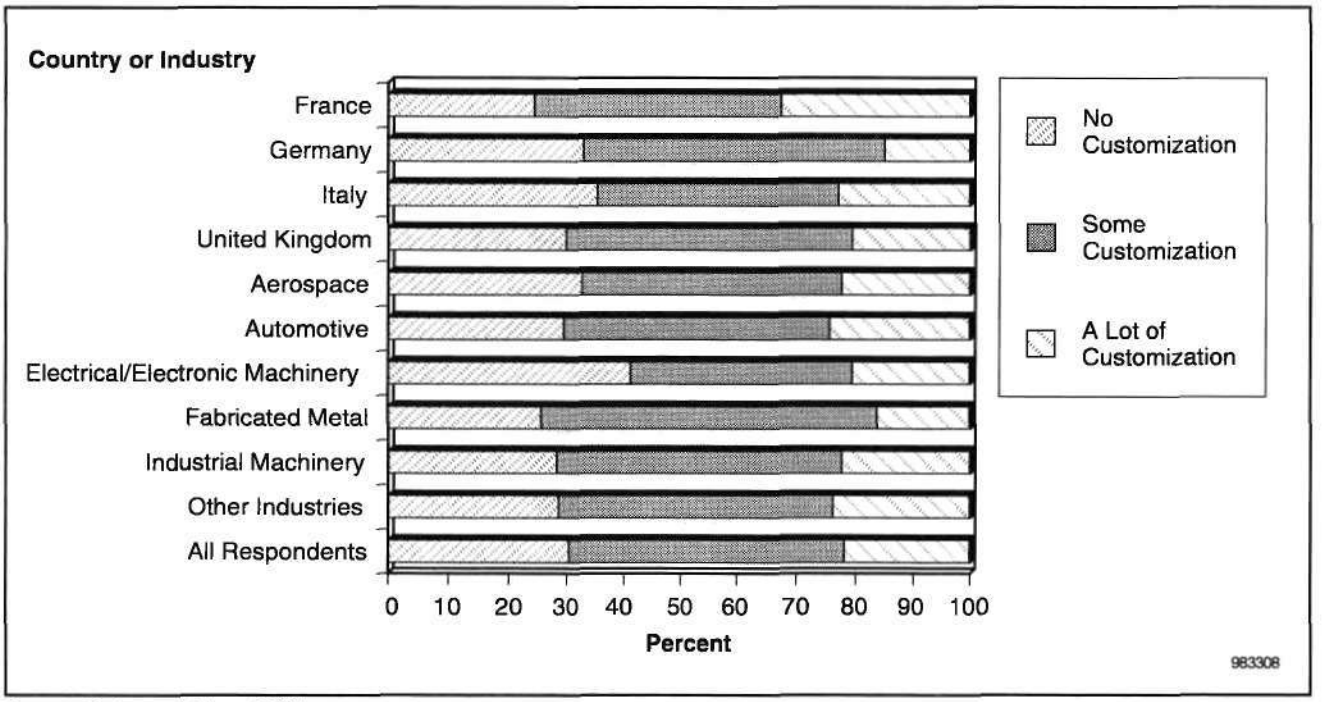
Figure 3-2
CAD Penetration by Country and Industry



Source: Dataquest (June 1998)

There is a marked difference in the extent of customization among individual countries and industries. In general, Germans appear to do less customization than, for instance, their French counterparts. Contrary to what we would have expected, 41 percent of the respondents in electrical/electronic machinery said they do no customization of their mechanical CAD/CAM/CAE systems. Given the fact that engineers in this industry are often having to deal with both electrical and mechanical design problems, we would expect more customization, at least in the area of integration among various software design packages. Similarly, 74 percent of respondents in fabricated metal said that they do a lot or some customization of their systems. We would have expected this percentage to be less, especially in light of the fact that many CAD software vendors have been focusing on offering functionality specifically for designers in this industry.

Figure 3-3
Customization of CAD/CAM/CAE Systems



Source: Dataquest (June 1998)

New Designs or Modifications

Not all discretely manufactured products are based on completely new designs. On the contrary, mechanical designers and engineers must spend part of their time modifying existing parts and assemblies instead of designing new part, assemblies, and products from scratch. We asked respondents about the proportion of new parts designed to existing parts that are modified. On average, 45 percent of their designs are modifications of existing designs, and 55 percent are completely new designs. There was little difference seen by country or by industry, though respondents in industrial machinery tended to design products from scratch more often than those in fabricated metal. The amount of modifications done points to a need to preserve legacy data in a form that will be accessible in the future and to tools that address editing rather than creation from scratch.

Designing in 2-D or 3-D?

For the most part, European mechanical designers in this survey design in both 2-D and 3-D. Details by country and industry are given in Table 3-1. The French report the highest percentage of 3-D design work, and Italians report the lowest. From an industry perspective, those in automotive tend to design more often in 3-D than those respondents in fabricated metal or industrial machinery. For those respondents who said that 3-D was their primary form of design today, we asked them what percentage of the 3-D functions available on their CAD/CAM/CAE system are used. The answers, shown in Table 3-1, are in line with what we have seen in previous North American-based surveys.

While the results shown in Table 3-1 are not surprising, they underscore the fact that there is still plenty of 2-D design work being done. While vendors would like to believe that the world has gone 3-D, users are clearly still working in 2-D, and their software needs cannot be ignored. Of course, optimistic vendors can see the high number of 2-D seats out there as an opportunity to convert those seats into 3-D.

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

	Yes (%)	No (%)	Percentage of 3-D Functions Used
By Country			
France	59	41	51
Germany	44	56	57
Italy	29	71	82
United Kingdom	42	58	69
By Industry			
Aerospace	47	53	62
Automotive	56	44	60
Electrical/Electronic Machinery	44	56	53
Fabricated Metal	37	63	62
Industrial Machinery	35	65	64
Other Industries	52	48	80
All Respondents	**45**	**55**	**62**

Source: Dataquest (June 1998)

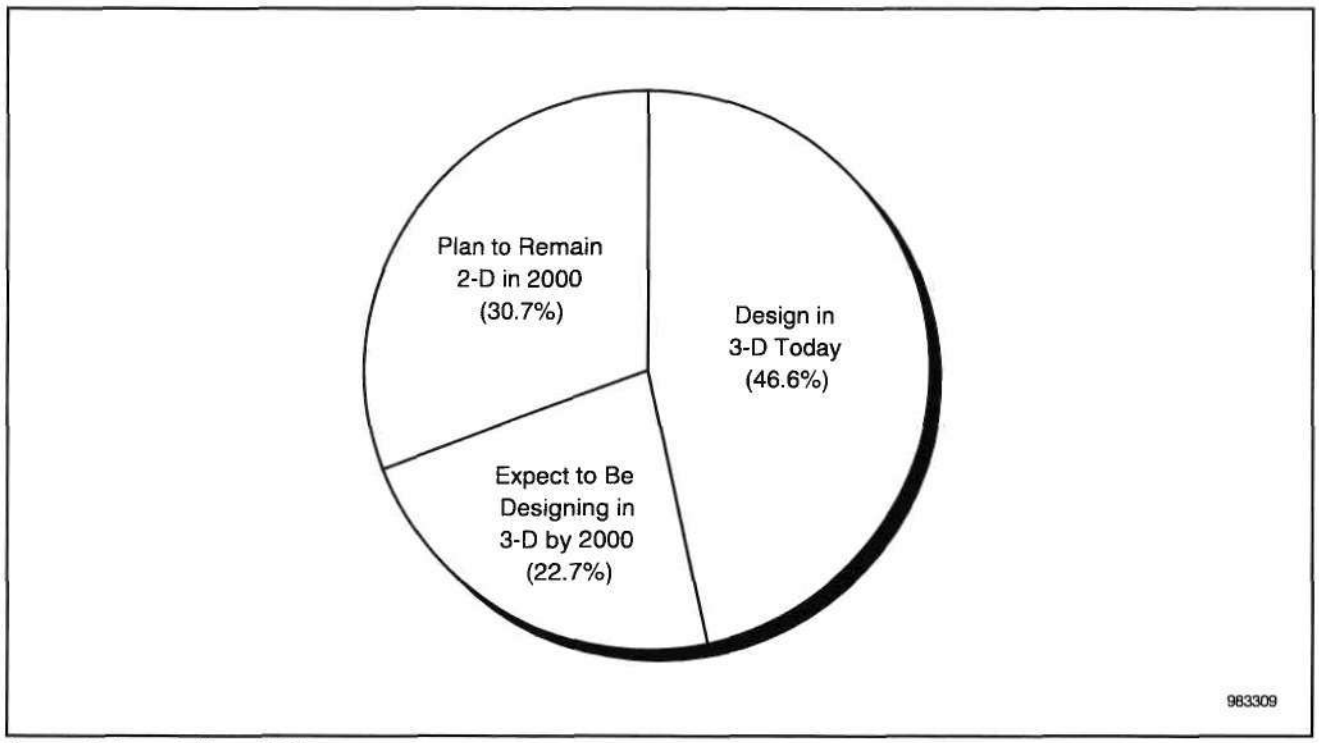
Reasons for Staying with 2-D

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 2000. Forty-two percent of these respondents said yes, and 58 percent said no. If we factor these results into the results from our question about whether a respondent's main design methods are 2-D or 3-D, we see that 2-D is clearly here for the long run (see Figure 3-4).

Among those respondents who are currently 2-D users and are not planning to move to 3-D by 2000, little difference among respondents was seen by country, except with the Italian respondents, for whom only 21 percent expect to move to 3-D by 2000. Similarly, by industry, only 30 percent of aerospace respondents expect to move to 3-D, while 58 percent of fabricated metal respondents expect to move to 3-D.

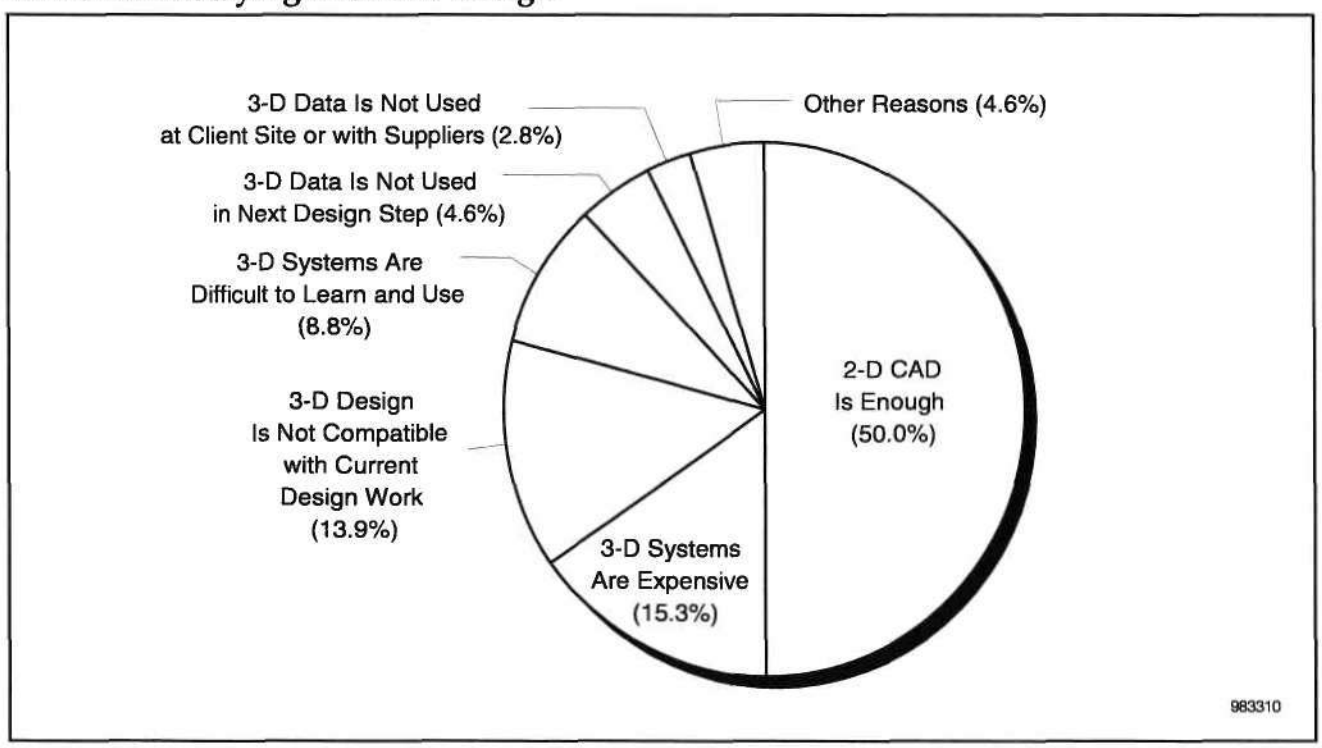
Overall, users cited many reasons for not planning to change to 3-D CAD by 2000. By far, the most commonly cited reason was that 2-D CAD is enough to meet their needs. All reasons are summarized in Figure 3-5. Interestingly, despite the proliferation of relatively inexpensive 3-D mechanical design packages with graphical user interfaces and multimedia-based learning tools, there is still the perception out there that 3-D CAD systems are expensive.

Figure 3-4
2-D or 3-D in 2000?



Source: Dataquest (June 1998)

Figure 3-5
Reasons for Staying with 2-D Design

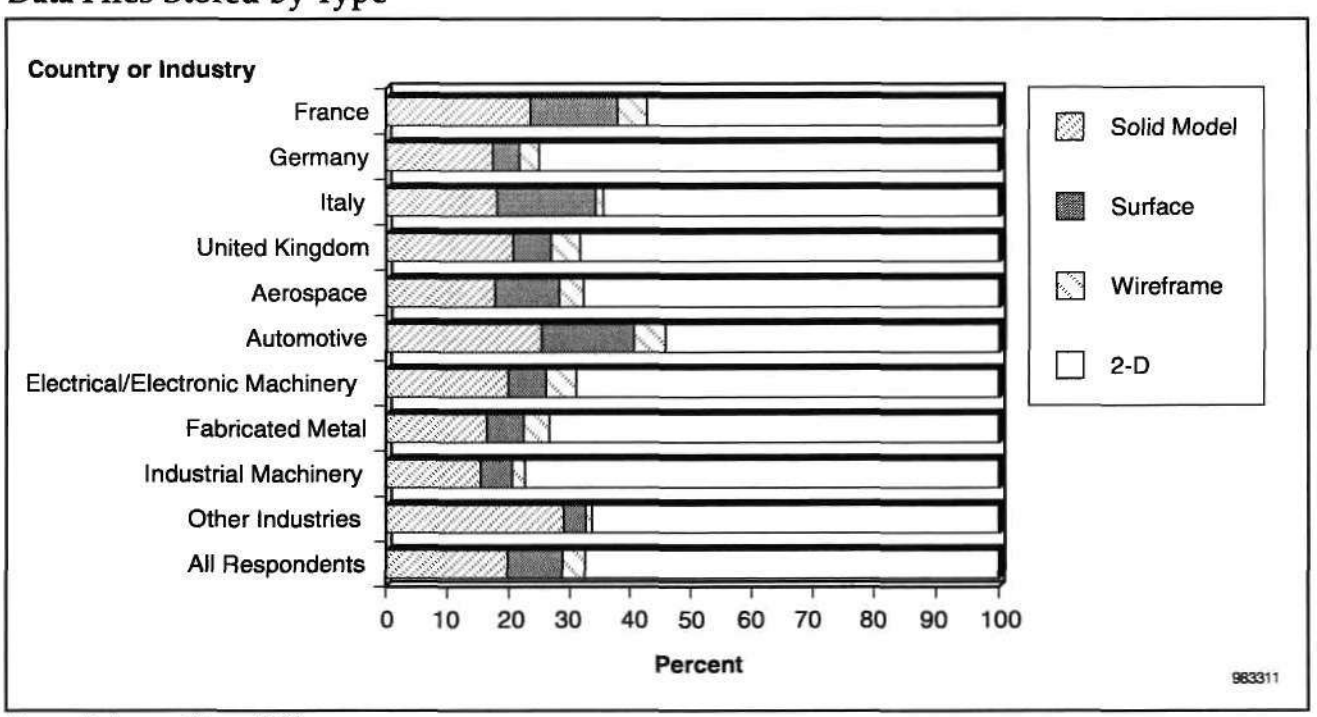


Note: Multiple responses allowed
Source: Dataquest (June 1998)

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 and storage requirements necessary to view and edit design data as it is retrieved. Figure 3-6 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 modeling 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 fabricated metal, and in Germany. As indicated in Figure 3-6, those in the automotive industry store more files as surface models than any other industry. We would expect this high storage of surface models, given the nature of automobile design and the "competitive" advantage one automobile manufacturer deems over another in its automobile surfacing capabilities. Similarly, respondents in France and Italy indicated a higher-than-average storage of surface models, reflective of the high amount of industrial design work that occurs in these two countries.

Figure 3-6
Data Files Stored by Type



Source: Dataquest (June 1998)

Methods for Transferring Design Files

Dataquest asked respondents to identify the main method for transferring design files from one system to another. Despite the relative sophistication of our survey sample, file transfer methods appear to be one step behind, with slightly more than one-half of our respondents indicating that the primary transfer method for design data was electronic means (such as through the Internet or via a direct link with a supplier or other site). However, while electronic methods dominate, files are still being transferred the manual way (on paper) or via "sneakernet" (on diskette or tape). The results for all responses are given in Figure 3-7.

From a country perspective, respondents in the United Kingdom indicate the highest use of electronic means for transferring files (60 percent of respondents said that electronic methods were the primary method), while those in France indicate the lowest (45 percent of respondents). Similarly, from an industry perspective, those respondents in the automotive industry use electronic methods for transferring design data more (61 percent of respondents) than those in fabricated metal (45 percent of respondents). The highest use of paper was seen in the United Kingdom (19 percent of respondents) and in fabricated metal and industrial machinery (14 percent of respondents in each industry).

Again, we caution vendors to not throw all their eggs into one basket, despite how enticing it might be for a vendor to be able to say, "Yes, our software lets engineering companies design project home pages where everyone can get access to the information." These vendors need to keep in mind that roughly half of the designers in our survey do not even have electronic means for transferring files.

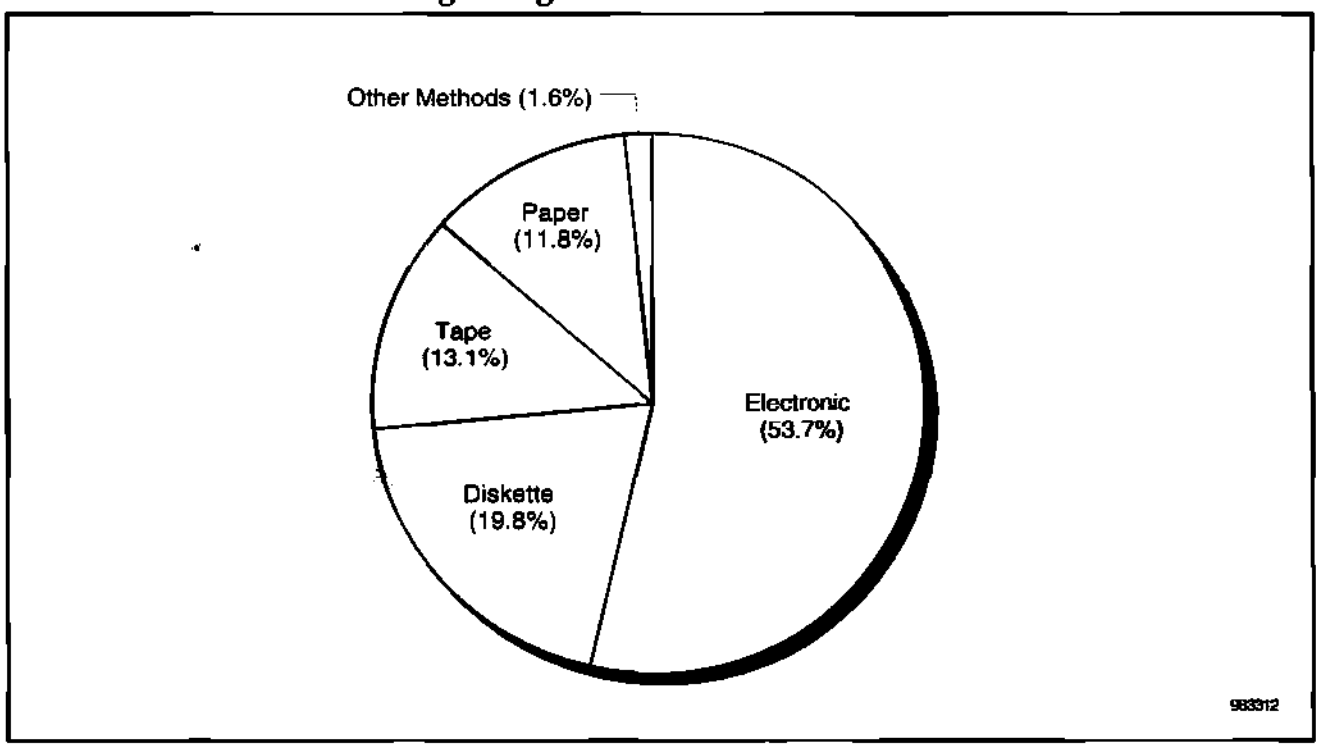
The STEP Standard

Standards have always been a more important issue in Europe, where they are often mandated by local governments, than in North America. STEP (aimed at management of data throughout the life cycle of a product) is no exception. While STEP is an international standard, much of the development work for the STEP standard, as well as requirements and specifications for future IT tools, has been occurring in Europe, through the efforts of the Advanced Information Technology (AIT) and European Strategic Programme for Research and Development in Information Technology (ESPRIT).

Users want the ability to transfer data between different CAD/CAM/CAE systems with a minimum of fuss and rework, something that can't be done with translators today. Further, users are interested in being able to access data throughout the life cycle of a product, where that product could be a computer (which has a relatively short life cycle) or a ship (which has a much longer life cycle). STEP has been drawing the interest of the CAD community for quite some time, but this survey, similar to survey results in earlier years, shows that STEP still has many years to go before it is widely accepted and used.

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Figure 3-7
Main Method for Transferring Design Files

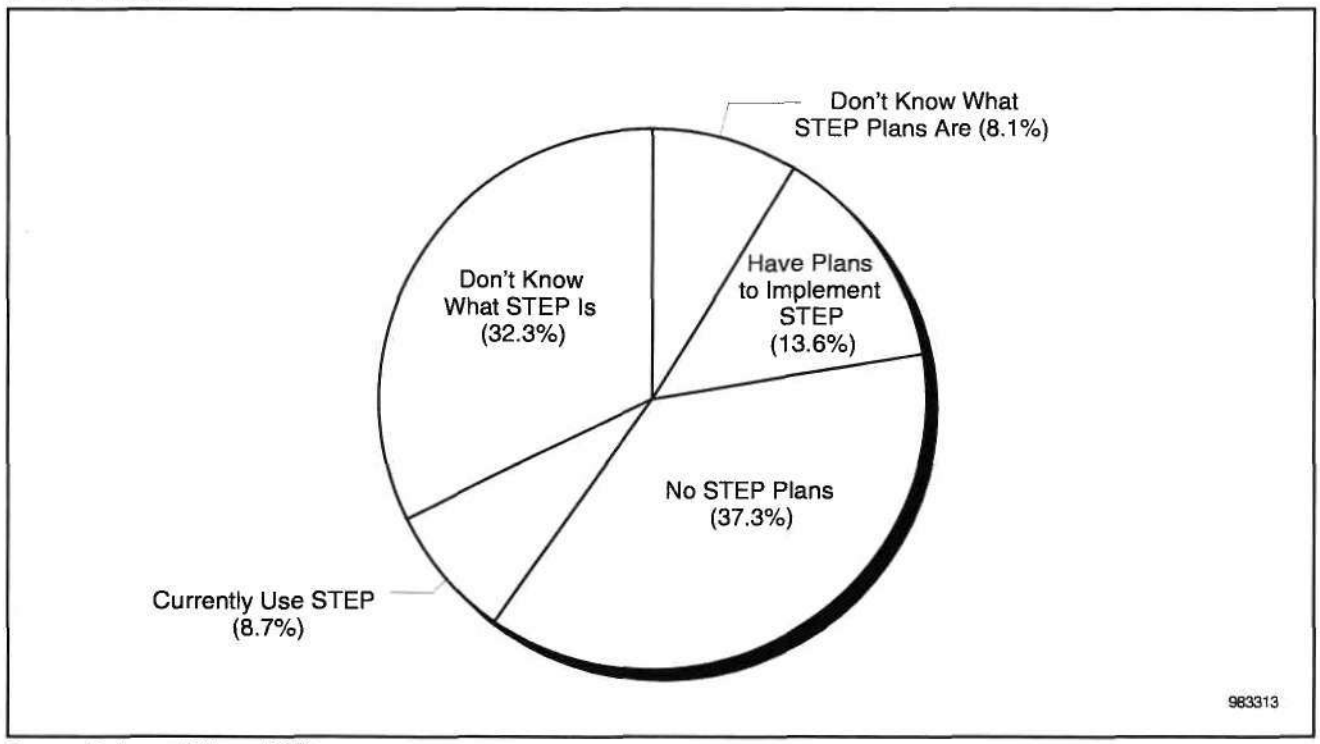


Source: Dataquest (June 1998)

Specifically, Dataquest asked users what their plans for the STEP standard are. The results are given in Figure 3-8. The highest rates of STEP use or plans, as well as awareness of the STEP standard, 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 results are similar to what we saw in North America in 1997). Respondents in aerospace, fabricated metal, and industrial machinery reported the least awareness of the STEP standard. We expected those in aerospace to show higher awareness of STEP, as some of the STEP development efforts have also focused on the aerospace industry.

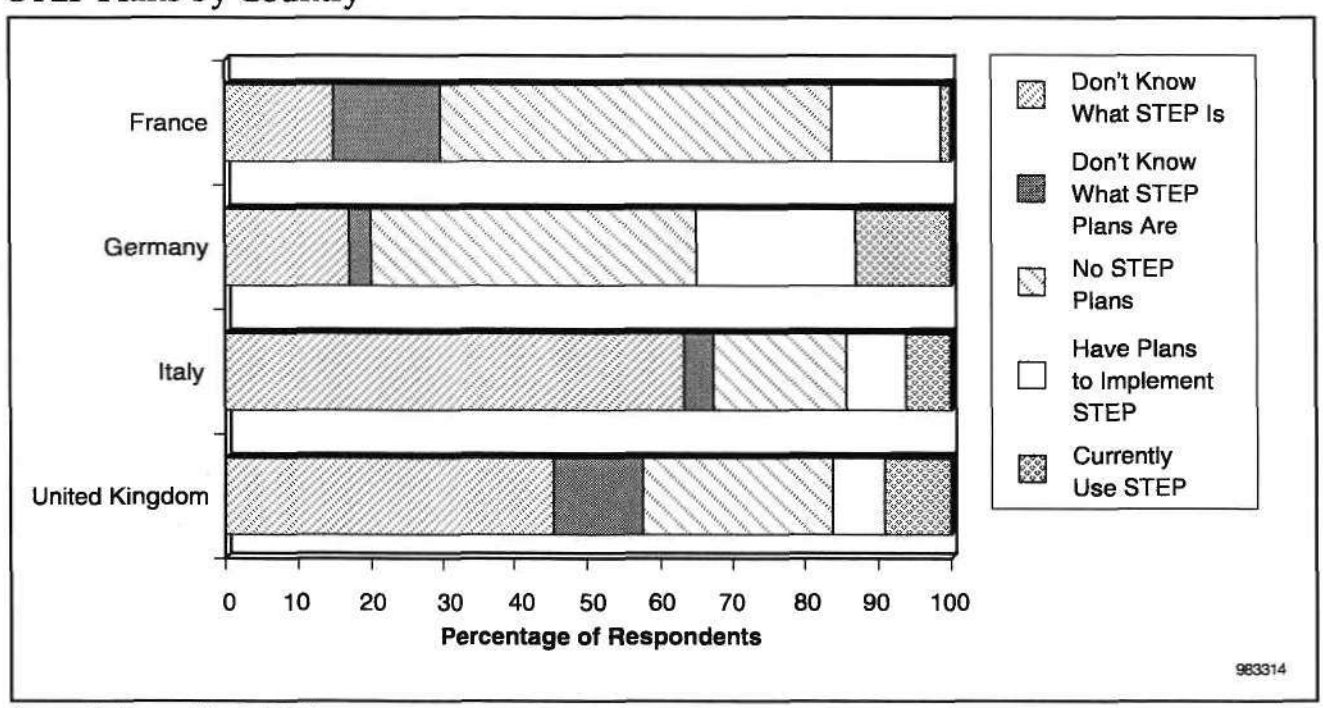
Figure 3-9 shows STEP plans by country, where it is quite apparent that awareness of the STEP standard varies greatly by country. We can characterize the French and German respondents in our survey as having the most awareness of STEP, and the Italian and U.K. respondents as having the least awareness. In any case, the lack of awareness of STEP is still quite high for all respondents. The results in Figures 3-8 and 3-9 regarding STEP awareness show little change from an earlier 1995 European mechanical user survey.

Figure 3-8
STEP Plans



Source: Dataquest (June 1998)

Figure 3-9
STEP Plans by Country



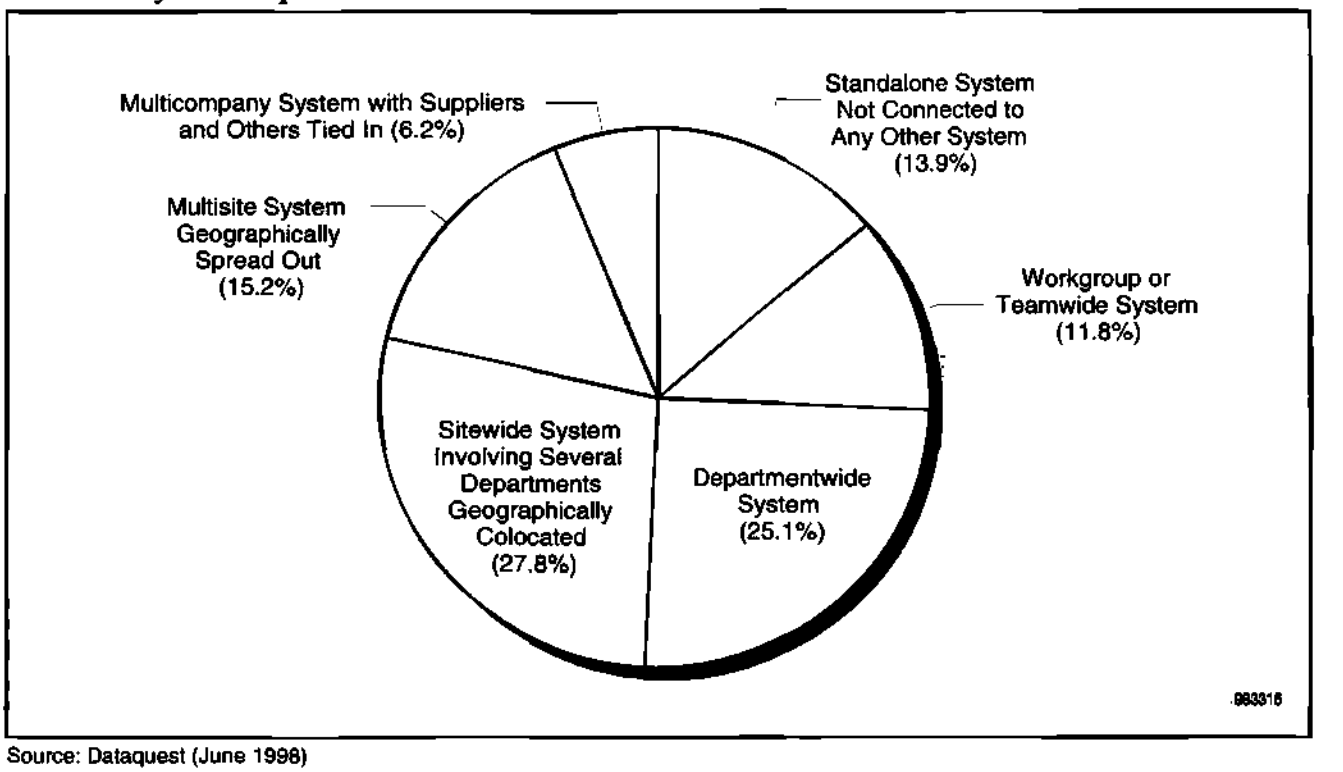
Source: Dataquest (June 1998)

Chapter 4
Future CAD/CAM/CAE Plans

Level of System Operation

Respondents indicated a number of levels of CAD/CAM/CAE system operation. Eighty-six percent of respondents are in some type of networked environment, as indicated in Figure 4-1. As in previous surveys, few respondents (6 percent) 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 intranet technology, client/server technology, and networking capabilities of CAD/CAM/CAE software. Readers should also note that results to this question may be somewhat skewed, given our focus on certain industries in this survey. As we would expect, automotive respondents drove up the response rate to a networked system with suppliers and others tied in (15 percent had such a network), whereas fabricated metal respondents pulled that rate down (no respondents had such a network).

Figure 4-1
Level of System Operation



Source: Dataquest (June 1998)

Migration Plans to NT

Dataquest asked users what their current CAD operating system is and what it will be in 2000 and in 2002. The results are summarized in Figure 4-2 and Table 4-1. It is important to keep in mind that these are responses from end users and not a Dataquest forecast of mechanical CAD/CAM/CAE operating systems.

According to our survey respondents, UNIX will indeed cede ground to Windows NT in mechanical CAD/CAM/CAE. Currently, 59 percent of our respondents use UNIX as their primary operating system for CAD. In 2000 and 2002, slightly over one-half of our survey respondents expect Windows NT to be their primary operating system, with UNIX as the main operating system falling to 30 percent in 2000 and 15 percent in 2002. Moreover, 26 percent of respondents are unsure what their main CAD operating system will be in 2002. While there are certainly users who already have operating system plans in place for the next five years, it is this 26 percent of "undecided" users who could be persuaded to go any way: UNIX, Windows NT, or other operating system. Readers should note that previous end-user surveys have consistently 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.

The overall numbers do not give the whole picture. It appears as though each country and industry will adopt the NT operating system at very different rates. Table 4-1 illustrates some of these differences. It appears as if the UNIX holdouts over the near term will be in Italy and in the automotive industry. 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 that have equivalent functionality to their time-tested UNIX counterparts.

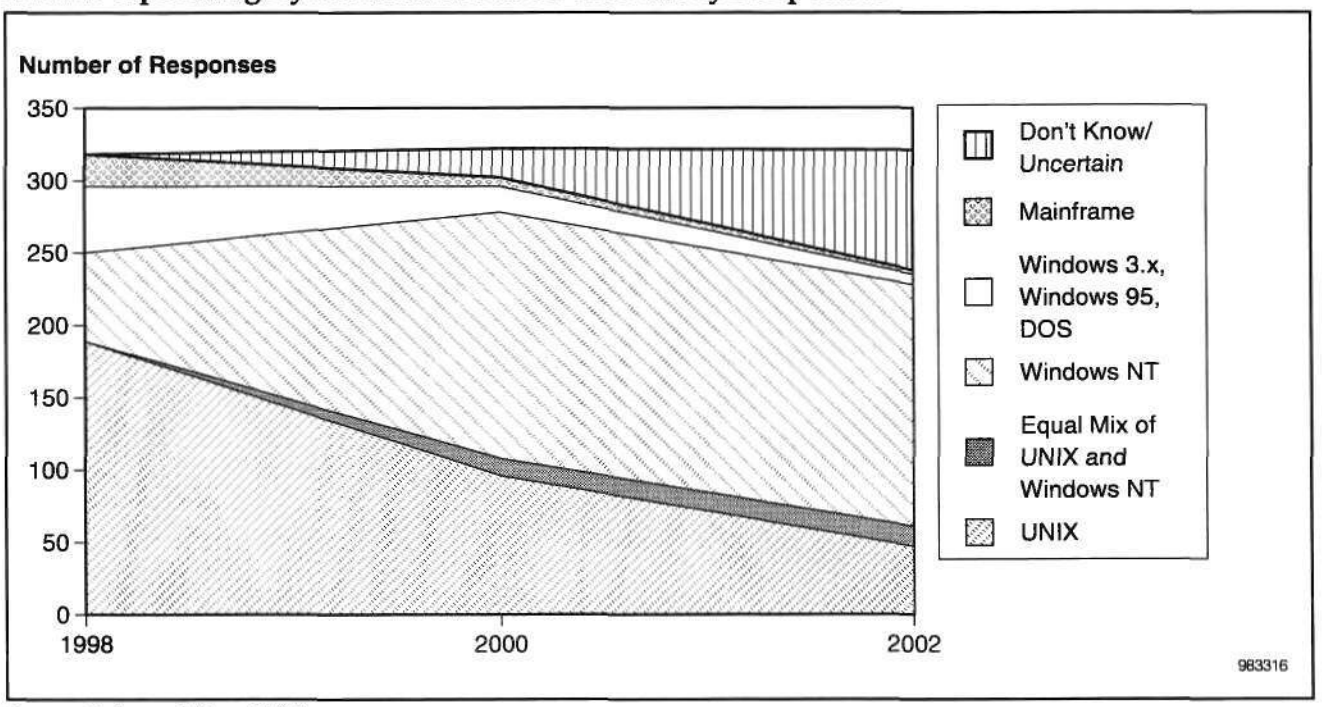
We continue to be surprised by the NT plans shown by aerospace respondents. Similar to our 1997 North American end-user survey results, a high percentage of aerospace users expect Windows NT to be their main operating system by 2002. This comes as a surprise, because aerospace sites tend to be larger 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.

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

The low anticipated deployment rate for Windows NT-based systems in Italy, and the high deployment rate in the United Kingdom, is probably reflective of the NT-based systems available on the market today. Many (but certainly not all) of these systems have been developed by U.S.-based vendors who typically develop an English version first, and then roll out versions for German, French, and Japanese. Other languages, such as Italian, are not first or second priority for these vendors.

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Figure 4-2
Future Operating System Plans Based on Survey Responses



Source: Dataquest (June 1998)

Table 4-1
Adoption of Windows NT by Country and Industry (Percent)

	UNIX in 1998	UNIX in 2000	UNIX in 2002	Windows NT in 1998	Windows NT in 2000	Windows NT in 2002
By Country						
France	64.00	32.43	6.76	17.33	54.05	45.95
Germany	60.40	19.80	9.90	15.84	60.40	54.46
Italy	81.63	57.14	44.90	6.12	26.53	32.65
United Kingdom	42.55	24.24	10.20	30.85	56.57	63.27
By Industry						
Aerospace	48.28	31.67	18.33	24.14	48.33	53.33
Automotive	76.92	49.37	20.51	12.82	40.51	50.00
Electrical/Electronic Machinery	67.65	20.59	8.82	17.65	64.71	64.71
Fabricated Metal	46.51	13.95	2.33	25.58	69.77	62.79
Industrial Machinery	55.29	22.09	13.95	20.00	55.81	44.19
Other Industries	52.38	28.57	19.05	14.29	42.86	42.86
All Respondents	**59.25**	**29.72**	**14.60**	**19.12**	**52.63**	**51.86**

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 1998)

What Is Driving the NT Decision

Dataquest asked respondents about their reasons for moving to the Windows NT operating system for their mechanical design work. The results are summarized in Figure 4-3 and Figure 4-4, where we have shown the results by all respondents, and by those respondents who identified UNIX as their primary operating system today. In either case, the two top reasons to move to NT were the prospects of easier system/networking maintenance and reduced hardware costs. But, UNIX hardware vendors should take note that the prospect of reduced hardware costs appears to be more of a driving factor among our UNIX-based respondents, where 32 percent of these respondents said it was the No. 1 reason to make the move to Windows NT.

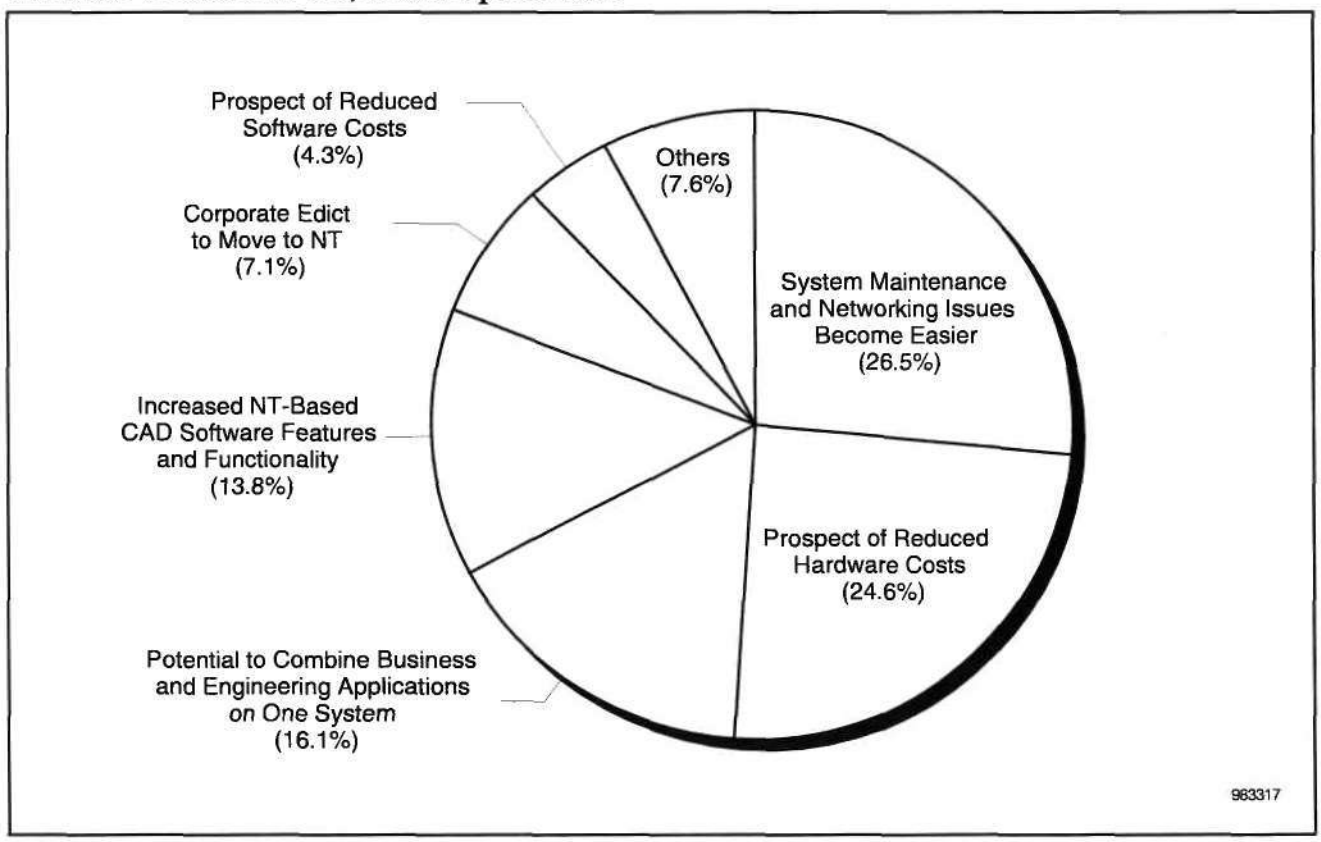
Dataquest also investigated the reasons users did not expect to adopt Windows NT as their primary operating system. The results, by all respondents and by UNIX respondents, are shown in Figure 4-5 and Figure 4-6, respectively. Here, the top reasons were satisfaction with current operating system, followed by a corporate edict to stay with current operating system/not move to NT. Little difference was seen between all respondents and UNIX-based respondents, except for the slightly higher percentage of UNIX-based respondents citing satisfaction with their current operating system as the main reason to not move to Windows NT.

While just last year, we saw NT-based CAD software features and functionality (or lack thereof) as a top reason for not moving to NT, this year that reason commanded only 9 percent of the responses. NT-based CAD software applications are clearly catching up in functionality. Similarly, hardware and software cost incurred with operating system changes did not factor highly in this year's survey, compared to last year's survey results. Legacy data issues continue to rank low among the areas of concern against moving to NT. Mechanical CAD/CAM/CAE software and hardware 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.

CAD Purchasing Decisions

Generally speaking, mechanical CAD/CAM/CAE purchase decisions in Europe tend to be less driven by corporate edict than in North America. Forty-two percent of our European respondents stated that CAD purchasing decisions are made based on corporate edict or a policy to standardize on one CAD system, versus 67 percent for North American respondents in 1997. There was some difference by country; for instance, CAD purchases at the Italian sites we surveyed appear to purchase CAD based more on corporate edict than sites in France, where purchases are more project-driven.

Figure 4-3
Reasons to Move to NT, All Respondents



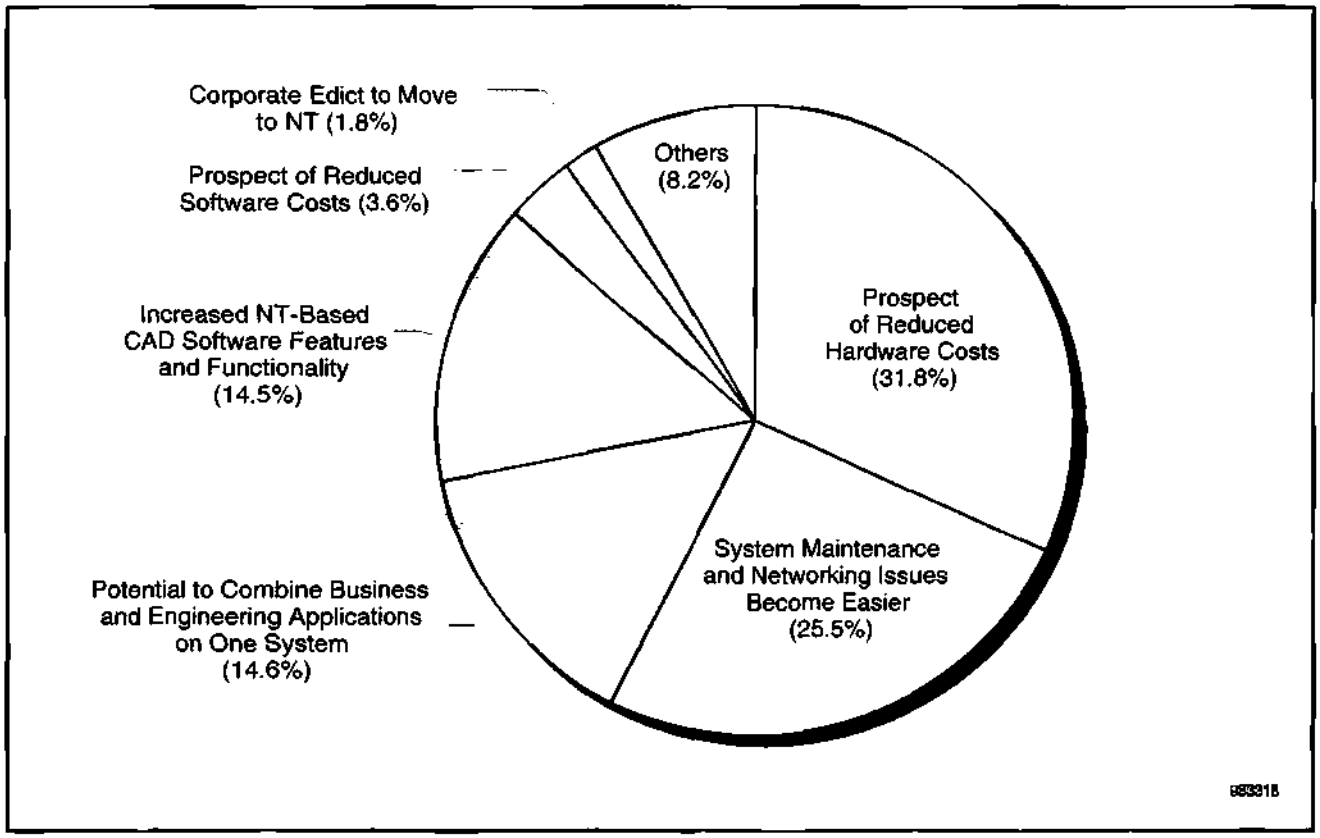
Source: Dataquest (June 1998)

What is more interesting, however, is that European sites, in comparison to their North American counterparts, will purchase CAD to upgrade their existing systems. Thirty-four percent of our European respondents said that CAD/CAM/CAE purchases at their company tend to be driven by a desire/need to upgrade old systems, while only 6 percent of North American respondents said that last year. This is in line with our belief that CAD purchases in Europe are quite cyclical, with companies going through CAD reinvestment periods every five to seven years, and that these purchases are often part of a larger IT investment strategy. A summary of results by country is given in Figure 4-7.

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 1998 to 2000, with little variation seen by country or industry (see Figure 4-8). The only areas where respondents indicated a much higher-than-average anticipated seat count increase is in Germany and in the automotive industry. The industry showing little opportunity for seat count growth is electrical/electronic machinery, where little change is expected over the next two years.

Figure 4-4
Reasons to Move to NT, UNIX Respondents

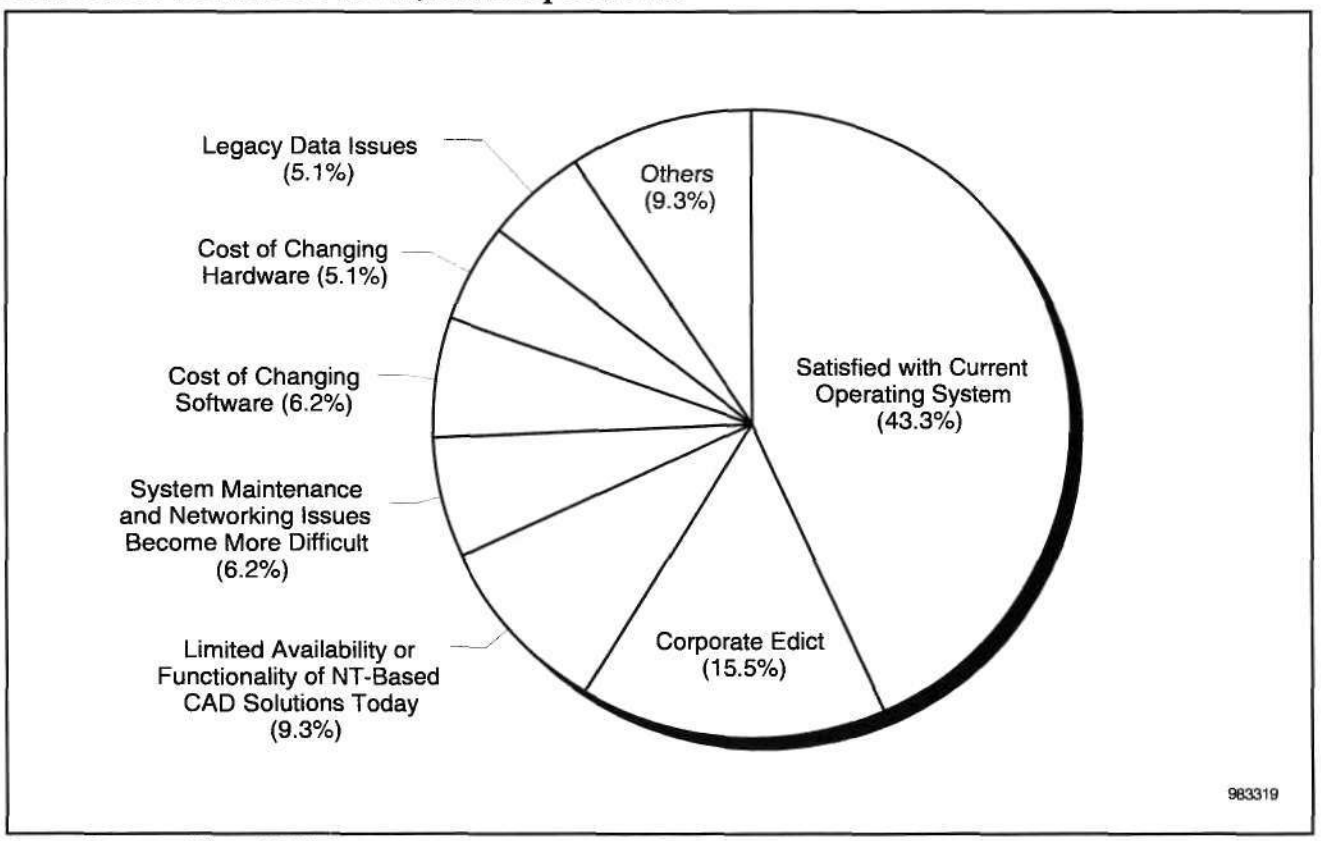


Source: Dataquest (June 1998)

The data in Figure 4-8 is roughly in line with what we presented in Figure 3-2, where we examined CAD/CAM/CAE penetration rates. There, we saw some opportunity for increased CAD seat counts at respondent sites, though we can say that the results in Figure 4-8 are slightly more optimistic than what respondents revealed in Figure 3-2.

The anticipated percentage change of seat count increases ranged from 19 percent in electrical/electronic machinery to 50 percent in fabricated metal, with the average overall responses being a 33 percent increase. From a country perspective, the anticipated percentage change of seat count increases ranged from 21 percent among Italian respondents to 44 percent among French respondents. Responses for the amount of change in seat count decrease were too few to analyze.

Figure 4-5
Reasons to Not Move to NT, All Respondents

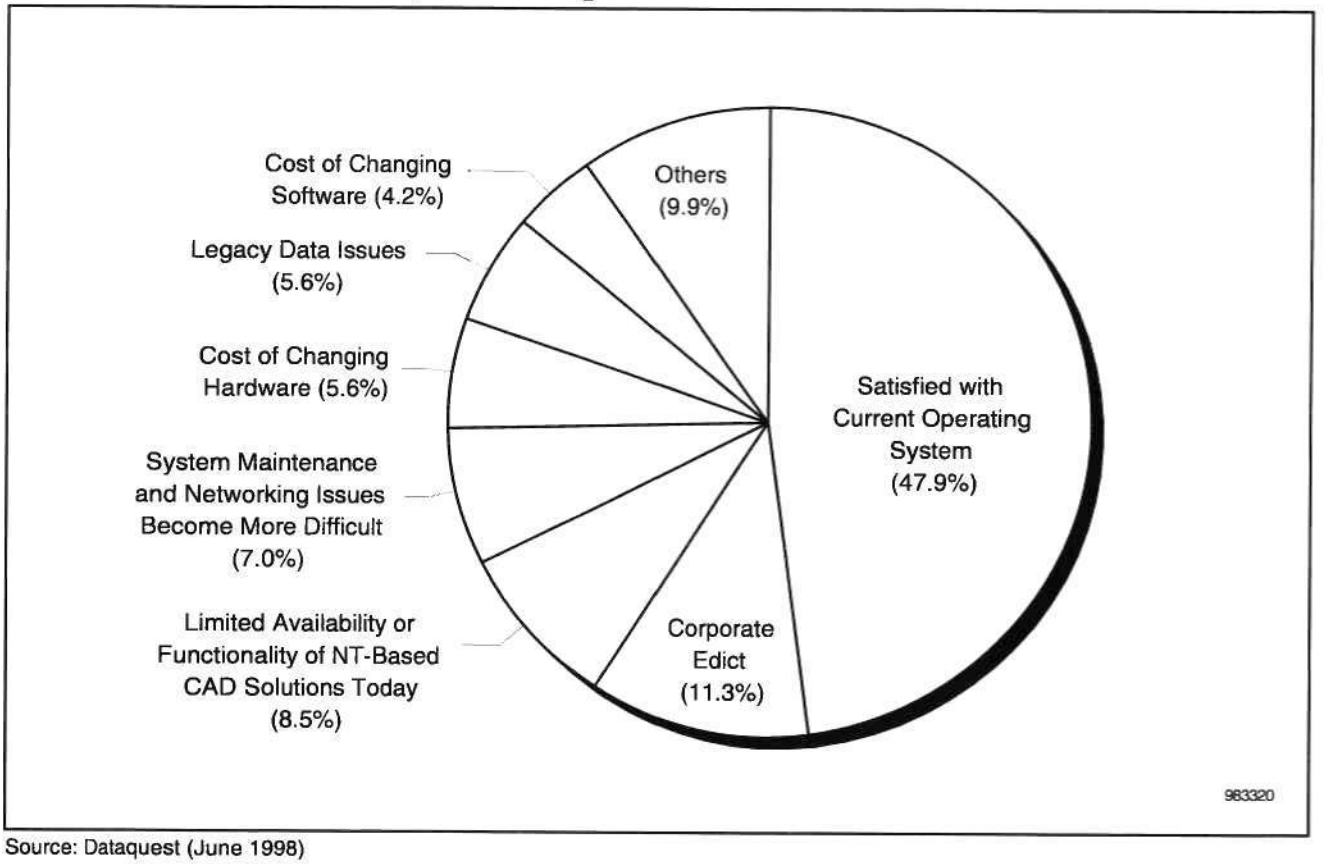


Source: Dataquest (June 1998)

CAD Software Retirements

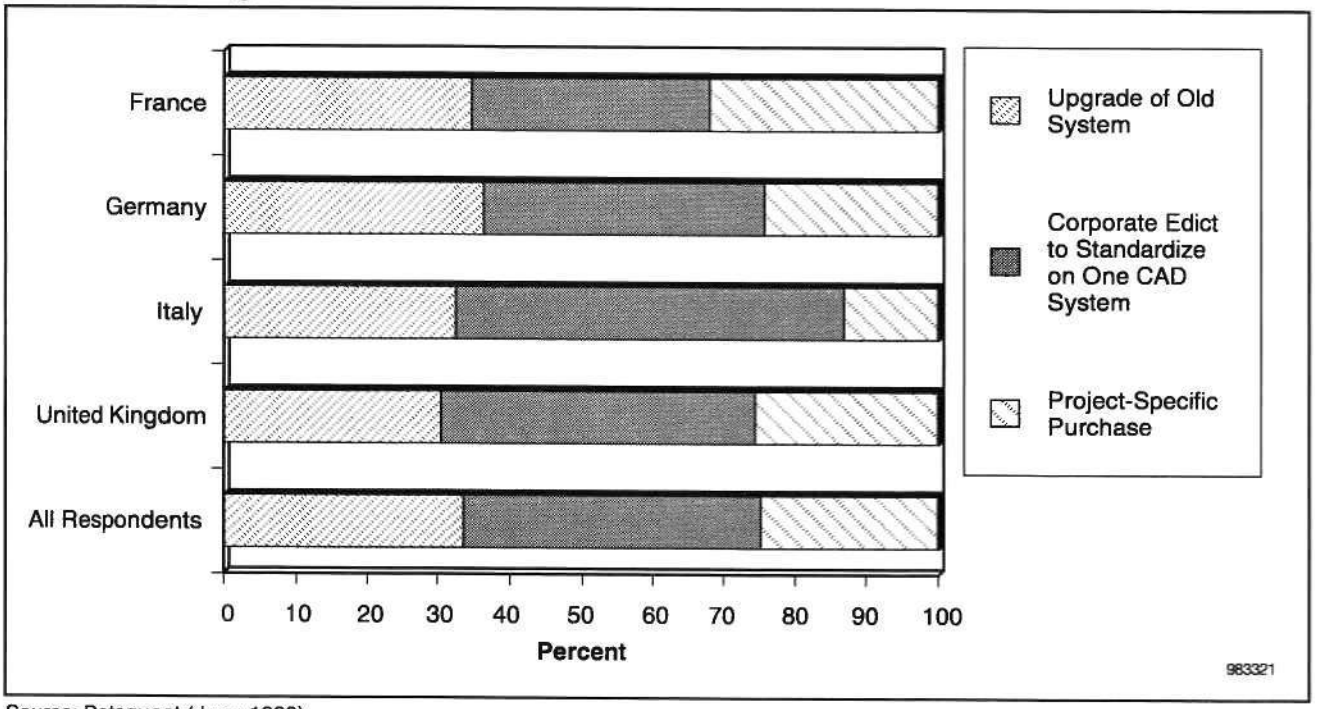
Fewer software retirements affect the capacity to absorb new modules in the future. Users were asked what percentage of their existing mechanical CAD/CAM/CAE modules they believe will be retired over the next two years. Overall, this year's survey respondents are expecting to retire 24 percent of their current CAD software, compared to 20 percent in our 1997 survey, and 10 percent in our 1996 survey. The automotive industry is expecting the greatest amount of software retirements (28 percent), while the fabricated metal respondents expect the least (15 percent). Likewise, Italian respondents expect to retire the most software (31 percent) while French respondents expect to retire the least (20 percent). No matter from what perspective we examine the data, the percentage of CAD software that users expect to retire over the next two years is high, which bodes well for continued growth in this market.

Figure 4-6
Reasons to Not Move to NT, UNIX Respondents



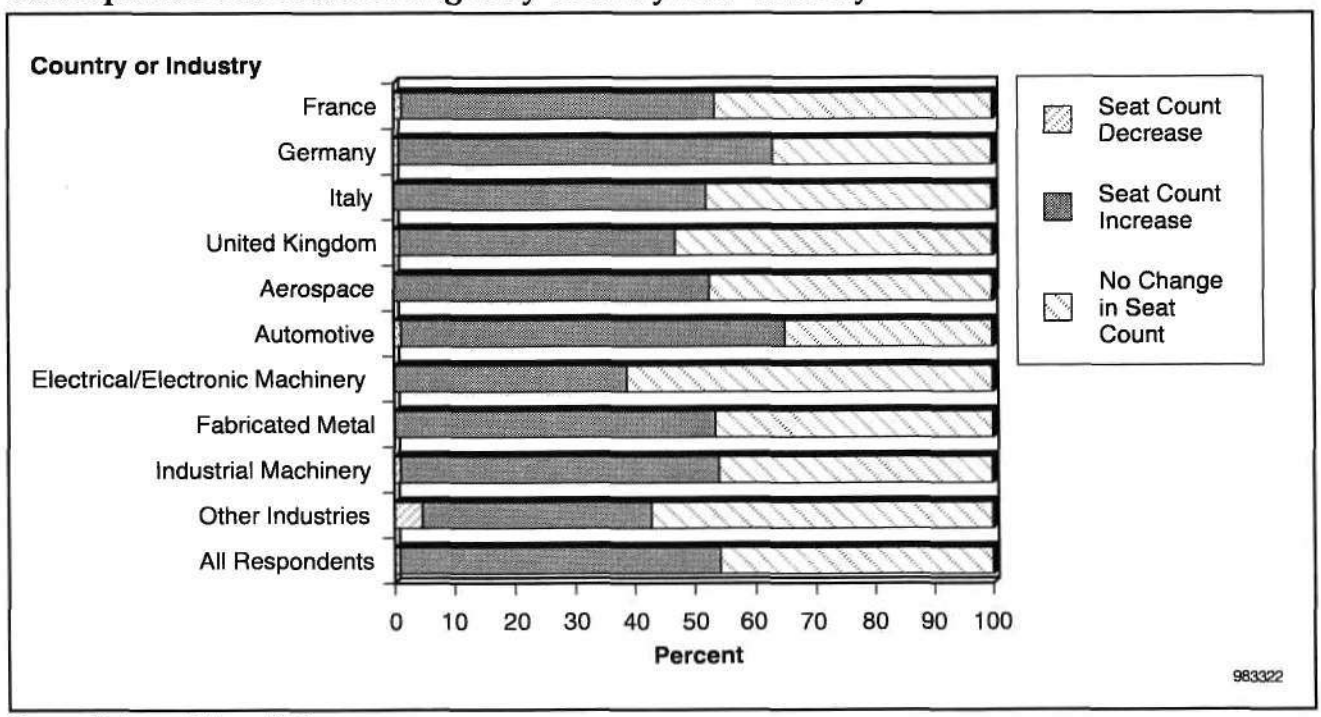
Source: Dataquest (June 1998)

Figure 4-7
CAD Purchasing Decision Drivers



Source: Dataquest (June 1998)

Figure 4-8
Anticipated Seat Count Changes by Country and Industry



Source: Dataquest (June 1998)

CAD Spending Plans

Dataquest asked respondents about planned increases or decreases in CAD spending for the next year. Specifically, respondents were asked if spending (that is, budgets) 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

The results are summarized by industry in Table 4-2, where there is some, but not a lot, of variation by country, industry, and spending category. As a group, more Italian respondents are expected to increase spending (for all categories examined in this section) than other respondents in our survey. Likewise, more French and German respondents are expected to decrease spending (for all categories examined in this section) than other groups in our survey.

User responses to our questions about planned spending/budget changes for CAD/CAM/CAE technology bode well for nearly everyone involved in CAD deployment: software developers, hardware vendors, and consultants. Similar to previous surveys, this survey reveals that European mechanical CAD users are expecting increased mechanical CAD/CAM/

CAE software and hardware spending over the next year. About 40 percent of our survey respondents indicate that software and hardware spending will increase from today's levels. Further, 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.

Dataquest expects that, over the next few years, CAD users in Europe will be seriously re-evaluating their existing mechanical 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. More specifically, some of this increased software and hardware spending is a reflection of the expected future transition toward NT-based CAD/CAM/CAE software in all of the countries and industries examined here. Looking to the future, as object-oriented CAD software, interoperable CAD objects, and new CAD 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 in peripherals such as printers and plotters. As a point of reference, this report includes a summary of respondents' current plotter technologies in Table 4-3. Ink jet plotters were the most frequently mentioned, followed by laser and electrostatic. Users in this survey plan to purchase, on average, five printers and two plotters over the next two years (see Figure 4-9 for results by country and by industry). These figures are quite a bit higher than the usual one or two planned plotter or printer purchases that we typically see.

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Table 4-2
Anticipated Spending Patterns for Mechanical CAD/CAM/CAE Technology

	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 (%)
By Country															
France	36	20	44	40	25	35	22	24	54	28	17	55	29	20	51
Germany	40	16	44	31	30	39	30	21	49	29	16	55	23	16	61
Italy	50	7	43	50	7	43	44	10	46	43	9	48	32	9	59
United Kingdom	46	9	45	45	16	39	38	13	49	30	6	64	20	7	73
By Industry															
Aerospace	41	12	47	39	17	44	36	15	49	28	14	58	24	14	62
Automotive	49	11	40	43	15	42	38	18	44	33	14	53	30	14	56
Electrical/Electronic Machinery	47	16	37	43	33	24	36	18	46	31	13	56	18	12	70
Fabricated Metal	40	17	43	33	29	38	23	21	56	36	2	62	22	5	73
Industrial Machinery	37	18	45	40	24	36	30	18	52	32	14	54	22	16	62
Other Industries	40	0	60	47	11	42	25	15	60	25	10	65	29	14	57
All Respondents	43	13	44	40	21	39	33	17	50	31	12	57	25	13	62

Note: Percentages in Table 4-2 are not the amount of increases or decreases in budgets, but are the number of respondents, expressed as a percentage, indicating an increase or decrease.
Source: Dataquest (June 1998)

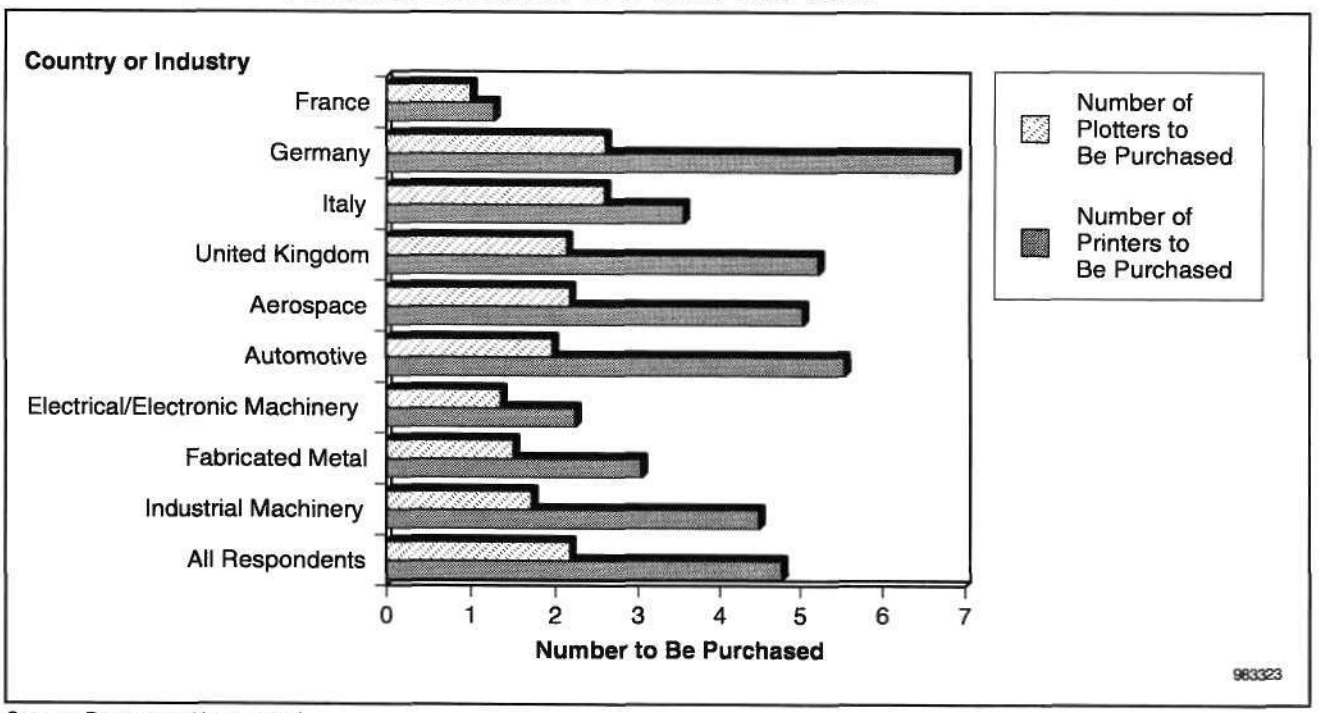
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Table 4-3
Plotter Technology (N = 563)

	Number of Responses
Ink Jet	171
Laser	152
Electrostatic	70
Color Ink Jet	66
Pen	57
Thermal	37
Others	10
Total	**563**

Note: Multiple responses allowed
Source: Dataquest (June 1998)

Figure 4-9
Planned Plotter and Printer Purchases over Next Two Years



Source: Dataquest (June 1998)

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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.

While we do not present the data in this chapter by country or industry, Dataquest clients should be reminded that any specific cuts of data are available through their inquiry service.

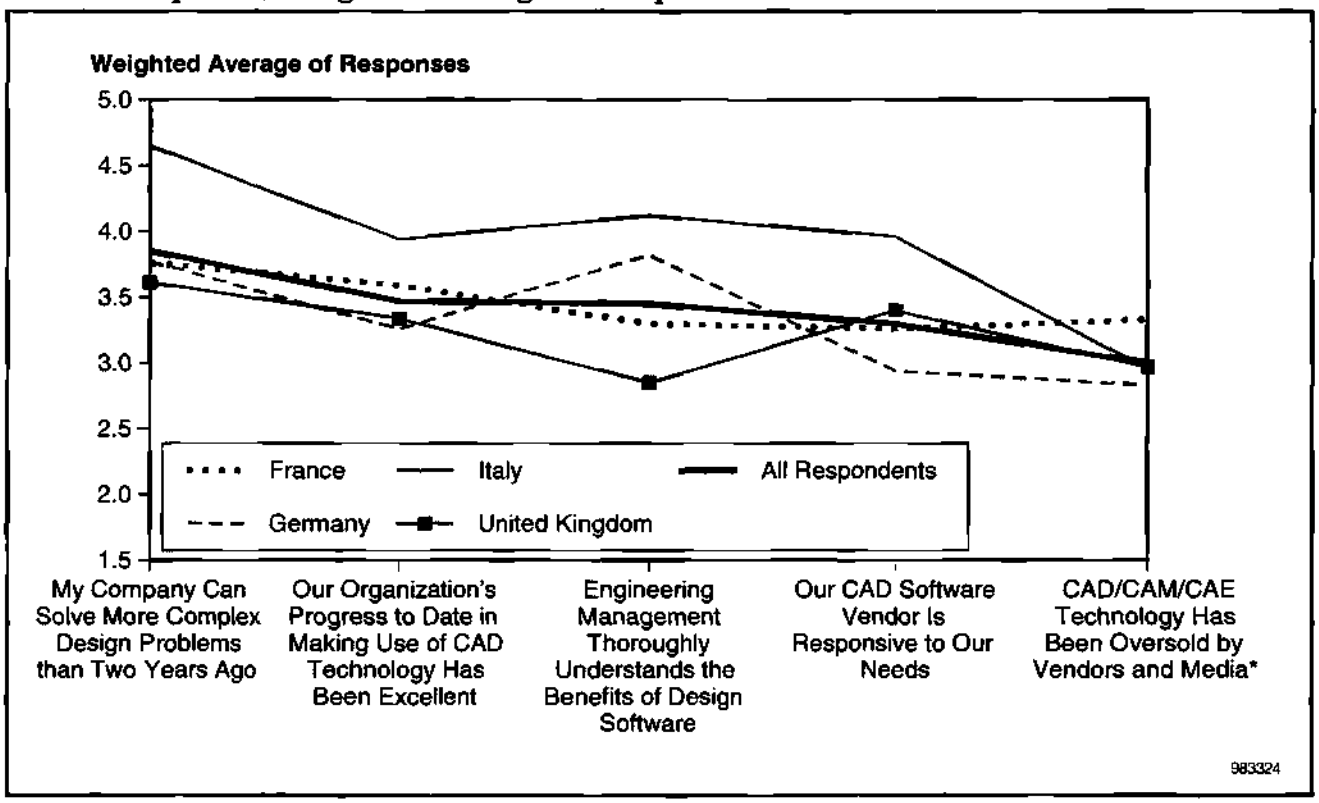
Is CAD/CAM/CAE Technology Helping to Meet Business Goals?

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 that 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. The weighted average of the results, by country, are displayed in Figure 5-1. Overall, respondents in this survey are fairly happy with their CAD/CAM/CAE systems with respect to their company's business goals, with the Italian respondents clearly the most satisfied of the group.

The results seen here do not differ greatly from what we have seen in other end-user surveys. While we could safely say that CAD technology has helped our European designers and engineers tackle more complex designs, we can't say that their engineering management understands the benefits of design automation. From a country perspective, the widest range of responses was seen when users responded to the statement "Engineering management thoroughly understands the benefits of design software," with respondents in the United Kingdom falling short of even agreeing (rating of 3) with that statement.

Figure 5-1
CAD Perceptions, Weighted Average of Responses



Note: Rating scale is from 1 to 5, where 1 is strongly disagree and 5 is strongly agree.
*Full statement is "CAD/CAM/CAE technology has been oversold by the vendors and media, compared to what can be accomplished for the investment required."
Source: Dataquest (June 1998)

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 and computer-aided engineering (CAE) applications
- Computer-aided manufacturing (CAM) applications and numerical control (NC) software
- Product data management (PDM)
- Data exchange and translation

Figure 5-2 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 around 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. Vendors should read the gray shaded areas as opportunities for software/system improvement.

The numerical values of the gaps (the difference between satisfaction and importance ratings, where a negative difference implies unhappy users, and a positive difference implies satisfied users) 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 1.2 difference, or gap. Data translation is one area that has always demanded attention from users, and these European users are much more unsatisfied with their translation and data exchange mechanisms than we typically see.

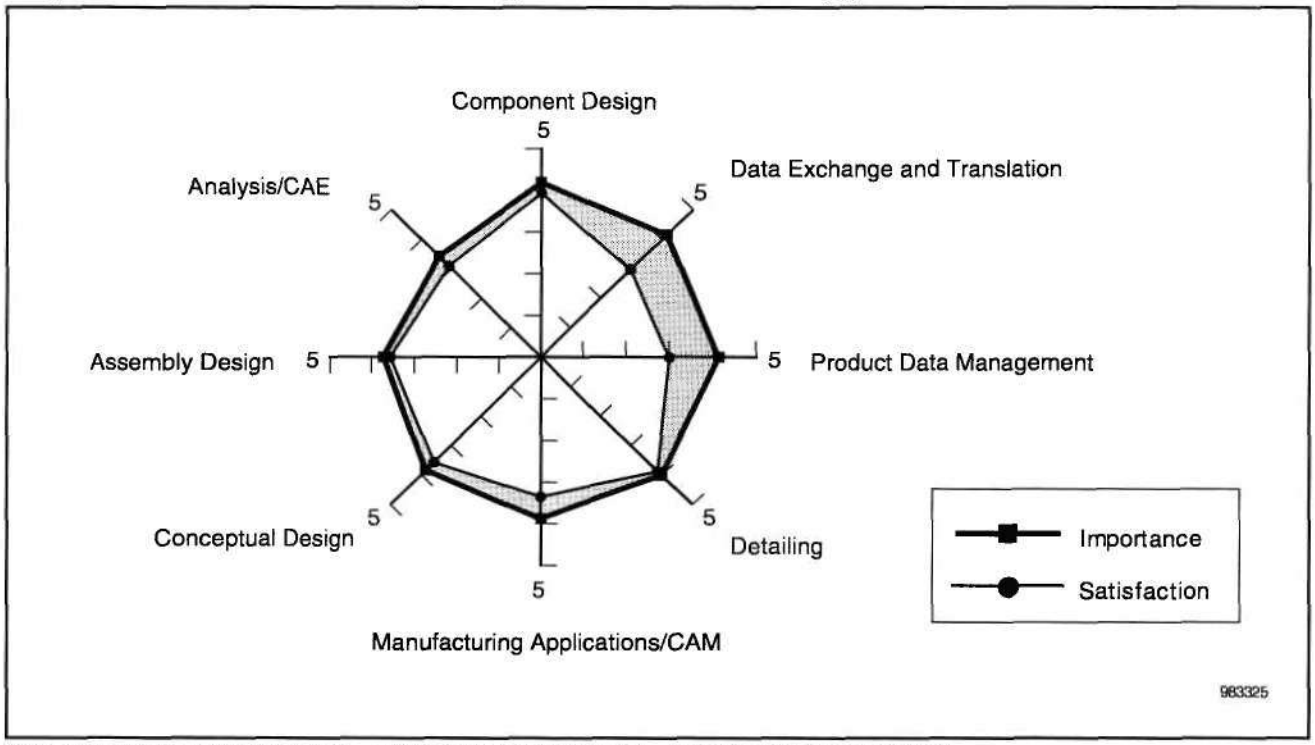
The high importance ranking given to detailing (ranking of 4.0) underscores the importance in mechanical design of this very basic application. However, in comparison to other applications, the gap here, negative 0.1, is not large.

Contrary to what we have seen in North American survey results, product data management ranked quite high in importance among these European survey respondents and low in satisfaction. By country, the German and French survey respondents showed the greatest dissatisfaction with PDM technology, where the gaps were negative 1.3 for each group. Data management is a much larger issue in Europe than in North America, partly driven by the fact that European governments often incorporate standards as mandates. Also, CAD investment in Europe is typically part of a 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, and data management becomes part of that strategy.

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 photorealistic imaging and 3-D graphics cards—that are targeted at making the lives of designers easier.

Figure 5-2
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 1998)

Table 5-1
Importance/Satisfaction Gap Analysis of Mechanical Applications

	Importance	Satisfaction	Gap
Component Design	4.2	3.9	-0.3
Data Exchange and Translation	4.2	3.0	-1.2
Product Data Management	4.1	3.0	-1.1
Detailing	4.0	3.9	-0.1
Manufacturing Applications/CAM	3.9	3.4	-0.5
Conceptual Design	3.8	3.6	-0.3
Assembly Design	3.7	3.6	-0.2
Analysis/CAE	3.4	3.1	-0.3

Note: Ratings on a scale of 1 to 5 (1 = not important/not satisfied, 5 = very important/very satisfied)
Source: Dataquest (June 1998)

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
- Accessing design information via a project Web site
- CAD to CAM integration
- CAD to CAE integration

Figure 5-3 and Table 5-2 outline user ratings for the items listed above. Clearly, these designers and engineers want a lot of performance from their CAD solutions—tight integration among modules (especially CAD to CAM integration), good graphics, and design optimization capabilities.

Integration of CAD with both CAM and CAE ranked high in importance and also showed sizable importance-satisfaction gaps. The user-perceived dissatisfaction with CAD to CAM and, to a lesser extent, CAD to CAE integration, is consistent with the importance-satisfaction gap we discussed earlier concerning data exchange and translation.

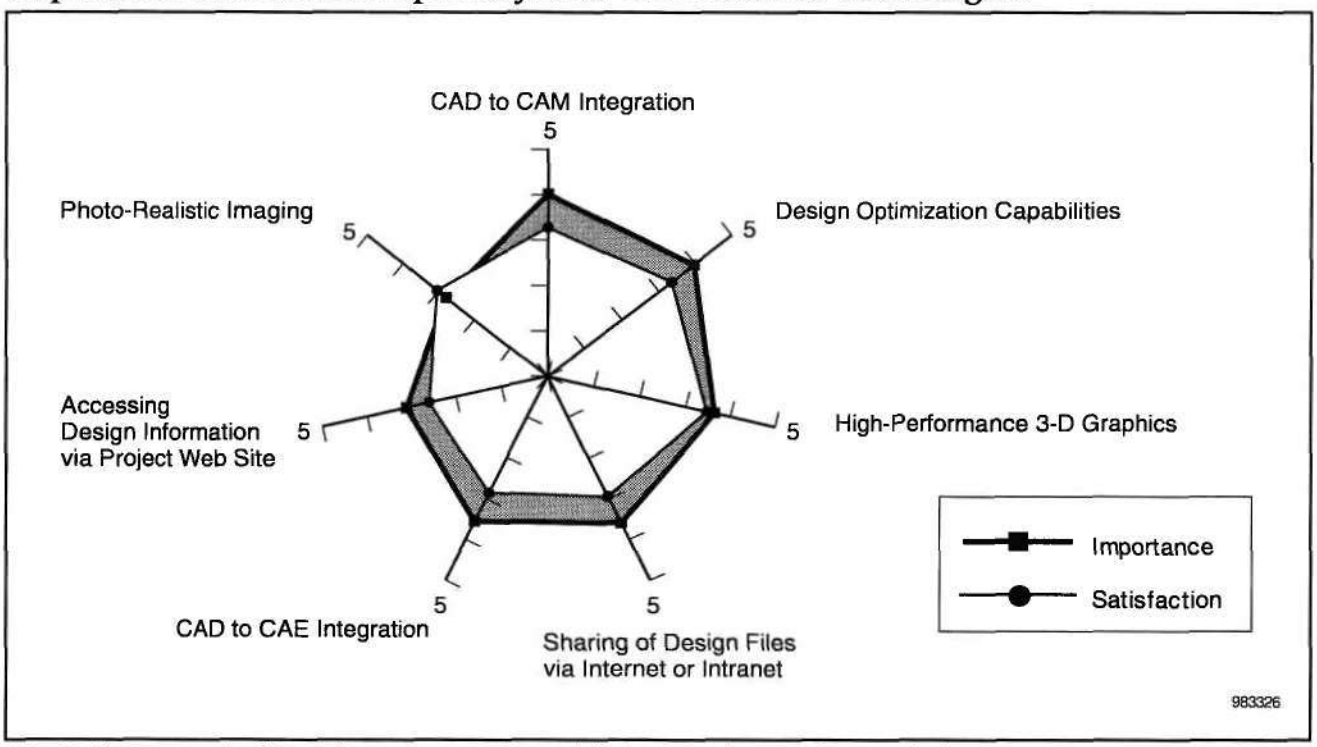
Better 3-D graphics is one area that UNIX-based workstation vendors tout over their PC-based and NT-based competitors. And, as our survey shows, graphics is ranked high in importance to these designers and engineers. (Surprisingly, however, photo-realistic imaging is of less importance, and users are 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.

Mechanical designers are beginning to use the World Wide Web, intranets, and the Internet for design- and engineering-related activities. Here, survey respondents are interested in sharing design files via the Internet or intranet and are interested in project Web sites, but their satisfaction with their abilities to do so today is not high. Readers should note, however, that such capabilities aren't at the top of these user importance rankings.

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.

Figure 5-3
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 1998)

Table 5-2
Importance/Satisfaction Gap Analysis of CAD-Related Technologies

	Importance	Satisfaction	Gap
CAD to CAM Integration	4.0	3.3	-0.7
Design Optimization Capabilities	3.9	3.3	-0.6
High-Performance 3-D Graphics	3.6	3.5	-0.2
Sharing of Design Files via Internet or Intranet	3.6	2.9	-0.7
CAD to CAE Integration	3.6	2.9	-0.7
Accessing Design Information via Project Web Site	3.1	2.6	-0.5
Photo-Realistic Imaging	2.8	3.0	0.3

Note: Ratings on a scale of 1 to 5 (1 = not important/not satisfied, 5 = very important/very satisfied)
Source: Dataquest (June 1998)

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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
- Software applications 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 5-4 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.

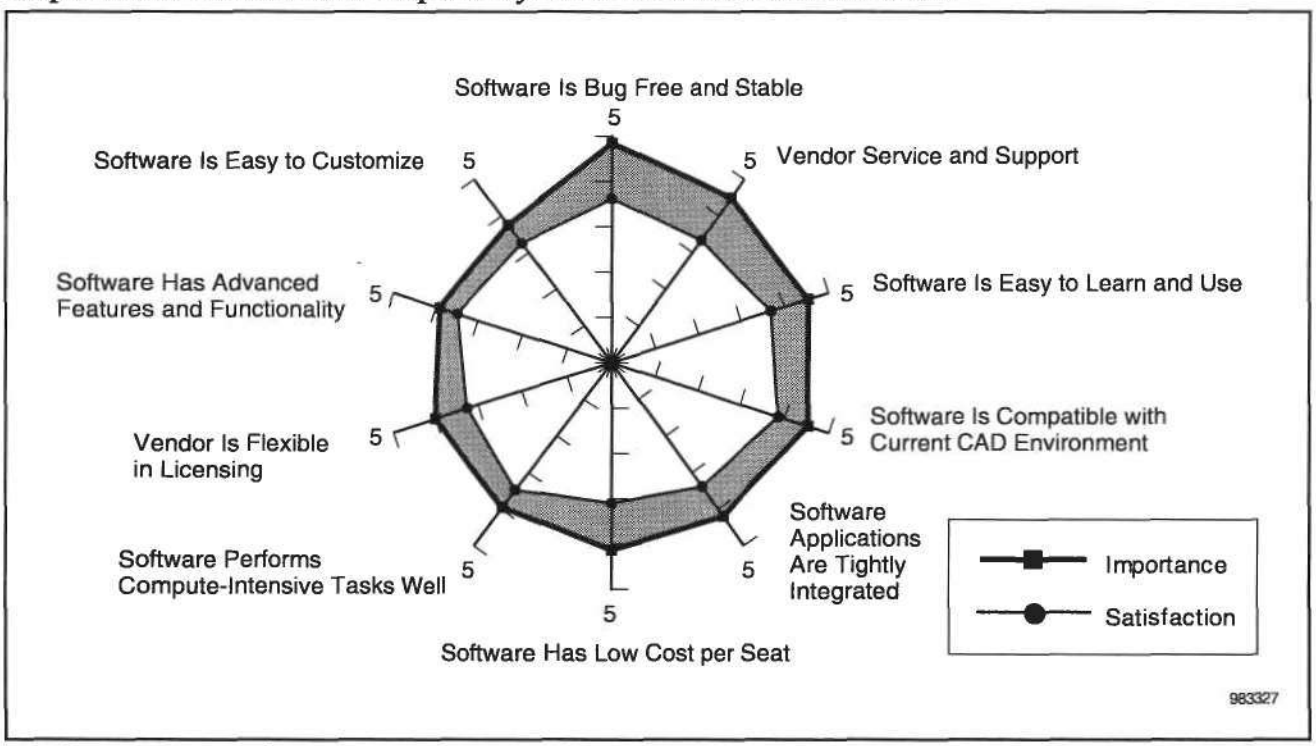
Topping the list in importance was the wish for software that is bug free and stable. The gap here is quite large—negative 1.2, and the importance rating is extremely high (4.9). Software stability has always been an issue with the mechanical design community and can sometimes be an impediment to the 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 European 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 with the onset of the midrange mechanical design packages, have vendors begun to concentrate on ease-of-use issues in earnest.

Of particular interest is the relatively large importance-satisfaction gap (negative 1.0) given to the statement "software has a low cost per seat." In previous North American surveys, this item has ranked high, but not quite as high as the European respondents have ranked it. Nor has the importance-satisfaction gap been as great. Examining the data by country reveals that respondents in France and Germany are particularly dissatisfied with CAD cost per seat (importance-satisfaction gaps of negative 1.4 and negative 1.2, respectively). Further, our European survey respondents, as a whole, appear to be more price sensitive than their North American counterparts. This sensitivity may be related to the tendency to make CAD purchases in large quantities in Europe (in particular, in Germany), versus the smaller sales that often occur in North America.

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 5-4
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 1998)

Table 5-3
Importance/Satisfaction Gap Analysis of an Ideal CAD Solution

	Importance	Satisfaction	Gap
Software Is Bug Free and Stable	4.9	3.6	-1.2
Vendor Service and Support	4.5	3.3	-1.2
Software Is Easy to Learn and Use	4.5	3.7	-0.8
Software Is Compatible with Current CAD Environment	4.5	3.9	-0.7
Software Applications Are Tightly Integrated	4.2	3.4	-0.8
Software Has Low Cost per Seat	4.1	3.1	-1.0
Software Performs Compute-Intensive Tasks Well	4.0	3.5	-0.5
Vendor Is Flexible in Licensing	4.0	3.2	-0.8
Software Has Advanced Features and Functionality	3.9	3.5	-0.4
Software Is Easy to Customize	3.8	3.3	-0.5

Note: Ratings on a scale of 1 to 5 (1 = not important/not satisfied, 5 = very important/very satisfied)
Source: Dataquest (June 1998)

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