Global Market Insight For Information Technology Companies

MECHANICAL CAD/CAM/CAE WORLDWIDE

Dataquest's Mechanical CAD/CAM/CAE Worldwide program provides comprehensive and insightful analysis of the dynamics driving the growth of markets for mechanical CAD tools and applications. The service balances detailed worldwide quantitative statistics with qualitative assessments of the industry's players, products, and channels. The service is an invaluable partner to help MCAD vendors, developers, users and integrators understand market dynamics, assess industry leaders, and make strategic investments and partnerships.

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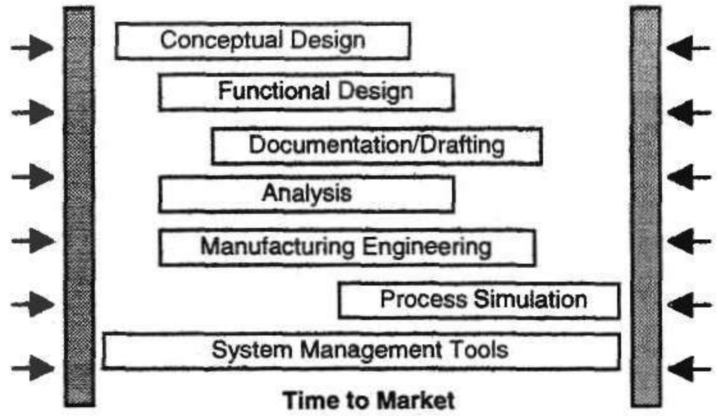
Market Coverage

Dataquest provides worldwide software shipments, market share, revenue, and market forecasts for mechanical CAD/CAM/CAE applications and players, including the following:

- Major Data Points
  - Total factory, hardware, and software revenue
  - Service revenue
  - Computer shipments
  - Distribution channels
- Geographic Coverage
  - North America
  - Major European countries (7)
  - Major Asian countries (6)
  - Rest of World
  - Worldwide
- Platforms
  - Personal computer
  - Technical workstation
  - Host-based
  - Server
- Operating Systems
  - All major PC and UNIX operating systems (10) plus VMS and VM/MVS
- Industries
  - The 25 major industry segments
- Applications
  - Documentation/drafting
  - Conceptual design
  - Functional design
  - Analysis
  - Manufacturing engineering
  - Manufacturing process simulation
  - System management tools
- Modeling Technologies
  - 2-D, 3-D, Solids, and Integrated

Mechanical CAD/CAM/CAE Systems–tools to compress the product design and manufacturing cycle.



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WHAT YOU'LL RECEIVE IN 1994

MECHANICAL CAD/CAM/CAE WORLDWIDE

User Wants and Needs Report

Key user issues and buying criteria are examined through a comprehensive survey of mechanical CAD users and managers

This year's end-user survey will be a worldwide study of mechanical CAD/CAM/CAE users and managers that will analyze the primary issues driving adoption and use of mechanical CAD in organizations around the globe. For the first time, this report will feature the perspectives of Japanese end users compiled with North American and European MCAD users. The study will uncover and analyze MCAD applications currently in use, buying criteria, decision makers, budget plans, importance of features, user satisfaction, productivity gains, site penetration, work habits, and concurrent engineering issues.

Market Statistics Report

The *premiere* quantitative statistics report on the mechanical CAD/CAM/CAE market

Dataquest's Mechanical CAD/CAM/CAE Market Statistics report provides the most reliable and comprehensive set of market data and forecasts available on the MCAD market. The report presents comprehensive hardware, software, and service forecasts and market share information on worldwide MCAD applications and companies. A total of four reports are published each year: two reports presenting market share and five-year forecasts are published in the first half of the year and then are updated during the second half.

Market Trends Report

The dynamics driving the growth of the mechanical CAD/CAM/CAE market are examined in detail in the 1994 Market Trends report

The Mechanical CAD/CAM/CAE Market Trends report includes detailed analysis from several perspectives on the forces driving the market. Detailed trends and issues are discussed as they relate to evolving technology, changing end-user requirements, regional differences, and related developments in the computer industry. High-level total CAD/CAM market statistics balance the opinions presented in this expert analysis of industry dynamics.

Focus Report

Special reports on "hot" software topics to watch

A detailed analysis of software distribution channels is the tentatively scheduled topic for the special focus report that will be published by Dataquest's Software Group services.

Dataquest Perspectives

Timely newsletters presenting analysis and commentary on key industry events and issues. Expected topics include MCAD market performance and forecast update, a revised subapplication forecast, ongoing research covering STEP progress, and comparisons of vendors from the end-user perspective that will be published on an event-driven basis throughout the year, with a minimum of four to be published in 1994.

News and analysis of major late-breaking mechanical CAD/CAM/CAE industry events will be delivered by fax.

DQ Software QuickTakes

A new online product being piloted by the services that comprise Dataquest's Software Group, DQ Software QuickTakes provides weekly summaries of the top news stories in the software industry, accompanied by the "Dataquest Take" for the most important events. This document is delivered electronically every Monday morning to subscribers at any e-mail address accessible via the Internet (including AppleLink, cc:Mail, CompuServ, IBM Mail, MCI Mail, AT&T Mail, and so on).

Dataquest

a company of The Dun & Bradstreet Corporation

Corporate Headquarters
1290 Ridder Park Drive
San Jose, CA 95131-2398
Phone: (+1) 408-437-8000
Fax: (+1) 408-437-0292

Boston Area
550 Cochituate Road
Framingham, MA 01701-9324
Phone: (+1) 508-370-5555
Fax: (+1) 508-370-6262

London Area
Holmers Farm Way
High Wycombe
Bucks HP12 4UL
United Kingdom
Phone: (+44) 895-835050
Fax: (+44) 895-835260

Munich
Kronstadter Strasse 9
8000 Munich 80, Germany
Phone: (+49) 89-930-9090
Fax: (+49) 89-930-3277

Paris
Tour Franklin
100/101 Quartier Boieldieu
92800 - Puteaux, France
Phone: (+33) 1-41-25-18-00
Fax: (+33) 1-41-25-18-18

Tokyo
Shinkawa Sanko Building
1-3-17, Shinkawa, Chuo-ku
Tokyo 104, Japan
Phone: (+81) 3-5566-0411
Fax: (+81) 3-5566-0425

Taiwan
3/F, No. 87 Sung Chiang Road
Taipei, Taiwan, R.O.C.
Phone: (+886) 2-509-5390
Fax: (+886) 2-509-5660

Korea
Trade Tower, Suite 3806
159 Samsung-dong
Kangnam-gu, Seoul 135-729
Korea
Phone: (+82) 2-551-1331
Fax: (+82) 2-551-1330

Dataquest

Dataquest Perspective

Software

Mechanical Applications Worldwide

In This Issue

"Best of Breed" Product Review for Rasna MECHANICA
Integrated mechanism and structural design optimization is shown to be a powerful tool for mechanical product design. In this report, Dataquest reviews the "best of breed" qualities of MECHANICA Motion and Structure from Rasna Corporation. We analyze the major features and functions of this product and illustrate a working scenario where maximum value is obtained from the use of the software.
By Mike Seely and Sharon Tan

"Best of Breed" Product Review for Rasna MECHANICA

A bicycle is a wondrous thing. World-expanding freedom and joy all rolled into a time machine. The exhilaration of that first downhill run is as close to flying as a ten year old can get. Soon, the highest and steepest off-road trail is found. The badge of honor goes to those who can make it to the bottom without touching the brakes. In my case, brakes did not matter much, as a three-speed English racer is not well designed for such adventure. Proper aim and balance, as you launched off the top, is critical to short-term life or death. Although, as I remember, no one actually died in numerous excursions into the bushes. Little did we know that we were pioneers in a bicycle market fast approaching 11 million units and $2 billion in annual sales in the United States. Almost 70 percent of these sales are mountain bikes.

The similarity between the old English 3-speed and the newest mountain bikes is like the similarity between apples and a Grand Marnier soufflé. The $3,000 to $4,000 price tag on the latest and greatest is fueling an explosion in conceptual design. Aerospace technology is being used to design, test, and manufacture the leading products. Composite materials, special alloy components, and state-of-the-art manufacturing processes are common elements of both industries. A fundamental difference in market dynamics forces the bike manufacturers into a very short product life cycle. Leading-edge design work is competitive for two years at best.

This environment was chosen to illustrate the best use of the latest design and analysis software from Rasna Corporation. An optimized design scenario for a GT mountain bike is used as a test case for this product review.

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Overview

The purpose of this report is to determine the "best of breed" qualities of MECHANICA 6.0 from Rasna Corporation. Our review is designed to illustrate a working scenario in which maximum value is obtained from the use of the software. The product description covers the major features and functions of the product. A Dataquest perspective at the end of this report positions the use of the product and analyzes the best-case scenario for strengths and weaknesses.

MECHANICA is targeted for designers who need to do conceptual design, including motion simulations, early in the design process. This is where the majority of a product's cost is determined; a point at which market appeal, functionality, and reliability are often determined. MECHANICA is also targeted toward component optimization across multiple disciplines, such as thermal, structural, and vibration optimization. The test case in this review will tackle the conceptual design of a mountain bike and subsequent optimization of specific parts of the rear suspension system.

This product review evaluates the sixth release of Rasna Corporation's MECHANICA. MECHANICA is among the first finite element analysis (FEA) design tools to use polynomial elements (p-elements) as the basis for analysis. The software allows for conceptual design, kinematic and dynamic simulations, and optimization and sensitivity studies. It includes modules for both structural and motion analysis; both modules are investigated in this product review.

Major benefits of the product lie in its use of p-elements, which allow for precise geometry representation with no defeaturing or simplification of the model. Additionally, the software allows for optimization across multiple disciplines (for example, thermal and structural) and for full dynamic and structural interaction. While most FEA packages are aimed at the analyst community, this product's target market is the mechanical design engineer. Consequently, engineers who are not experts in analysis can use this software in the initial conceptual design stages to explore a variety of possible design scenarios. After detailing the design, engineers can use this software to optimize parts given selected constraints. Later, analyst experts can evaluate the progress to verify that all significant factors have been considered.

This review is divided into several sections:

- The Design Challenge
- Design Study Overview
- Conceptual Design with Sensitivity Analysis and Optimization
- Detail Design
- Final Kinematic Simulation

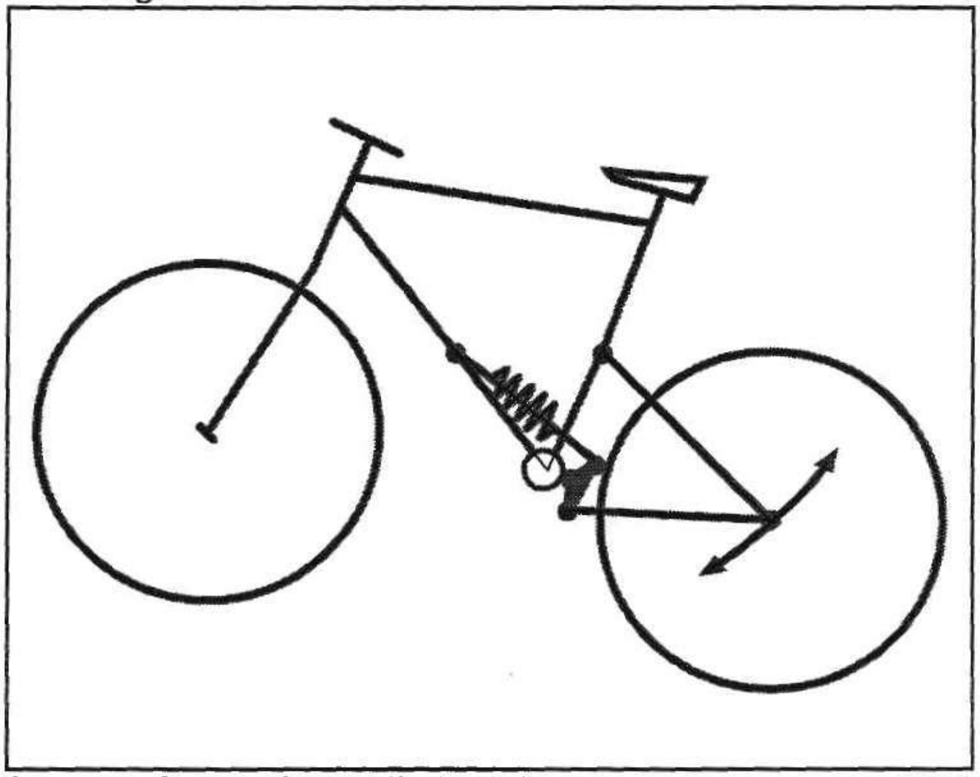
The Design Challenge

The design problem is based on designing the "ultimate suspension bike," where weight is minimized while suspension geometry improves handling and control while going downhill and improves rideability and power transfer for the rider going uphill. Many combinations of movable links with connected springs and dampers have been tried. All of the major and many of the specialized bike manufacturers have multiple designs in production. Experience suggests that the major components of the suspension should be mounted low in the frame and that the highest loads should be directed to the strongest frame components. The general motion of the rear axle should be up and back under compression. This will help the rear wheel roll over rocks, roots, and obstructions.

Any vehicle making a quick stop will tend to dive in the front. This motion on a steep downhill is dangerous on a bicycle. The proposed rocker link in the rear suspension is designed to reduce this effect, because rear-wheel braking will compress the suspension and lower the rear of the bike. Suspension travel must be long enough to allow this motion to have the desired effect.

Figure 1 shows a sketch of the bike frame with the proposed suspension. The black dots show the general location of the pivot points on the frame, rocker, and rear hub. The small triangular shape is the rocker. It pivots in the middle and has a spring and shock absorber mounted to the top and connects with the lower tube on the bottom. As the rocker rotates, this pushes the lower tube back and forth, which moves the rear wheel. A few specific dimensions are known, such as the length of the angled tube. The

Figure 1
The Design Sketch



Source: Rasna Corporation, Dataquest (October 1994) G4006228

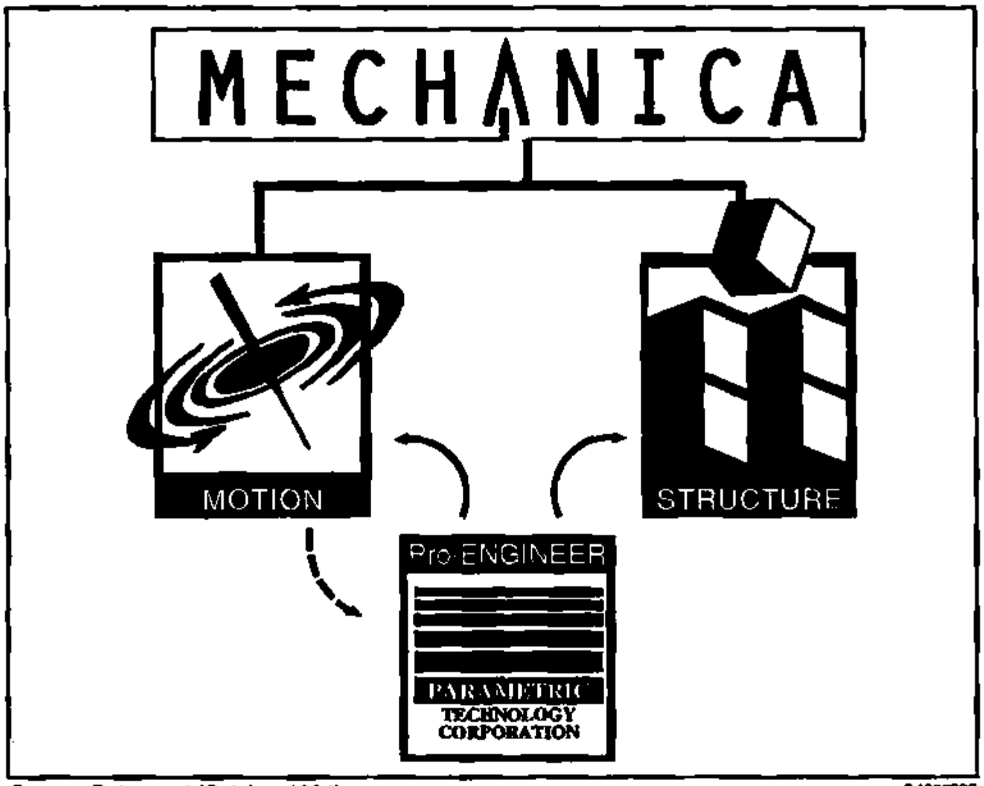
lower tube and rocker dimensions are sketched in to begin the design study. The purpose of this study is to optimize the suspension action by selecting the best locations for all the pivot points. Later, specific loading conditions will be evaluated to properly size the component parts.

Design Study Overview

The general strategy in this design study will take the conceptual design and evaluate each dimension to optimize rear-wheel travel. After the basic length of each of the tubes and rocker are set, the loads at each of the connections will be evaluated. Sensitivity studies and optimization analyses will help determine the size and shape of the specific components during detail design. Because the focus of this review is on conceptual design and, later, part optimization, the detail design developed with a CAD system is not reviewed. An interface is available for several different CAD systems. In this case, Pro/ENGINEER was used to develop the detail design, checking form and fit of components.

After detail design, the new geometry can be fed back into MECHANICA, and the design can be verified and revised if necessary. At this point, motion simulations can be performed to ensure the integrity of the model. This will verify that the design still meets the basic design goals, confirm that proper clearance exists between parts, and identify any highly stressed components. In this case, the rocker was found to have high loads, but the initial design was so strong that the designers felt that weight could be removed from the part and that it would still maintain the necessary strength. Component optimization is used to change the shape of this part, completing the design test case. Figure 2 provides a graphical representation for the workflow between MECHANICA and Pro/ENGINEER.

Figure 2
The Design Study Process



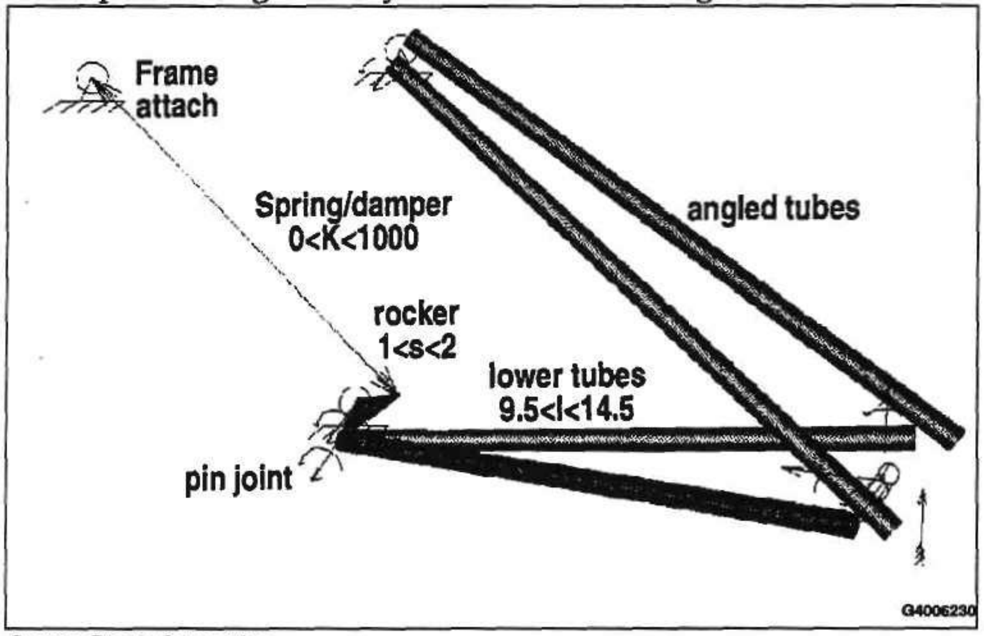
Source: Dataquest (October 1994) G4006229

Conceptual Design with Sensitivity Analysis and Optimization

The rough design sketch is quickly simulated in MECHANICA Motion using mass primitives. These are basic shapes used as building blocks in the design process. Cylinders, plates, and free-form objects are easily built to form the assembly. The relative motion of the parts in the assembly is defined by adding pin joints, slider location, and other kinematic elements. After all of the connection points are identified on each part, the system will automatically assemble the components. Problems at this stage indicate missing or incorrect assignment of connectivity. Figure 3 shows the basic components in the assembly. These parts are more easily viewed on-screen, where they can be rotated and magnified.

The first evaluation of the suspension movement found that the rear-axle travel is too small. It is decided to do a sensitivity study to determine the relative importance of changes in length of each side of the rocker arm and of the lower tube to increase this travel.

Figure 3
Conceptual Design of Bicycle Frame with Design Variables



Source: Rasna Corporation

Table 1 shows the upper and lower limits for the design variables in question. These values and the current values shown in Table 1 specify the starting point in the simulation. The rocker arm has only two key dimensions for this part of the evaluation. The upper length determines the lever arm for connection to the spring. The lower length locates the connection point for the lower tubes in the assembly and determines the ratio of forces in the rocker. The upper ground point is assumed to be on some strong part of the frame and locates the attachment point of the spring/damper. The lower ground point is the center pivot for the rocker arm.

Three sensitivity analyses were run, in which each design variable length was stepped through its range of proposed values. The results from these analyses were examined graphically, giving the designer a good idea which variables most affect vertical displacement of the rear hub. Because all of these variables were found to significantly affect the motion, all were used in the following optimization process.

Table 1
Sensitivity Ranges for Conceptual Model

Part	Lower Limit	Upper Limit	Current Value
Spring k Constant (Pounds)	0	1,000	300
Upper Rocker Arm Length (Inches)	1	2	1
Lower Rocker Arm Length (Inches)	1	2	1
Lower Tube Length (Inches)	9.5	14.5	9.5

Source: Rasna Corporation, Dataquest (October 1994)

We next moved to the optimization process, which let the computer test many combinations of each of the variables to find the optimum combination of values so that the vertical displacement of the rear pin joint is maximized. The optimization process added the constraint of the load condition, with the spring constant initially loaded at 300 pounds with a range from 0 to 1,000 pounds.

We assumed an initial load on the rear part of the frame in an upward motion in order to simulate a cyclist riding over a bump. This force was modeled as a cosine function with an amplitude of 150 pounds and a duration of two seconds. Again, we ran MECHANICA Motion with this optimization criteria. The resulting optimized design increased the lower rocker arm length to 2.0 inches, the upper arm to 2.0 inches, and the lower tube to 14.5 inches. This new design resulted in nearly a 4-inch displacement at the rear wheel.

The main benefit found in this process is the quickness and ease with which the design is optimized. Multiple design choices were quickly evaluated, component parts were identified, and rough shapes were determined. An important element of this process is the integrated load calculation ability. Loading constraints can be used in the optimization process.

Detail Design

At this stage, a CAD system is needed to build a fully featured representation of each component. This process will verify the form and fit for all of the components.

The data from MECHANICA Motion is often transferred to a CAD system using IGES. In this case, it was decided to generate the component models directly from the few key dimensions using Pro/ENGINEER without an IGES transfer. The speed of the parametric interface makes this a straightforward process. An analysis of the detailing process is not part of this study. Any one of several CAD systems can be used for this activity.

Final Kinematic Simulation

After the detail design is completed, the assembly is transferred from Pro/ENGINEER into MECHANICA using Direct Geometry Access (DGA). This interface brings complete model information, including part model geometry and mass property information, into MECHANICA for verification and motion simulation. Figure 4 shows the assembly after detail design. Actual tube cross sections have been specified. Parts to attach the wheels, spring, and crank set have been added. Because the detail design contains the material specification, the mass weight of each part is available.

The kinematic elements for connectivity using pivot points and ground points are added to the model. The assembly is usually brought into MECHANICA as an exploded view to aid in this process. The model will automatically reassemble itself after the connection points are added.

Loading conditions from the conceptual design are applied to the new model. A motion simulation was run, and the results were examined. As expected, the physical movement of the frame meets the design goal, and the components do not have any interference problems while moving.

Because the mechanism evaluation will determine the loads and forces in each of the components, a quick review is made to determine which parts need closer evaluation for stress analysis. This is quickly done by selecting any pair of variables and requesting a results diagram. Literally dozens of graphs can be made in a few minutes to illustrate the current status of any part of the design. Figure 4 shows several time versus load analysis results at the locations specified. Using this technique, we noticed that the load on the rocker arm spiked up to nearly 600 pounds at the midway point through the simulation run. As a result, we selected the rocker arm for closer evaluation and shape optimization. Other parts could be evaluated if necessary.

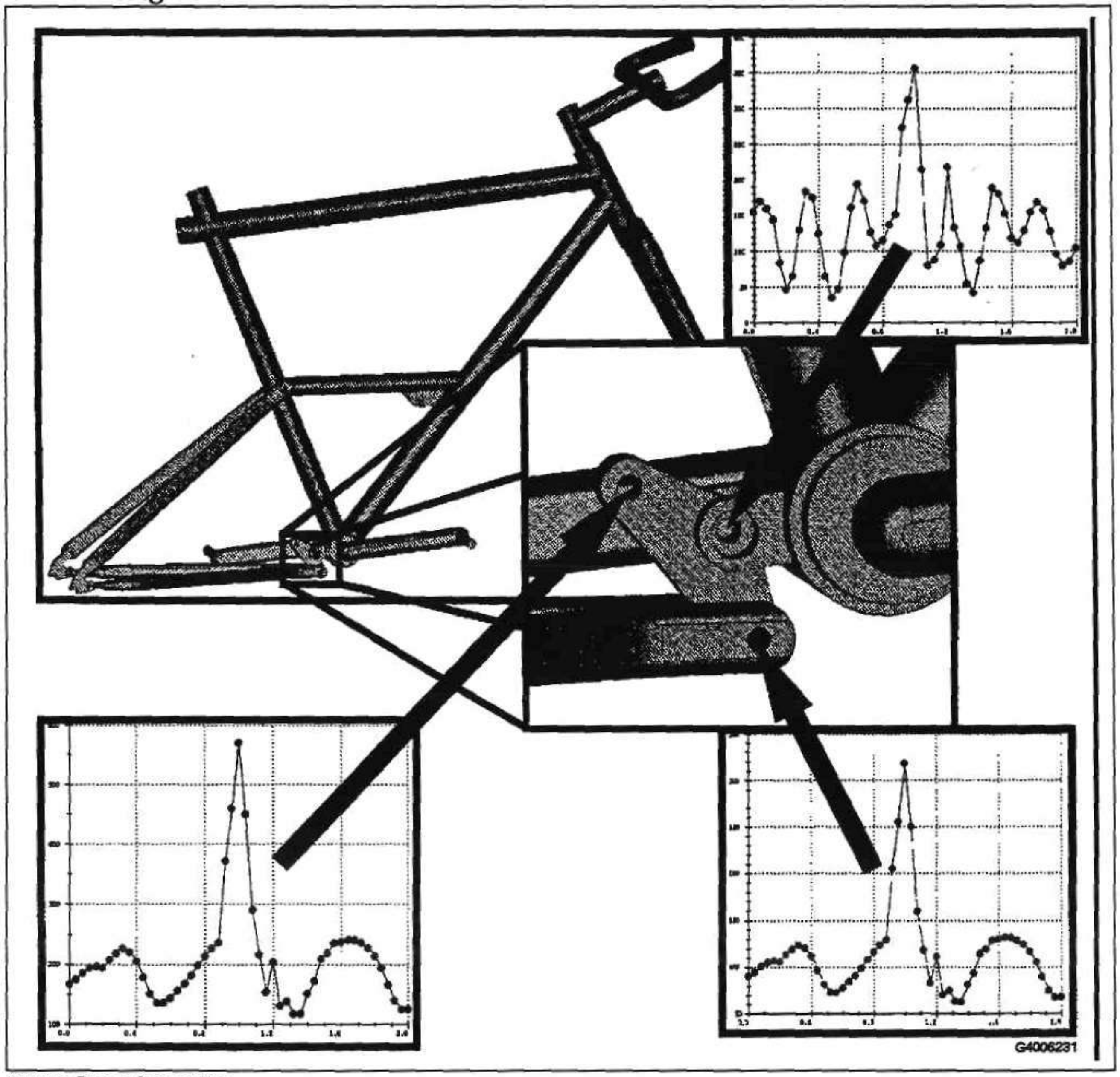
Component Optimization

The rocker arm is a key component in the design. It controls the rear suspension movement and holds the bottom half of the bike together. For this review, we examined the rocker arm, performing both a static simulation and an optimization reducing the mass of the rocker but maintaining structural constraints.

For the static simulation, we used MECHANICA's automesh function to mesh the rocker. Because MECHANICA uses adaptive p-element technology for meshing, the resulting mesh maps exactly to the geometry of the part. The entire part was meshed in only 107 elements. Next, we applied the peak loading conditions and forces that were calculated in the previous motion simulation. Figure 5 shows the direction of forces on the mounting holes in the rocker arm. Deflections and stress levels were analyzed. The analysis took approximately five minutes. A wide variety of results diagrams and shaded images can be used to understand the effects of the load. The results were displayed in shaded contour diagrams for both von Mises stress and arm deflection. Examples of these on-screen images are shown in Figure 6.

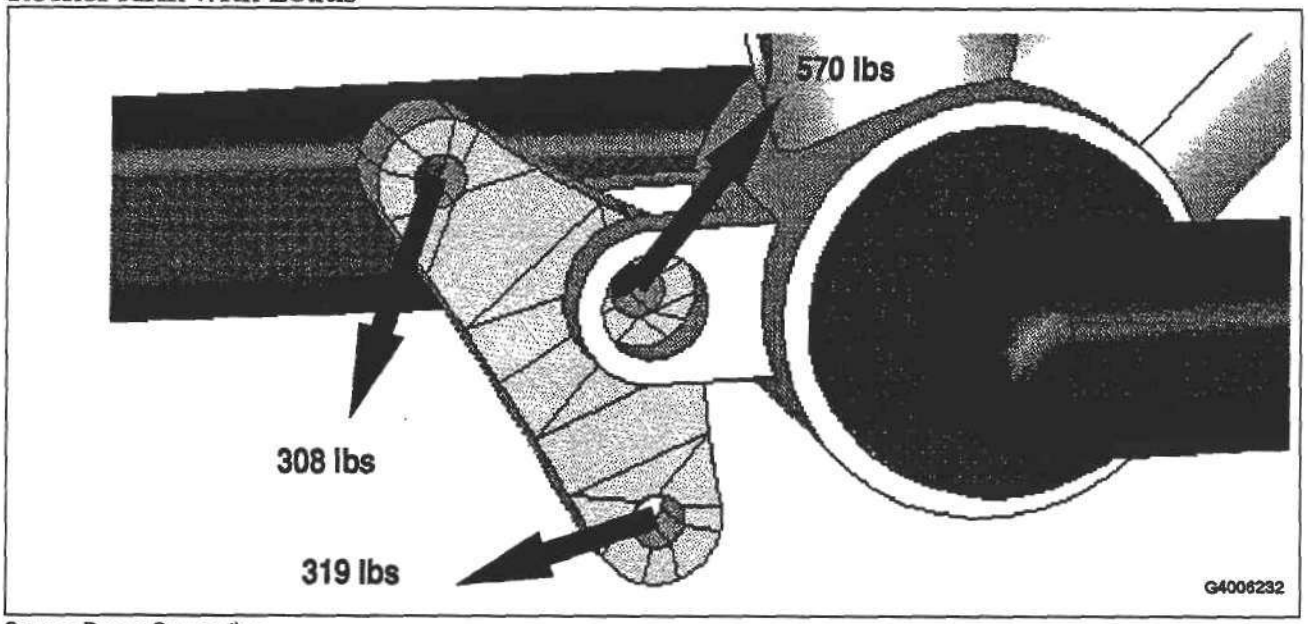
Next, the optimization study is planned. In a part like this, the easiest value to change to reduce volume is the thickness. In this case, the part thickness was fixed at 0.5 inches to maintain bearing load requirements. This leaves only four variables: the radius values on each side of the rocker, and the side radius near the holes. To ensure the maximum range of variation and to eliminate the possibility of analysis problems because of deformed elements, the rocker was remeshed by hand. Element shapes were chosen that would operate well during the drastic shape changing that would occur during the optimization process. A side benefit of this remeshing was a reduction in the number of elements from 107 to 26. This will cause the analysis to proceed almost four times faster than with the system-created mesh.

Figure 4
Detail Design



Source: Rasna Corporation

Figure 5
Rocker Arm with Loads



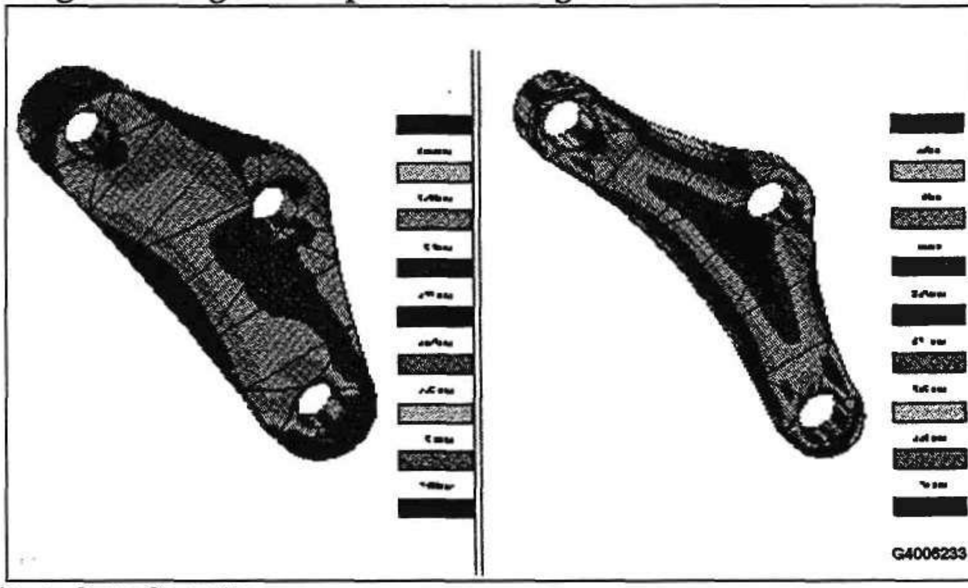
Source: Rasna Corporation

The optimization parameters are outlined in Table 2. We ran the optimization, allowing the radii to vary as shown in Table 2 and the rocker arm material to vary from stainless steel to aluminum. Again, we were able to examine graphs of the deflection and stress versus the various radii as well as the mass of the part as it went through the design iterations. Diagram results show the history of the mass, deflection, and von Mises stress marching toward the design goal. The results indicated that the deflection and stress are nearly constant when the lower radius is changed but that they vary more quickly when the upper radius is changed. The minor reduction in side radius quickly increased the stress level up to the target zone. Because the side radii are all tangent to the upper and lower radii, the interrelationship of these values is fairly complex. The problem was solved in 13 iterations, all under program control.

The final results of the optimization indicated that the weight was reduced from 3.06 ounces to 0.61 ounces. Some of this weight change was because of a change in material from stainless steel to aluminum. Almost half of the savings was due to shape optimization. At this point, once optimized, the rocker arm can be put back into the assembly and ported back to Pro/ENGINEER for documentation and manufacturing processes. Figure 6 shows before and after shots of the optimization process.

This discussion is a representative simplification of the many steps required to complete this actual design problem. As in any conceptual design and verification process, many moments of inspiration can and should take place. The total time involved is dependent more upon the number of ideas that are discarded than the number that are worked through to final form. This frame design from concept through component optimization would take about two days for an experienced user to complete using a Silicon Graphics Indy workstation.

Figure 6
Original Design and Optimized Design



Source: Rasna Corporation

Table 2
Optimization Parameters for Rocker Arm

Feature	Lower Limit	Upper Limit
Stress (psi)	0	15,000
Maximum deflection (Inches)	0	0.01
Upper Radius (2 places) (Inches)	0.75	5.00
Lower Radius (Inches)	3.0	15.0
End Radius (3 places) (Inches)	0.2	0.3

Source: Rasna Corporation, Dataquest (October 1994)

Product Description

MECHANICA's core modules, Motion and Structure, are explored in detail in this product review. Both of these modules can stand alone for individual structural or mechanism applications or used together as a single, integrated application. The whole product line is based on a core technology that allows the products to be used in a very effective manner with high accuracy.

The target group for these tools is the mainline engineers and designers that must quickly develop high-quality product ideas. These tools can be used before CAD to develop conceptual design models using sensitivity studies and optimization to aid the design process; our preceding example illustrates the value of that approach. MECHANICA can be used at any time throughout the product engineering and manufacturing engineering process. This is accomplished with a DGA module that brings CAD detailed assemblies into MECHANICA for verification and optimization of product revisions or tool and fixture design.

Accuracy of Results

Accuracy of results is quickly identified as a point of differentiation. A common analysis technique used in many analysis codes is based on hierarchical-element (h-element) technology. The accuracy of the resultant calculations is dependent upon the number and shape of the individual elements. A large element in an area of high stress may hide a potential problem area. Accuracy in this case is dependent on a subdivision of large elements into smaller and smaller elements until differences in results become small. The analysis is believed to have converged on the correct answer at this point. Rasna is a pioneer in developing a different element technology based on p-elements. The p-elements can have more complex shapes with curved edges. This provides an immediate benefit in that far fewer elements are needed to fill a shape. Typically, a 10-to-1 reduction in the number of elements is found when comparing h-element and p-element problems. Because of the more complex geometry, it is not surprising that p-elements are more compute intensive. This issue has been optimized by evaluating convergence on an element-by-element basis. This process will increase the polynomial order on each element edge until the desired level of convergence is reached. As each element edge reaches this state, it is marked as completed and removed from the ongoing calculations. This dramatically speeds up the convergence process. Relaxing the accuracy tolerance will further speed up the process.

Sensitivity Studies

The elements of a design can be very complex and interdependent. Even with relatively simple components, it is not obvious which design variables most affect the performance of the final product. MECHANICA is often used to do what-if studies to evaluate the impact of changing individual or multiple design elements. This process results in sensitivity studies by which the designer develops a sense of what is important in the design and what is not. For the key design factors, a suitable range of values can be determined. This information is critical to quickly setting up an optimization study and gives the designer an intimate feel for the performance of the design.

Simultaneous Multidiscipline Optimization

As the family of MECHANICA products develop, it is important to recognize that each of the products has been designed to work in a coordinated way. Thermal, structural, and vibration simulations can all be used in an integrated environment during simultaneous optimization. The optimizer uses a gradient search technique to balance the design goal in each discipline.

MECHANICA Motion

MECHANICA Motion is a complete design synthesis and optimization application for multibody dynamics design. This means that a mechanism with multiple parts can be assembled with static or steady motion dynamically simulated and optimized. Resulting loads can be evaluated and passed to MECHANICA Structure for additional analysis.

MECHANICA Cams is an extension to MECHANICA Motion for automatic profile definition of cams based on user-defined motion. A cam shape can be derived from the desired motion of the mechanism or the resulting output motion, and forces of a specific cam can be evaluated.

MECHANICA Loads is an extension to MECHANICA Motion for user-defined or third-party load input requirements.

Enhancement and additional modules in beta test include subassembly optimization and the output of equations of motion.

MECHANICA Structure

MECHANICA Structure is a complete application for structural modeling and optimization. Automatic accuracy convergence is a major feature applied to structural and vibration studies. These include linear static and modal analysis. MECHANICA Structure supports design sensitivity studies to aid in the evaluation of multiple variables and the impact on a possible design solution.

MECHANICA Thermal is an extension to Structure for heat-transfer design. This allows the user to integrate thermal and structural design concerns in multidisciplinary optimizations. Users can specify engineering goals and limits on the temperatures in an assembly, as well as the stresses caused by those temperatures in a single optimization.

MECHANICA Vibration is an extension to Structure for vibration analysis and optimization. This provides dynamic analysis of structures including time, frequency, and random and shock response.

Other extensions are available to enhance the ability to connect to other systems and to share data. Enhancements and additional modules in beta test include contact modeling, buckling, and spot welding.

Dataquest Perspective

Conceptual design can be accomplished quickly and easily with MECHANICA. The combination of motion and structural analysis broadens the range of problems that can be tackled. The extensions available for thermal, cam, and vibration analysis further increase the utility. While the software will not solve nonliner, large deformation, or dynamically changing problems, the remaining set of potential solutions is very large. An estimated 60 to 70 percent of all analysis problems can be solved with the current MECHANICA family of products. This percentage is higher for the typical engineer or designer, because they most often do structural, thermal, and vibration studies and leave the esoteric analysis to the experts.

The Test

The bicycle suspension test case offers an excellent scenario to examine the functionality of the software. The simplicity of the design problem allowed a straightforward process to test the first-level analysis and optimization capability of MECHANICA Motion and Structure. The design scenario begins in a conceptual design activity. This illustrates the ease of use and utility of the software and highlights the loose connection to a CAD environment. Tending the data transfer process is necessary but wasted effort. Subsequent releases of the software will move toward a very close integration with several leading CAD companies.

The integrated use of mechanism and structural design is very compelling. It is difficult to estimate the frequency of need for integrated analysis, but when needed, this environment is very effective. A more complex test case could have evaluated the capability of thermal and modal analysis. Given more time, a cam-based mechanism could have been evaluated as an alternative design solution in the bike suspension problem.

Ideal User

MECHANICA is geared toward two groups of designers: the engineers who need to perform design analysis and trade-off studies without having to rely solely on the expertise of an analyst, and the engineers involved in conceptual design of a product, regardless of whether they are primarily CAD engineers or conceptual designers. Ease of use makes this product suitable for either situation or type of designer. Future operation in a CAD environment with integrated analytical tools will make this environment more productive.

The professional analyst has not been ignored. MECHANICA is a powerful addition to classic FEA technology. Most experts are masters of mixing technology to get the best solution to a difficult problem. Ease of setup, accuracy control, and rapid model development are valuable assets.

CAD Interface

As existing products are revised and new products evolve in the detail development process, the need to evaluate the proper function of the design increases. A fundamential value in the use of MECHANICA comes from the ability to share part and assembly with many of the leading CAD/CAM systems. MECHANICA can be used before CAD detail design or can interface in and out of the design process as the product information moves through product development.

The ease of model transfer with DGA to PTC Pro/ENGINEER makes model simulation and optimization an easy detour at any point in the design and manufacturing engineering process. A direct interface is available to most of the leading CAD/CAM systems, including Computervision CADDS, EDS Unigraphics, Hewlett-Packard SolidDesigner, IBM Catia, and Autodesk AutoCAD.

A major enhancement in this process is due later this year with MECHANICA 7.0. The enhanced interface will share parametric values to modify the model geometry after simulation. Because Pro/ENGINEER cannot read-in an external solid model, the parametric interface must be used to automatically update an existing Pro/ENGINEER model. Other vendors may allow direct interface with MECHANICA and the transfer of parameterized models as a new object.

P-Element Technology

MECHANICA is the leading analysis package using adaptive p-elements. While traditional FEA software uses h-elements, in which the strain is constant or varies linearly across the element, MECHANICA uses p-elements, in which the strain across an element can vary depending on the polynomial function representing it. MECHANICA's use of adaptive p-elements, in which each edge of the element can be represented by a different order polynomial, allows it to model complex geometric surfaces and to quickly converge on the correct answer. Fewer elements are needed with p-technology, which simplifies the mesh-modeling process.

Large models and large models with small features seem to be a specific area where p-elements have an advantage. Numerous examples can be found, such as engine blocks or aircraft bulkheads. Rasna is being encouraged to continue performance enhancements and added functionality as the other FEA vendors adopt p-element technology. The rigor of this movement by other vendors is unclear. Imitation is indeed the sincerest form of flattery. In the CAD/CAM/CAE world, time has proven that a good idea is often copied and quickly improved. The technological hurdle and a prevalent not-invented-here factor could assist Rasna in maintaining a lead.

Simultaneous Multidisciplinary Optimization

Multidisciplinary optimization allows the user to simultaneously optimize across structural, vibration, thermal, and dynamic applications. Because use of this kind of technology has been very limited, the value of this integrated tool is not fully appreciated. Most designers have been forced to think of only one portion of the design problem at a time. Time constraints force designers to perform only a structural or thermal analysis but not a true optimization. Automotive or aerospace design problems offer many examples of this type of situation. Things that get hot are often load-bearing members. Vibrations induced by natural frequencies reduce fatigue life, leading to service problems and product failure.

As the value of this kind of design simulation and optimization grows, we expect this level of analytical support to become a common expectation in the design environment.

Future Developments

Several major enhancements are planned for MECHANICA 7. Most of these extensions have been mentioned in the product description section, above.

Longer-term development may tackle additional capabilities in dynamic or nonlinear applications. No apparent limitation in p-element technology would preclude development in this area. Large deformation simulation, such as vehicle crash testing or computational fluid dynamics (CFD), is not expected in any short-term development. Market demand is being used to set priority in all short- and long-term development projects.

As the benefits of MCAE, product performance simulation, and design optimization become well known, we expect user demand to push beyond the general structural, thermal, and mechanism simulation. It is easy to imagine an engineer saying, "I don't care what materials or what manufacturing processes are used; I need an optimization tool that can deal with every option." A 100 percent solution for this person is years away. Where the available tools fit the job, the benefits of simulation and design optimization can be experienced now.

Background Information

Rasna Corporation, headquartered in San Jose, California, was founded in 1987 to develop, market, and support a family of mechanical CAE products centered around finite element analysis. The company released its first product, MECHANICA Structure, in April 1990. Since then, five new products, MECHANICA Motion, MECHANICA Thermal, MECHANICA Vibration, MECHANICA Cams, and MECHANICA Loads have been introduced. The company is dedicated to providing two major releases of the MECHANICA product family per year. An initial public offering is being discussed as a business development option in the near term.

MECHANICA supports the following hardware:

- UNIX-based workstations including Digital Equipment, Hewlett-Packard, IBM, Silicon Graphics, Sun Microsystems, and leading Japanese UNIX-based workstation vendors
- Windows/NT-based personal computers
- Cray and Convex high-performance computers

Supplier contact:

Rasna Corporation
2590 North First Street
San Jose, CA 95131
Phone: 408-922-6833
Fax: 408-922-7256
Internet address: jam@rasna.com
Mosaic address: http://www.rasna.com

By Mike Seely and Sharon Tan

For More Information...

Mike Seely, Director .... (408) 437-8178
Internet address .... mseely@dataquest.com
Via fax .... (408) 437-0292

Dataquest Perspective

Software

Mechanical Applications Worldwide

In This Issue

The Japanese Mechanical CAD/CAM/CAE End User: Pent-Up Demand and a Window of Opportunity

What's driving the demand for mechanical CAD/CAM/CAE applications in Japan? Are end users hungry for the next set of tools? How much of an opportunity do vendors have to penetrate this market? In this article, we take an in-depth look at the Japanese mechanical designer. We report on our findings from recent end-user survey in Japan and assess potential market opportunities for the vendor community.
By Michael J. Seely and Sharon Tan

The Japanese Mechanical CAD/CAM/CAE End User: Pent-Up Demand and a Window of Opportunity

During the first and second quarters of 1994, Dataquest conducted an in-depth survey of Japanese CAD/CAM/CAE end users to better understand the dynamics of this end-user environment. This article highlights some of the study's findings, identifying the best opportunities for CAD/CAM/CAE vendors and users. This article also draws comparisons to a 1993 Dataquest end-user survey of U.S. and European CAD/CAM/CAE end users. For more detailed analysis and findings, see Dataquest's reports, entitled *CAD/CAM/CAE Mechanical Applications: User Wants and Needs* (CMEC-WW-UW-9401), dated September 12, 1994, and *Mechanical CAD/CAM/CAE: Complex Issues and Technologies from the Users' Perspective* (CMEC-WW-UW-9301) dated May 31, 1993.

Dataquest forecasts that the worldwide market for mechanical CAD/CAM/CAE tools will grow at a 6 percent compound annual growth rate (CAGR) during the next five years. The worldwide market for mechanical CAD/CAM/CAE software revenue was $2.3 billion in 1993; in Japan, this market reached $723 million. Growth is being fueled by the perception that this technology is indispensable in a design and manufacturing environment, independent of industry or region. CAD/CAM/CAE tools are no longer limited to the experts; these tools are now being used by employees in every job description and for hundreds of applications across the enterprise. The forces of downsizing are playing a significant role in forming changes in market penetration.

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Today's purchaser of CAD/CAM/CAE tools is dealing with a complexity of issues and technologies that was unimaginable a decade ago. Several issues measuring user importance and satisfaction evaluations are explored in this survey, from high-level strategic business issues to application and module integration issues. Easy-to-use software with strong vendor support will continue to motivate the mainstream buyer of CAD/CAM/CAE tools in Japan.

Study Background

Dataquest's goal is to provide a comprehensive understanding of the mechanical CAD/CAM/CAE market by collecting and analyzing data from vendor and end-user perspectives. This study examines the mechanical CAD/CAM/CAE market from the perspective of purchasers and managers of these resources in a corporate setting. The respondents for this survey were all Japanese companies.

In 1993, Dataquest completed a survey of U.S. and European CAD/CAM/CAE end users. Because of the similarity between the survey of Japanese end users and our earlier U.S./European survey, we now have a worldwide database of end-user preferences and responses upon which to draw conclusions. The two surveys we conducted were nearly identical, with only slight changes made to the Japanese survey in order to capture trends that are specific to Japanese-based end users. Throughout this article, we make comparisons and highlight differences on a regional basis wherever appropriate.

Current Work Environment

A series of questions were used to determine the overall use of all major CAD/CAM/CAE applications and to provide an understanding of the current work profile. Specific and focused questions determined the number and types of files produced and the leading vendors for each application area.

Data Files Active by Type and Segment

The issue of data file storage is interesting for several reasons. First, the disk manufacturers and systems integrators need to know the volume of files that need to be online to support the daily work activity. Also, the mix of data file types is important to gain understanding of the level of use of the various modeling technologies and to suggest the level of graphics performance necessary to view and edit the information as it is retrieved.

Figure 1 shows the total number of files stored in each group, sorted by type of modeling technology used to create the files. All sites have a mix of 2-D or 3-D wireframe/surface and solid model files. The share of 3-D wireframe, surface, and solid model files is growing slowly as use of these tools increases. It is interesting to note that, in general, the use of 2-D files in Japan is about the same as in the combined entity of the United States and Europe. Approximately 72 percent of files are 2-D files for sites in Japan or in the United States/Europe. However, there are notable exceptions for certain industries such as service/design/consulting and industrial machinery, where Japanese sites have a lower percentage of 3-D files, and other industries such as automotive, where Japanese sites have a much larger percentage of 3-D files. The average use of solid modeling is also lower in Japan.

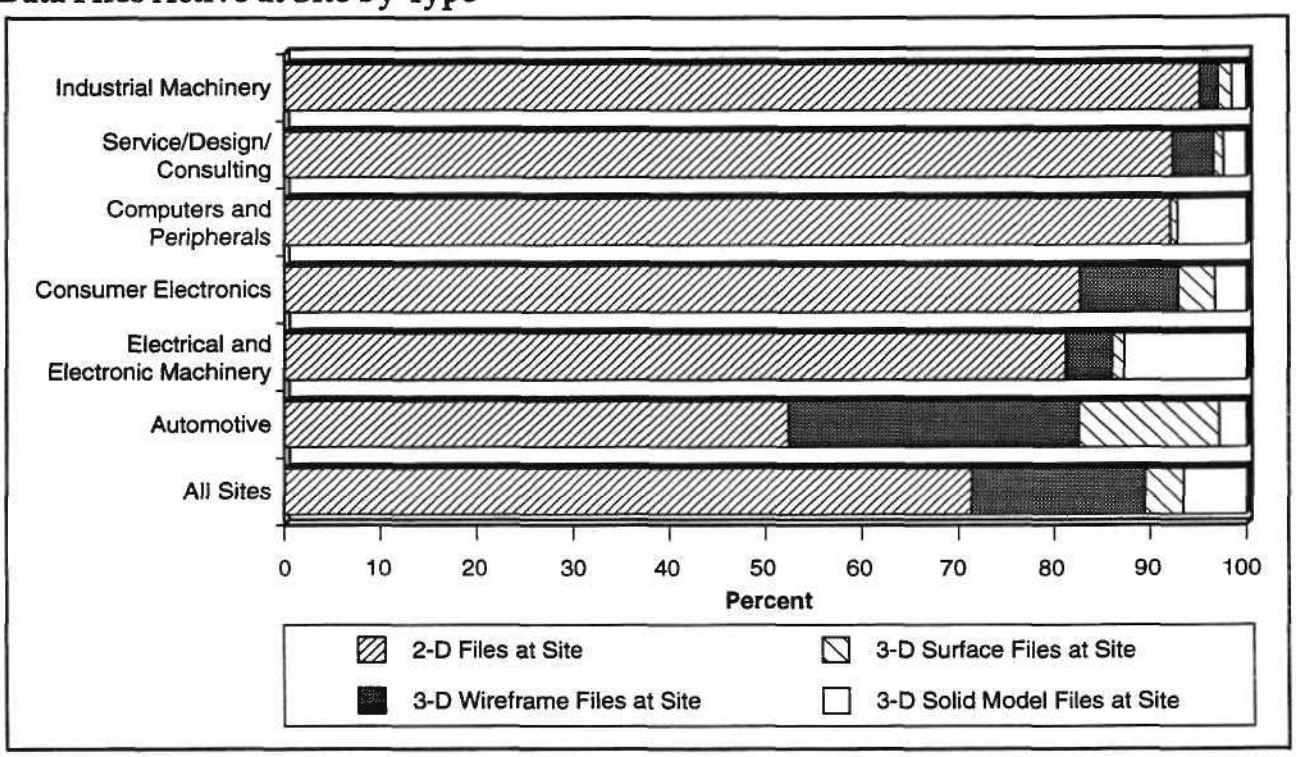
The volume of files varies widely, with the computers and peripherals industry producing the largest number of active files per user. As one might guess, larger sites obviously have more active files than smaller sites.

Leading Vendors by Subapplication

User opinion varies widely concerning the feature/function and value of a certain software product for a certain task. Many vendors are offering a full range of products that address some utility in each of the major subapplication areas. In our survey, we asked, "Which vendor makes the primary software tool used for drafting, design, analysis, and manufacturing applications?" Figure 2 shows the leading vendors in each subapplication based on a percentage of those end users who answered the question.

It appears that no one vendor dominates all of the subapplications in the mechanical CAD/CAM/CAE industry. Also, with the exception of C. Itoh Techno-Science, NEC, and Toyota, no Japanese vendors appear in the top five subapplication listings. Additionally, many of the leading analysis

Figure 1
Data Files Active at Site by Type



Source: Dataquest (September 1994)

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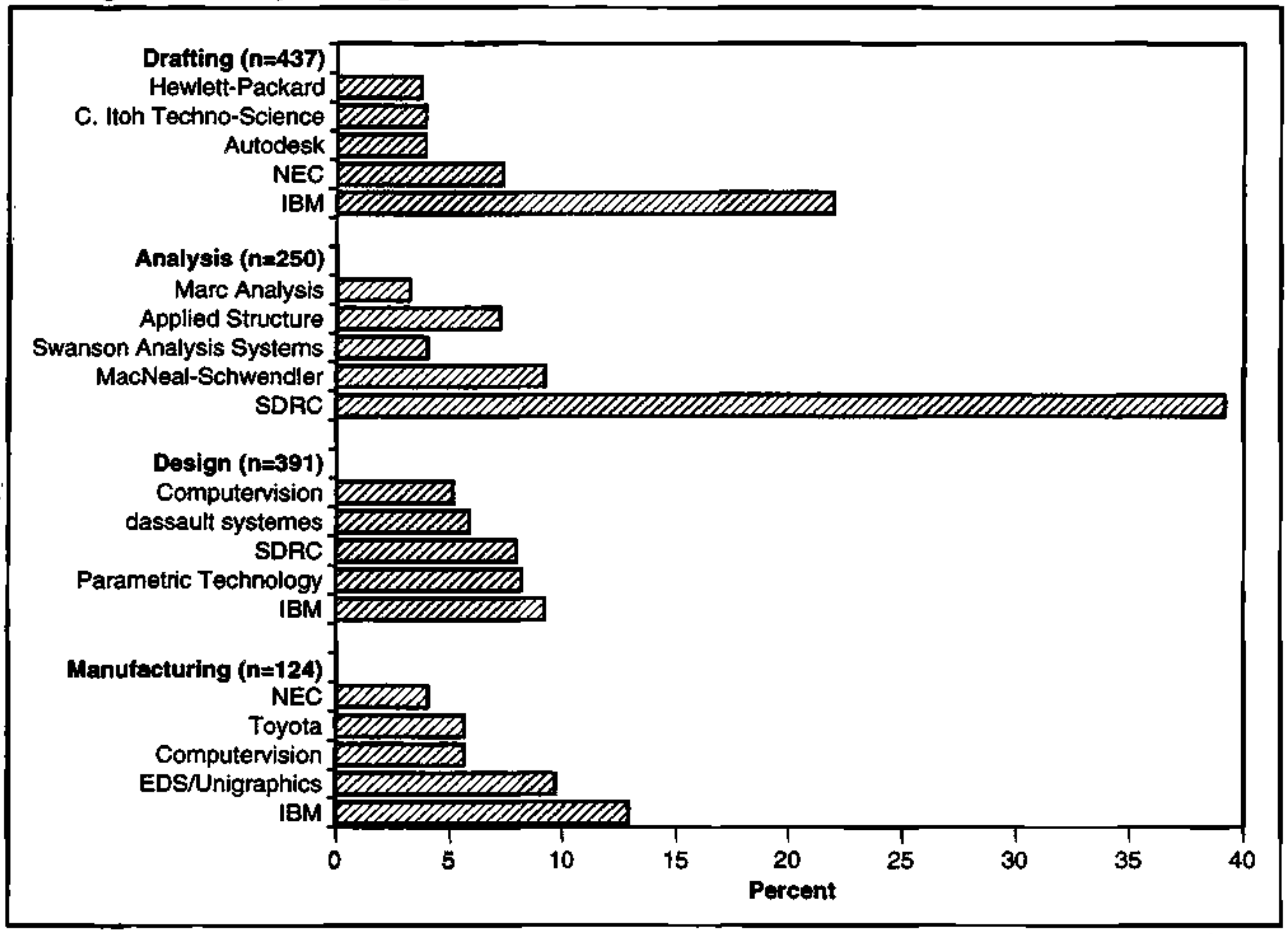
Figure 2
Leading Vendors by Subapplication



Source: Dataquest (September 1994) G4004838

vendors may not be well represented in this survey because the primary focus is on higher-level integration issues.

Product Data Management

As engineering projects become more involved, and products become more complex, product data management (PDM) becomes a pressing issue. Only recently have companies in Japan, the United States, and Europe begun to look at this issue seriously. The most promising use of PDM is seen in the electrical and electronic industry, where 34 percent of respondents either have a PDM system or have plans to implement one. The computers and peripherals industry closely follows in its use of or plans for PDM systems. Service/design/consulting lags far behind the rest of the end users in PDM plans: only 5 percent of respondents have a PDM system or have plans for implementation.

Further examination of the survey data reveals that nearly 70 percent of those end users using a PDM system have developed their own system. Commercial vendors make up the balance. Surprisingly, the penetration rate of vendors with PDM products, such as Sherpa, SDRC, EDS, and Intergraph, appears to be quite low, according to the survey responses revealed here.

Penetration

One of the fundamental issues driving the mechanical CAD/CAM/CAE market is understanding the penetration of this technology into every sub-application and task. Changing user dynamics and expectations make this a moving target. In this section, we examine the experience base of the survey respondents and site penetration.

Experience Base

One element of the issue of market penetration concerns the idea that users are reluctant to learn about new products. Conventional wisdom suggests that a user will find something that works and then continue to use that product until forced to do something different. The results of this survey show a different picture.

We asked how many different vendors' products the end users have learned to use, and how many new products they expect to learn in the next two years. For all industries combined, Japanese end users have learned to use 3.2 products, currently use 2.2 products, and plan to learn about 1.9 products in the next two years. This compares with our previous U.S./European survey results of 3.7 products learned, 1.9 products being used, and 1.0 new products to be learned in the next two years. Table 1 shows the split by industry for Japanese respondents. Users in the service/design/consulting industry have learned to use more than 4 different products on average. Of these, 2.4 are still in use. At the other end of the spectrum, users in industrial machinery have learned 2.7 products on average and plan to learn among the fewest number, 1.6 products, in the future.

Table 1
Change in Product Use by Industry

	Vendors' Products Learned	Currently Used	New Vendors' Products in Next Two Years	Retirement Rate* (%)
All Japanese Sites	3.2	2.2	1.9	31
Service/Design/Consulting	4.2	2.4	1.5	43
Consumer Electronics	3.6	2.7	2.1	25
Automotive	3.4	2.5	1.8	26
Electrical/Electronic	3.3	2.3	2.0	30
Computers/Peripherals	2.8	2.1	1.5	25
Industrial Machinery	2.7	1.9	1.6	30

* Retirement rate is defined as the percentage change between vendors' products learned and currently used.
Source: Dataquest (October 1994)

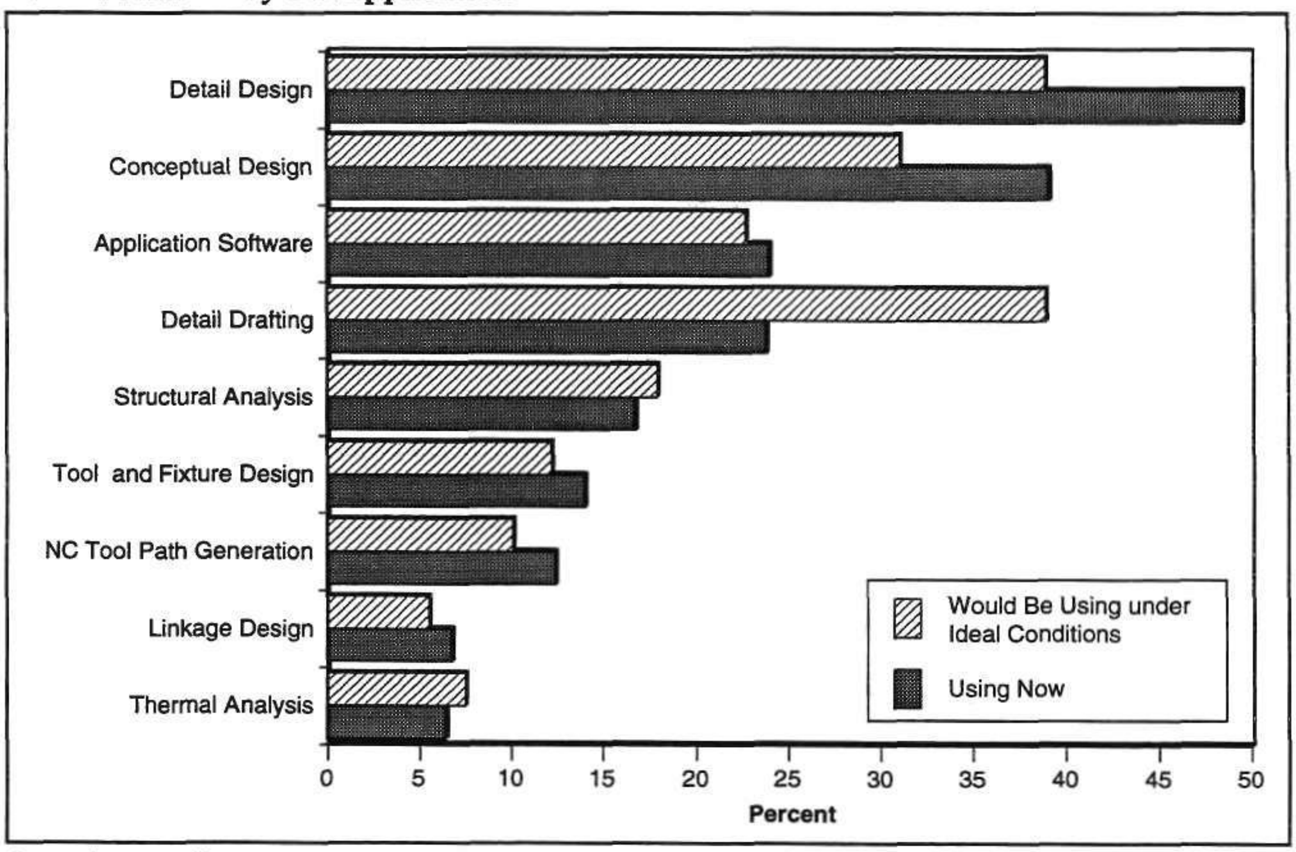
Site Penetration by Subapplication

For each of the major mechanical subapplications, we asked a series of questions such as "How many people are using mechanical tools in each of these areas? How many would be doing this kind of work using CAD/CAM/CAE tools under *ideal* conditions, with highly functional tools?" For our purposes, an ideal system was one in which a system would be cheap, fast, and easy to use and would have complete and highly productive functionality. In our U.S./European survey, structural analysis had the largest unmet need. This year, our Japanese respondents stated that detail drafting has the largest unmet need, with a possible potential growth rate of over 63 percent (see Figure 3). A significant drop in potential users for design tasks was also found. The other applications for analysis and manufacturing applications have minor growth or decline potential.

Buying History and Plans

Several questions were asked in the area of buying history and plans in order to better define the expectations of the users in future system purchases. We asked several in-depth questions on the current mix of hardware (platforms and peripherals) and planned decreases or increases in hardware, including seat counts, software module changes, and the future mix of modeling types.

Figure 3
Site Penetration by Subapplication



Source: Dataquest (September 1994)

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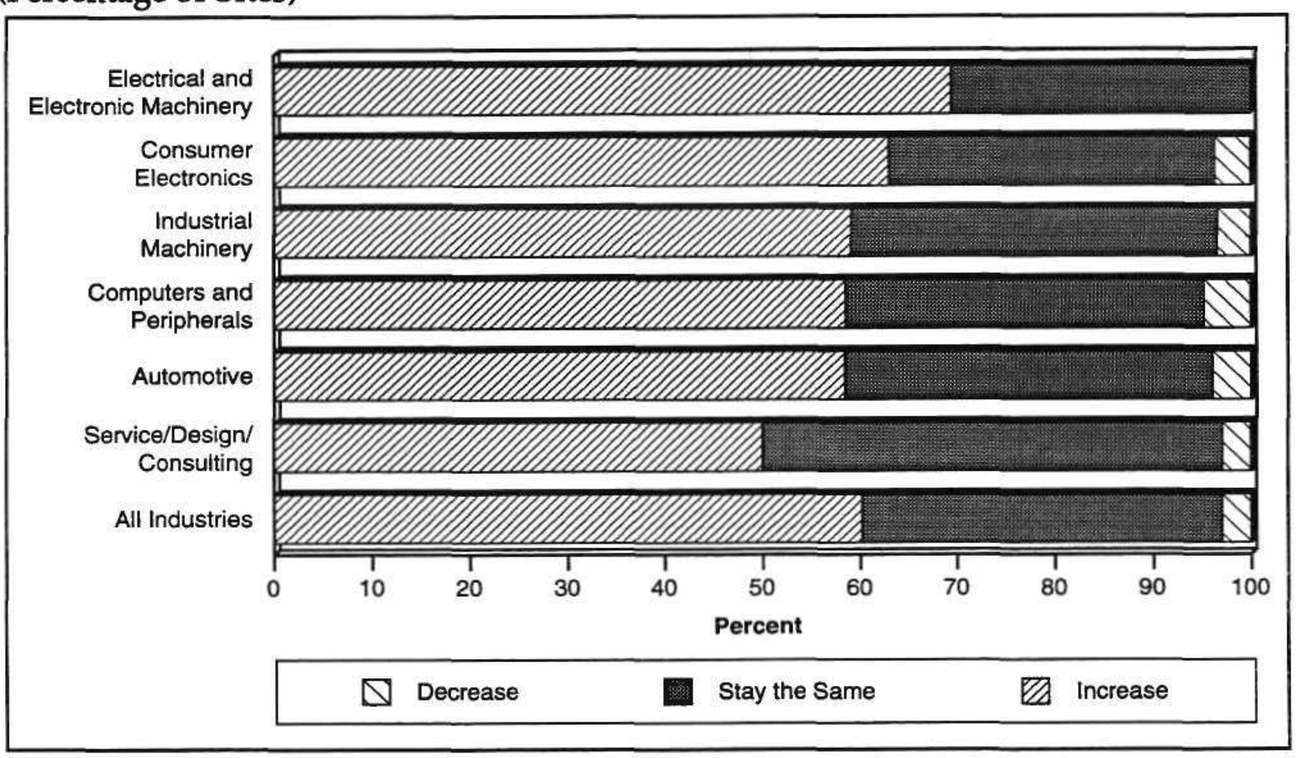
The purchase of new seats in the last two years in Japan was led by the PC platform (51.4 percent), closely followed by technical workstation-based products (47.1 percent), and lagged by mainframe-based products (1.6 percent). The mainframe-based product percentage (of the total purchases) is expected to remain approximately the same during the next two years. A slight 4 percent shift in computing mix is expected, with more PC-based solutions being purchased and fewer workstation solutions being purchased during the next two years.

In comparison to the responses from our U.S./European survey, mainframe-based purchases in Japan have composed a very small percentage of computing purchases during the past two years and are expected to compose even less of the total percentage of computing purchases in the next two years. Even though Japan has a relatively large installed base of mainframe-based computing systems, the downsizing trend in Japan is undoubtedly contributing to the decline in mainframe-related purchases.

Will the seat count for mechanical CAD/CAM/CAE applications increase, stay the same, or decrease in the next two years? The answer to this question, with analysis by industry, is shown in Figure 4. Overall, approximately 60 percent of sites are anticipating an increase in seat count, 37 percent are anticipating no change, and 3 percent are anticipating a decrease. More electrical and electronic sites are growing, with nearly 70 percent of these sites expecting an increase in seat count.

Figure 4
Expected Change in Mechanical CAD/CAM/CAE Seat Count by Site (Percentage of Sites)



Source: Dataquest (September 1994)
G4004645

Very few sites are expecting a decrease in seat count. Of those that are, the largest anticipated decrease is in the consumer electronics industry (33 percent), but this is expected at less than 4 percent of the sites. For all Japanese sites, the actual amount of the expected decrease is quite small, on average 16 percent, at only 3 percent of the sites.

Modeling Technology Planned for New Software Purchases

A fundamental issue in understanding the planned software acquisition activity concerns the core modeling technology supporting the application modules. We asked several questions concerning the future use of 3-D applications. First, we asked if 3-D design will become the main method of design in the next two years. Approximately 75 percent of respondents answered "yes" to the question. The answers varied somewhat by industry, with industrial machinery holding the low ground (60 percent of respondents said "yes") and consumer electronics and automotive industries holding the high ground (approximately 87 percent).

The most common reason cited for not *currently* using 3-D CAD/CAM/CAE tools was that 2-D CAD was enough (29 percent), followed by the reason that 3-D systems are very expensive (21 percent) or very difficult to use (21 percent).

We then asked that, of all new software planned for purchase in the next two years, what percentage falls into each of the following categories: 2-D only, 3-D wireframe, 3-D surface modeling, solid modeling-based, and fully integrated 2-D, 3-D, and solids-based product.

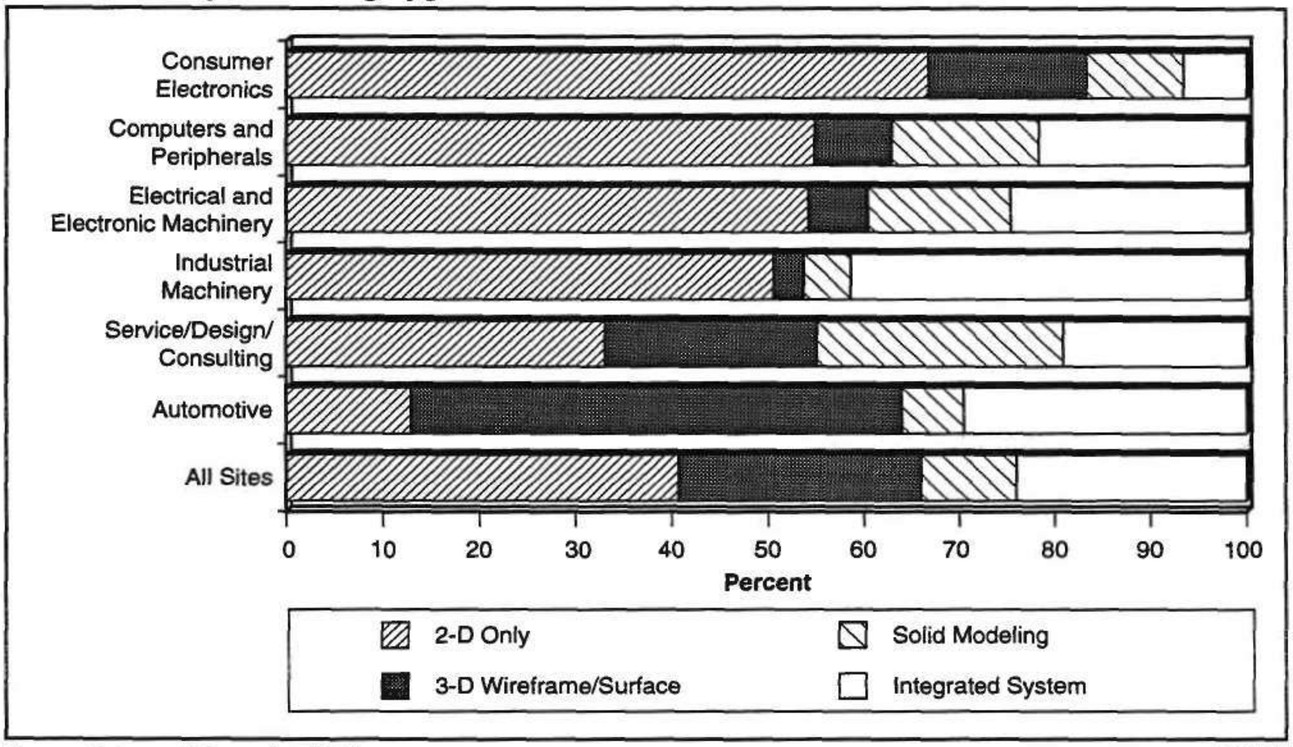
Figure 5 shows the variation in responses. Almost 35 percent of all Japanese respondents said that they need a solid modeling-based or fully integrated solution. This contrasts sharply with the U.S./European users, of whom nearly 50 percent stated that they needed a solid modeling-based or fully integrated solution. The relatively higher interest in 2-D-only solutions in Japan is a strong reminder that many drawings are still made in this environment. The continued 2-D interest is encouraged by ongoing development to increase the value of these applications. All of the latest advances in parametric and predictive input tools are available in a 2-D format. In fact, most of the latest thinking in enhanced user interface techniques is developed first in a 2-D mode.

Importance and Satisfaction Evaluation

Gap analysis is a classic way to evaluate the relative importance and level of satisfaction among a number of related issues. We asked the respondents to rate a number of issues relating to software satisfaction on a scale of one to five, with five being very important or satisfied and one being not at all important or satisfied. A rating of three is viewed as neutral.

For nearly all issues evaluated in our study, the level of satisfaction was below the level of importance. This is unusual for an analysis of this type and indicates a general performance of a given product below expectations or needs. Moreover, the Japanese end users tended to show greater

Figure 5
Future Seats by Modeling Type



Source: Dataquest (September 1994)

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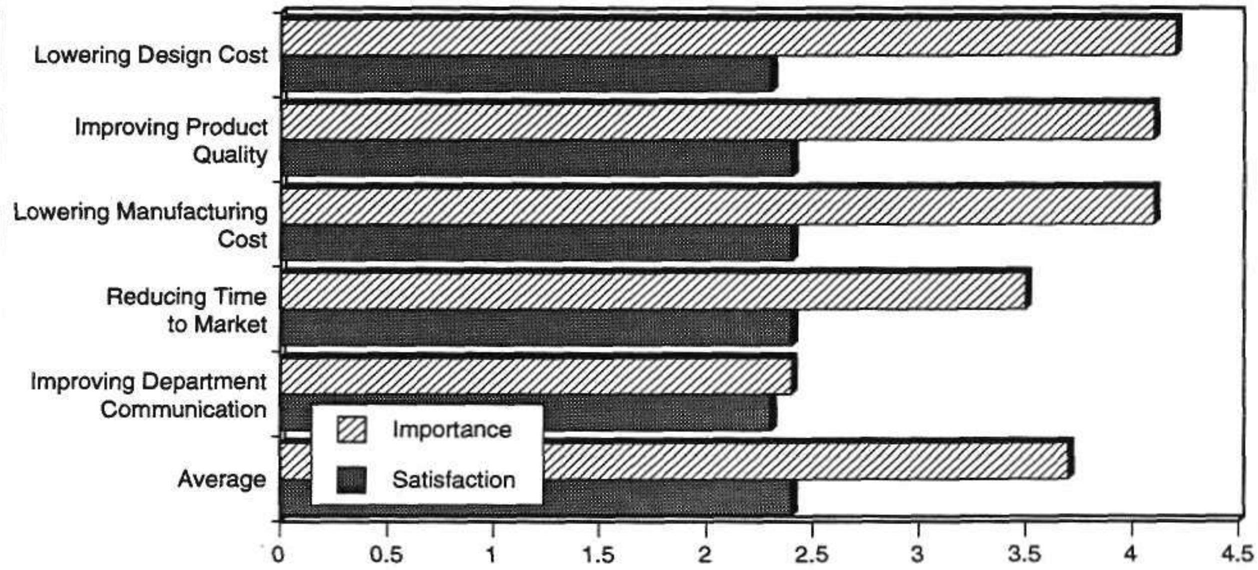
dissatisfaction with their software (as evidenced by the relatively low satisfaction scores) and tended to have greater importance/satisfaction gaps than the U.S./European end users. Here, we present the findings of our importance/satisfaction analysis for two areas: strategic business issues and software issues.

Strategic Business Issues

A variety of issues can be used to evaluate the importance of strategic issues in the success of a business. The Japanese companies interviewed in this survey see lowering design costs as the top strategic business issue (see Figure 6). It is no wonder that lowering costs is a top issue because Japanese companies tend to market a large number of diverse products. This degree of innovation can be readily observed in the consumer electronics and automotive industries of Japan.

Improving product quality, which was ranked first by U.S. and European respondents, came in a very close second for this survey of Japanese respondents and was tied with lowering manufacturing costs. Clearly, one of the more important benefits of using CAD/CAM/CAE tools is to improve the quality of the end product. Perceived product quality can justify higher purchase pricing, while real product quality can lower potential litigation expense. In any case, the top three strategic reasons for CAD/CAM/CAE justification all had a gap rating of 1.7 or higher. We believe that these end users are not happy with the ability of their

Figure 6
Importance and Satisfaction Evaluation of Strategic Business Issues



Note: On the scale of 1 to 5, 1 is not important or satisfied; 5 is very important or satisfied.

Source: Dataquest (September 1994)

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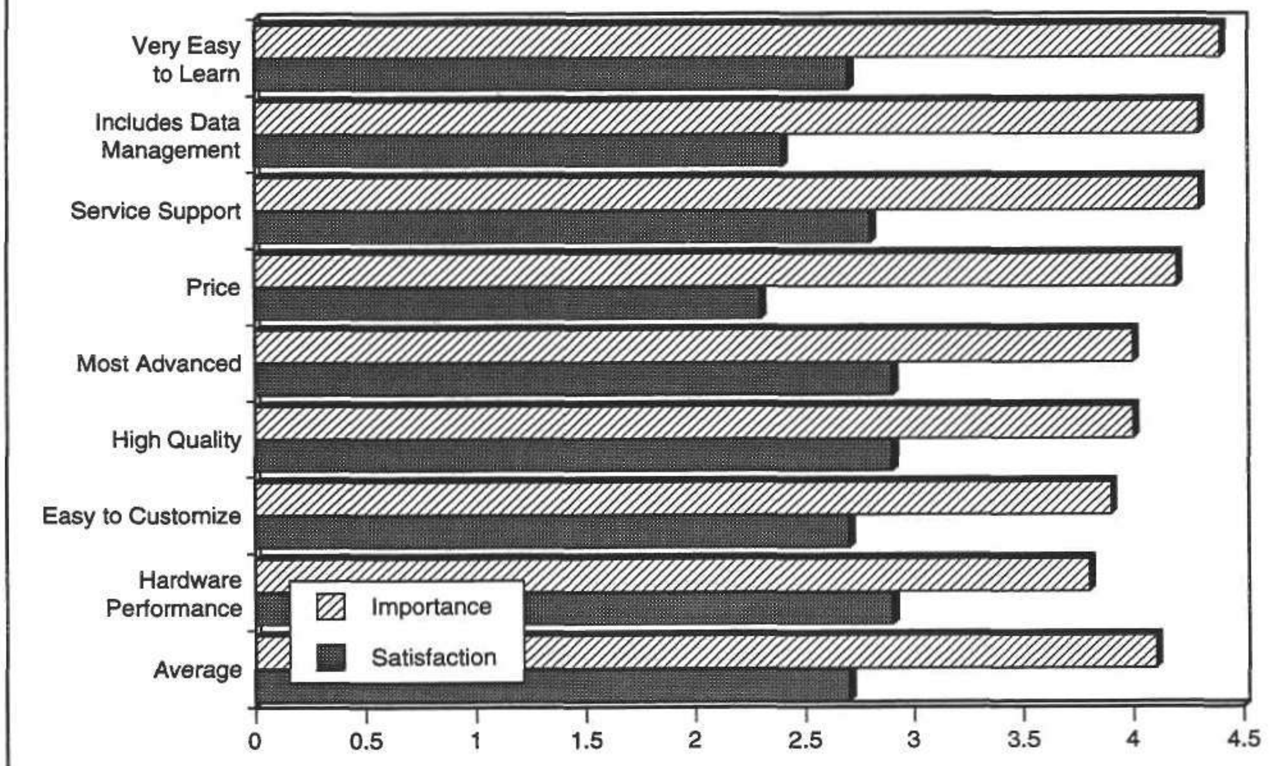
automation tools to provide competitive advantage at the strategic level. Vendors that can demonstrate an ability to provide these tools will have a significant advantage in the next five years.

Software Issues

Again, our Japanese survey respondents have a slightly different perception of importance and a large difference in satisfaction with regard to software issues than our U.S./European respondents. On average, the level of dissatisfaction for Japanese end users was twice as large as U.S./European end users. The results are shown in Figure 7. Here, the most important software issue was having access to very easy to learn software, while in our U.S./European survey, the most important issue was software quality (that is, buggy software, corrupt data files, and weak interfaces among modules). Having access to software that includes data management and that provides good service support is the second and third issues for Japanese end users. Both of these issues have a large importance/satisfaction gap of negative 1.9, indicating that there is much room for improvement on both of these fronts.

Overall, Japanese end users seem to be more dissatisfied with software features and functionality than U.S. or European users, as evidenced by the larger importance/satisfaction gaps for these issues. Although one could argue that because of cultural differences, it is unfair to compare the Japanese end-user satisfaction ratings with U.S./European ratings. Whether that statement is true or not is irrelevant—the gaps are present nonetheless. If a vendor is interested in marketing its tools in Japan, it is up to the vendor to close these gaps, whether they are real or perceived.

Figure 7
Importance and Satisfaction Evaluation of Software Issues



Note: On the scale of 1 to 5, 1 is not important or satisfied; 5 is very important or satisfied.

Source: Dataquest (September 1994)

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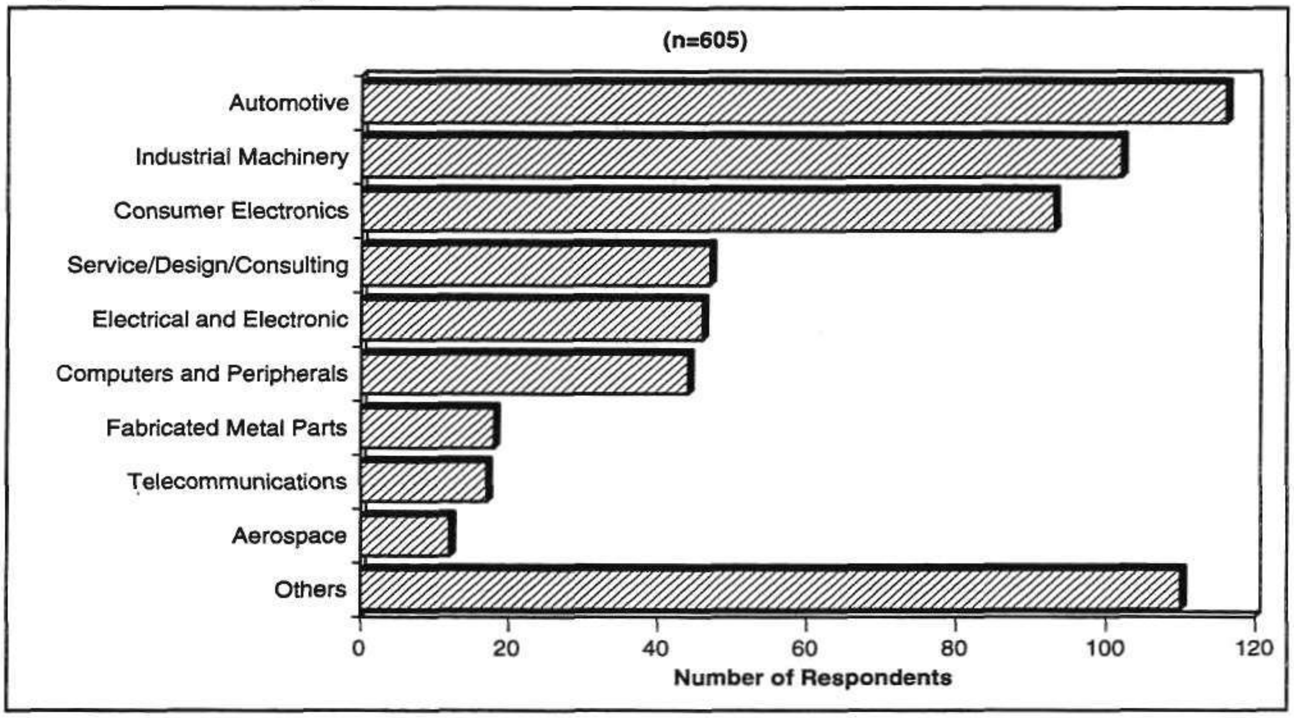
Site and Respondent Demographics

This survey focuses on a set of respondents selected from a filtered but random population of users identified by more than a dozen of the leading vendors and distributors in Japan. More than 630 sites were surveyed in Japan. Site size was not controlled, nor was industry. The result gives a broad representation across the user environment. The respondent profile included people involved in the decision-making process of new system purchases, those who are currently or have been users of mechanical CAD/CAM/CAE tools, people working in a major discrete manufacturing industry, and employees in one of the major departments of potential use.

Nearly 50 percent of respondents to this survey hold the title of department, group, or chief engineer, followed by CAD system managers (25 percent) and the group of designers, engineers, and analysts (23 percent). These respondent job classifications provide good insight into use of equipment, budgets, and site penetration levels.

Figure 8 shows the distribution of the respondents' companies by industry. Almost all categories had sufficient responses to allow for a statistically

Figure 8
Respondents' Primary Business



Source: Dataquest (September 1994)

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valid comparison among industries. Comparison is made in the automotive, computers and peripherals, consumer electronics, electrical and electronic, industrial machinery, and service/design/consulting industries. The aerospace, fabricated metal parts, and telecommunications industries did not have a sufficient number of responses to be examined from an industry perspective, but responses from these groups are included when looking at the aggregate survey data.

For this survey, the R&D/new product development group was the largest, followed closely by product engineering. Very few respondents were in training and education. This is in contrast to our U.S./European survey, in which the largest group of respondents came from design and computing services.

The Japanese respondent group as a whole is well experienced with several years of hands-on use. The average years of experience for survey respondents was 5.7 years, compared with 7.4 years from our U.S./European survey.

Recommendations

Many opportunities exist in the Japanese CAD/CAM/CAE end-user community to market a better solution based on newer technology and PC-based or workstation-based platforms. The Japanese users want easy-to-use software with improved integration among the modules, better data management, and strong service support. The recommendation in this case is to design easy-to-use software with these qualities for the installed base and for new customers.

Even with the economic problems recently seen in Japan, do not ignore this important market. Many companies are considering how to upgrade to the next-generation hardware platform and software combination. The Japanese end users, as a whole, plan to learn twice as many new products as do the U.S. or European users during the next two years. Additionally, no one vendor dominates all of the subapplications in Japan. There is a huge void between the interest in product data management and the penetration of such products among end users.

Vendors should expect some fundamental changes in the organization and structure of many manufacturing companies in Japan. Strategic changes are being made to improve the competitiveness of these operations.

The idealized viewpoint of some of the future-looking questions in the survey indicate, at best, a strong interest in moving the latest design optimization tools into the hands of specialists. A less optimistic evaluation finds a reduced interest level in advanced technology. An advanced function for detail drafting was voted the highest for potential user growth.

In any case, there is clearly a need for new technologies or improved tools in Japan. The Japanese end users must be convinced that these new tools will work, and ease of use/training is a strong factor in any buying decision. While these end users are eyeing 3-D modeling technologies and integrated solutions, they still are relying on 2-D modeling for a large portion of their design work. There is an interest and need for PDM, yet it hasn't quite taken off. End users are showing strong interests in adopting new technologies, but the majority of them have not yet been convinced of the benefits.

By Michael J. Seely and Sharon Tan

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For More Information...

Michael Seely, Director .... (408) 437-8178
Internet address .... mseely@dataquest.com
Via fax .... (408) 437-0292

Dataquest Perspective

Software

Mechanical Applications Worldwide

In This Issue

"Best of Breed" Product Review for ANSYS/ProFEA
Analysis software is proving to be an invaluable part of the design engineer's toolset. In this report, Dataquest reviews the "best of breed" qualities of the ANSYS/ProFEA finite element analysis tool from ANSYS Inc. We analyze the major features and functions of this product and illustrate a working scenario where maximum value is obtained from the use of the software.
By Mike Seely and Sharon Tan

"Best of Breed" Product Review for ANSYS/ProFEA

Why use CAE? Innovation and analysis have been key elements of mechanical design since Leonardo da Vinci spun the wooden propeller on his helicopter. The reason he could not fly is part of the answer to this question.

The proliferation of new materials, new manufacturing processes, and expanding market demand are creating a wonderland for the creative engineer/designer. What could Leonardo have done with composite materials and a reliable 300-horsepower engine that is smaller than a man? This is the challenge for the engineers of today. They have access to a mind-boggling array of tools, materials, and processes. This endless variety is, in fact, the fuel driving the development and use of better CAE technology. Empirical data and personal experience often provide insufficient evidence to make good engineering decisions in today's design environment. Sophisticated analytical tools are needed to aid the design process toward a rapid, high-quality solution.

Over two million engineers, designers, and technical experts are investing more than $400 million each year for access to the latest engineering analysis software. This subsegment of the mechanical CAD/CAM/CAE market is expected to grow more than 12 percent this year.

Overview

The purpose of this article is to determine the "best of breed" qualities of the latest release of ANSYS/ProFEA 5.0 from ANSYS Inc. Our review is designed to illustrate a working scenario in which maximum value is

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obtained from the use of the software. The product description covers the major features and functions of the product. The "Dataquest Perspective" will position the use of the product and analyze the best-case scenario for strengths and weaknesses.

ANSYS/ProFEA is targeted for designers who need to do quick what-if analyses early in the design process. The benchmark process in this review will tackle the optimization of a sprinkler handle design.

This product review evaluates the third production release of ANSYS Inc., ANSYS/ProFEA 5.0. ANSYS/ProFEA 5.0 is completely integrated with the Pro/ENGINEER mechanical design automation software from Parametric Technology Corporation (PTC). ANSYS/ProFEA is the first finite element analysis (FEA) design tool to provide design optimization from within the Pro/ENGINEER environment. It includes feature-based parametric optimization and sensitivity studies for linear stress, vibration, and thermal analysis.

Ease of use and integration with Pro/ENGINEER are the major benefits of this product. Many of the common FE analysis pitfalls have been anticipated and reduced or eliminated by procedural or default value organization. A detailed analysis of a conceptual design may be generated in a fraction of the time required by the more traditional analysis methods. The analysis function is a natural extension of the Pro/ENGINEER design environment for the experienced user. While no panacea for the novice entering the world of engineering analysis, this structured environment reduces the overhead to a manageable level during the learning process.

This review is divided into several sections:

- Test Case Review
- Test Process and Results
  - Initial Analysis
  - Design Change
  - Optimization Evaluation
- Product Description
- Dataquest Perspective
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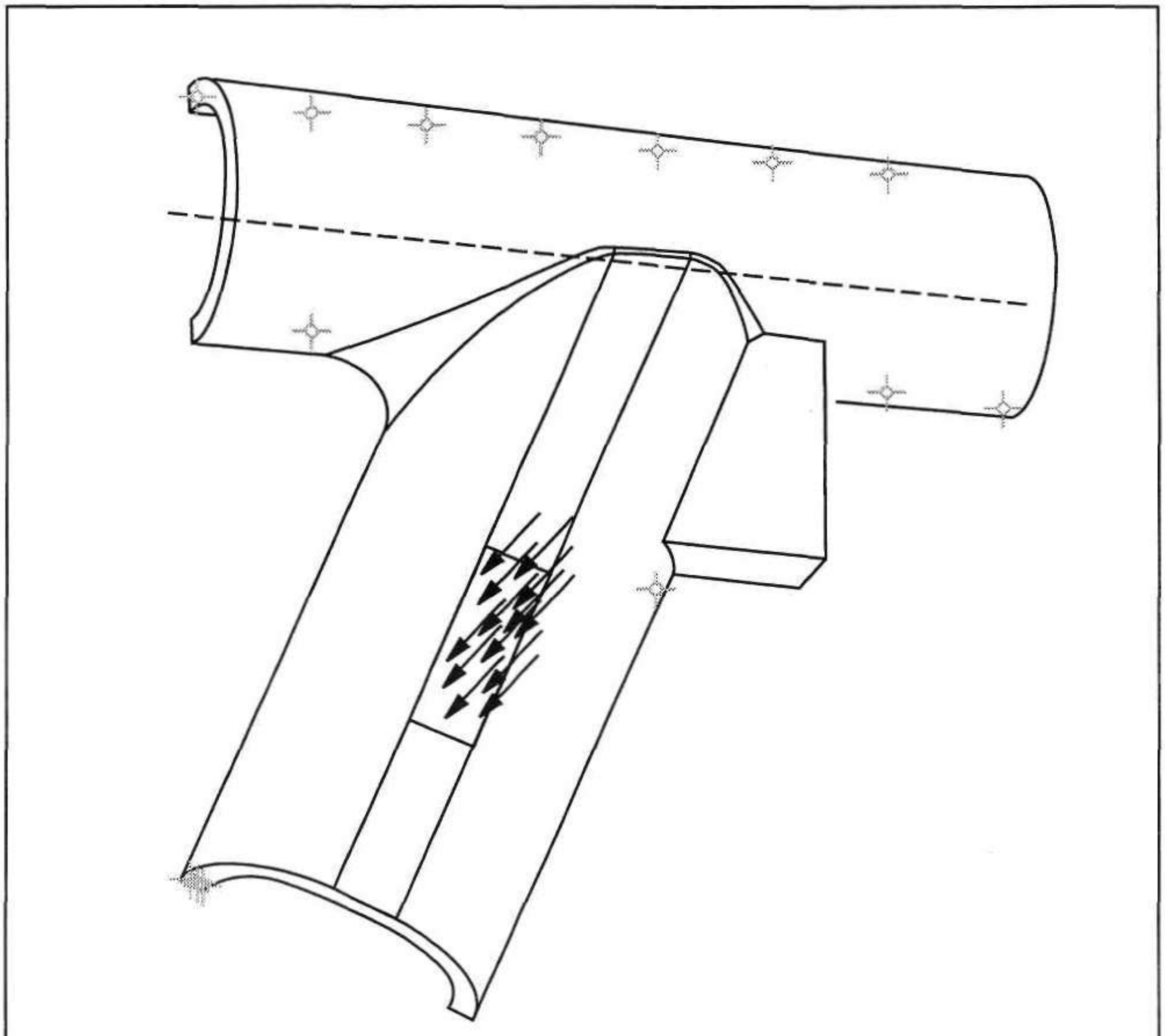
Test Case Review

A sprinkler handle for a garden hose was selected as the test case problem. The design problem is based on a question of structural integrity assuming a crushing side load as the result of a person stepping on the handle while it is lying on the ground. In addition, a weight reduction is desired that directly affects material cost per part, a major cost driver for plastic parts. Figure 1 shows a diagram of the sprinkler handle with loading conditions.

Figure 1
The Benchmark Problem: Sprinkler Handle with Load Conditions



Source: ANSYS Inc.

G4004956

Because our focus is component design analysis and not part modeling, the part model is assumed to be a recently completed conceptual design waiting for first-order analysis and optimization. For this case study, only the handle was considered; the nozzle and other parts were ignored because they add little to the structural integrity of the assembly. The problem was further simplified to take advantage of the symmetrical nature of the part. The following list outlines the pertinent information for this demonstration:

- Software version
  - Revision 5.0A of ANSYS/ProFEA
  - Pro/ENGINEER release 12.0
  - ANSYS-Pro/ENGINEER Interface (API)
- Computer
  - Hewlett-Packard 720
- Memory/swap space
  - 96MB RAM/150MB swap
- Element type
  - Parabolic 3-D structural shell (10-node)
- Number of elements
  - Approximately 2,000

Test Process and Results

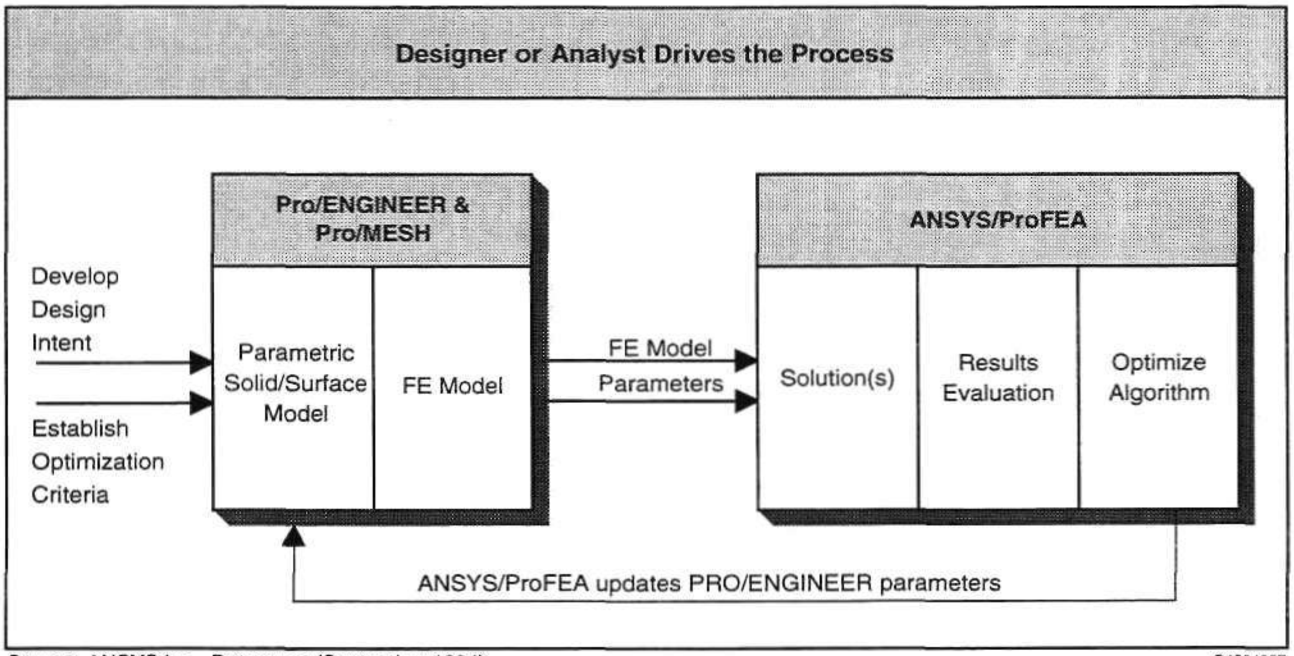
A designer would typically set the initial test conditions, perform an analysis, and then review the results. This is accomplished in a five-step process for the initial analysis. This familiarization process serves two purposes: it verifies that the problem has been set up properly, and it begins the evaluation process necessary to make the desired changes in the design. This first look may give the design engineer an idea for a potential change. This is easily accomplished by going to the Pro/ENGINEER part model. Using the parametric geometry editing feature, the part model is quickly modified. Because the part has an analysis history, automatic mesh creation and reanalysis are accomplished with just three menu picks. The designer now has some understanding of the performance of the part under load and corresponding test parameters, so an optimization study can be started.

The optimization process uses all the information from the earlier analysis. In addition, this process is directed by selecting dimensions and geometric feature parameters as the items to be optimized. Part weight is mostly governed by the wall thickness of the handle. The crushing strength of the handle is determined mostly by the spacing, thickness, and number of the ribs inside the handle. The parameterized values for each of these are identified as the variables for optimization.

Initial Analysis

Using the Pro/ENGINEER interface, we rotated and exploded the part. Access to the ANSYS/ProFEA software is achieved by simply picking ANSYS from the Pro/ENGINEER menu. ANSYS/ProFEA is completely integrated in the Pro/ENGINEER design environment, as shown in Figure 2.

Figure 2
Pro/ENGINEER and ANSYS/ProFEA Interface



Source: ANSYS Inc., Dataquest (September 1994) G4004957

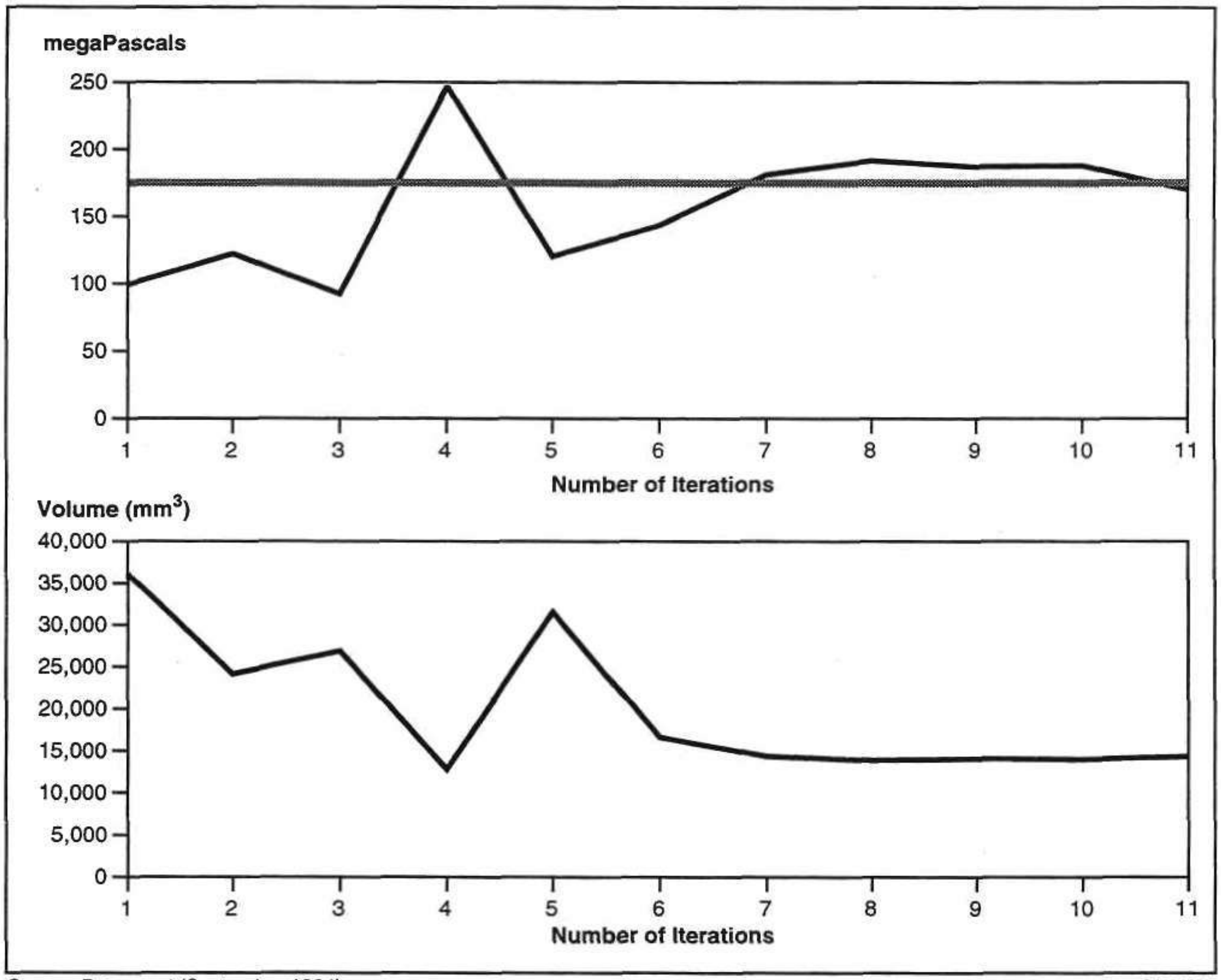
To perform a structural analysis on the part, we first reviewed load conditions, displacement boundary conditions, and mesh settings. One of the first things we noticed was that the simplistic (intuitive) ANSYS/ProFEA menuing system is very similar to Pro/ENGINEER's menuing system. Even the HELP information is accessed and written in the same manner as Pro/ENGINEER's HELP information, allowing the designer who is comfortable working in Pro/ENGINEER to immediately be productive in the ANSYS/ProFEA environment. The ANSYS/ProFEA training and user guides also have a similar look and layout to the Pro/ENGINEER guides.

We then generated a parabolic shell finite element model using Pro/MESH. Accessing Pro/MESH is accomplished transparently through a menu pick in the ANSYS/ProFEA menu. At this point, it is possible to check the model for elements that exceed the Pro/MESH settings for aspect ratio, distortion index, and midside node placement.

We ran the analysis directly from the ANSYS/ProFEA menu. Our analysis revealed that the maximum von Mises stress was 146 MPa and the maximum deflection with the load applied, as shown in Figure 3, was less than 1mm.

The main benefit seen from this simple analysis was the ease of use of the software. ANSYS/ProFEA is readily accessible from within the Pro/ENGINEER environment. Finite element model generation, meshing, and running of the analysis are simple menu picks from the screen. The menus are intuitive, easy to follow, and do not require a large amount of expertise on the designer's part for performing the mesh generation.

Figure 3
Optimization Path
Objective: Minimize volume (mm^3) von Mises stress below 175 megaPascals



Source: Dataquest (September 1994)

G4004958

Design Change

Because ANSYS/ProFEA works closely with Pro/ENGINEER, making simple design changes to the sprinkler handle was quick and easy. We made the height of the ribs inside the cavity 60 percent smaller, and we simply made the change on the original Pro/ENGINEER solid model. At this point, because the two software pieces are tightly integrated through the API, we were able to mesh the resulting solid, apply load conditions as in the analysis evaluation, run the analysis, and look at the results. This entire procedure took less than five minutes.

Our analysis showed that the von Mises stress reached approximately 250 megaPascals with the smaller ribbed design, whereas in the original design the stress was 146 megaPascals. This is clearly a weaker design than the original. A series of cut-and-try sequences can be done. This is time consuming and tedious work for the designer. Luckily, this iterative evaluation can be automated with ProFEA.

Optimization Evaluation

We next performed an optimization, with the objective of decreasing the weight of the handle while keeping both stress and displacement within their allowable limits. We allowed the various components of the handle to vary, as shown in Table 1. Because the designer has some analysis experience with the part at this time, setting the minimum and maximum value is not difficult. If the results of the optimization do not meet the overall design objectives, another design approach can be created and optimized.

We set up the parameters shown in Table 1 using menu picks from the ANSYS/ProFEA menu. The procedure involved setting the design variables (ranges for shell thickness, rib thickness, and number of ribs), the design objective (minimize volume), and the design constraints (minimum/maximum tolerance for von Mises stress, and minimum/maximum tolerance for displacement). At this point, we proceeded with the same steps as described in the earlier analysis problem—creating a finite element model mesh and running the optimization.

Table 1
Volume Optimization Parameters

Feature	Minimum	Maximum
Shell Thickness	0.75mm	2.50mm
Rib Thickness	1.00mm	4.00mm
Number of Ribs	3 ribs	11 ribs
Maximum von Mises Stress	0 MPa	175 MPa
Maximum Displacement at Load Contact Point	0mm	1.00mm

Source: ANSYS Inc., Dataquest (September 1994)

The system took approximately 11 iterations to reach an optimal answer, taking approximately one minute per iteration. The optimization algorithm that ANSYS/ProFEA uses involves several random guesses at various design variable combinations and then intelligent guesses, based on previous results, until a solution is derived (see Figure 3).

Our final results showed that the optimal sprinkler handle, under the conditions described in Table 1 and Figure 3, has a shell thickness of 1.4mm (down from 4.0mm) and 8 ribs (from 11 ribs) of thickness 1.0mm (from 2.4mm). The resulting volume was reduced from 36,000 cubic mm to 14,285 cubic mm, where the maximum von Mises stress was 181 megaPascals. It is interesting to note that the optimization algorithm may suggest 7.6 ribs or some other fractional number. The number is rounded up or down when brought back to Pro/ENGINEER for model update. This ensures a valid model but can cause difficulty for the optimization process if the value range is small. In other words, giving the optimizer a choice between 20 values is more effective than making it choose between 2.

Product Description

The fundamental purpose of ANSYS/ProFEA is to combine the ease of use of the Pro/ENGINEER product modeling with ANSYS analysis capabilities. To simplify the use and to maximize the value of the combined products, a subset ANSYS capability is integrated into the Pro/ENGINEER environment. This combined environment uses the parametric nature of the modeling process to help automate the specification of design parameters for the analysis and optimization process. The user interface has been modified to include the necessary functions for analysis, such as definition of loading and boundary conditions, material properties, and the type of analysis to be performed.

Analysis begins by building the part or assembly models with Pro/ENGINEER. Automatic meshing is performed with Pro/MESH, creating the FE mesh model. This mesh model, with the related parameters specifying the conditions for analysis, is passed to ProFEA for analysis. Figure 2 shows a flow diagram of this process and illustrates the significant functional components of this product set. By adding optimization criteria to the start of the process, a series of analyses can proceed under program control with a variety of optimization options. Sizes such as wall thickness can be varied, as can shape features controlled by dimensions. Feature parameters can be modified in similar fashion, optimizing the configuration for bolt hole patterns, slots, or webs. Design considerations such as minimal weight, maximum strength, or heat dissipation ability can drive the optimization process. Although these options do not cover all the potential optimization scenarios, they do offer a powerful design tool.

Although the product requires the user to have a good working knowledge of Pro/ENGINEER, it does not mandate that users possess an extensive background in finite element analysis. In fact, the combined capabilities of the Pro/ENGINEER and ANSYS/ProFEA products provide an environment in which an engineer or designer can experiment and learn the effects of specific changes in the design. The user must have enough experience in the design process to consider the possible product failure modes or worst-case situations.

This tool is geared toward the design engineer, working in a concurrent engineering environment, who needs to perform basic, what-if analyses of conceptual designs and rapidly assess the impact of design changes. This product is not targeted toward the more traditional analysts, who need to perform more complicated analyses. However, this latter group may find the ANSYS/ProFEA to be a valuable tool in rapid mesh model creation and evaluation of design constraints.

Because ANSYS/ProFEA is linked to Pro/MESH, you do not need to take a snapshot of the geometry and transfer it to the CAD system. Things like this almost always require manual intervention, especially if solid modeling is involved. Assuming that geometry transfer is perfect, there are five steps to go through for analysis with ANSYS/ProFEA. With each design update, ProFEA is three steps. The highlights of ANSYS/ProFEA 5.0 are as follows:

- Provides an easy and reliable way to perform quality stress, vibration, and heat transfer analysis and optimize new and existing designs
- Complete integration with Pro/ENGINEER
  - Perform analyses within a Pro/ENGINEER style environment
  - Use Pro/MESH assembly meshing techniques
  - Support large assembly analysis with contact surfaces
  - File translation is unnecessary because the user interface manages the creation of mesh models, boundary conditions, and results information within the Pro/ENGINEER model
- Ease of use
  - Both thin-walled and solid objects can be automatically meshed
  - Intuitive interface requires a simplified five-step process to complete an analysis, compared to an eight- or nine-step process typical in other systems
  - Check Model function allows quick review of constraints, loads, and boundary conditions before analysis run
  - Can use local design constraints to improve optimization efficiency or to better model known areas of concern
- Optimization capabilities
  - Sizing optimization allows design variables such as shell thickness to be optimized
  - Shape optimization allows any dimension in Pro/ENGINEER to be optimized

- Topology optimization addresses the question of where material should or should not be

- Access to more advanced analysis tools via the ANSYS-Pro/ENGINEER interface to full ANSYS program

Following is a list of program specifications:

- Analysis types
  - Linear stress
  - Natural frequency vibration (mode shapes)
  - Steady-state heat transfer
- Materials
  - Linear
- Structural loads
  - Displacements
  - Temperatures
  - Forces
  - Pressures
  - Body loads (gravity and acceleration, centrifugal, angular acceleration)
- Heat transfer loads
  - Temperature
  - Convection
  - Heat flow
  - Radiation
- Design variables
  - Dimensions
  - Features
- Element types
  - 3-D spars
  - 3-D beams
  - 3-D shells
  - 3-D solids
- Optimization objectives
  - Minimize weight
  - Minimize cost
  - Match frequency

- Match frequency
- Minimize stress
- Maximize heat flow
- User defined

- Optimization constraints
  - Stress
  - Displacement
  - Frequency
  - Temperature
  - Heat flow
  - User defined

Dataquest Perspective

Ease of use and anticipation of early pitfalls are the major benefits of this product. A detailed analysis of a conceptual design may be generated in a fraction of the time required by the more traditional analysis methods. Each step in the process has been evaluated for automatic or semiautomatic operation, with the most logical or robust analysis options set as system defaults.

The Test

The test part offered a reasonable scenario to examine the functionality of the software. The simplicity of the problem allowed quick viewing of the user interface in each step of the process and allowed real time viewing of the optimization process. Typical design problems in many industries can take minutes to dozens of hours to cycle through an optimization process. The good news is that you don't have to watch it. We would expect users to evaluate this software on a part or assembly that matched the complexity of a typical design problem. A decision needs to be made for the necessary turnaround time for the analysis process. If overnight is acceptable, a wide range of computing resources can be used. If ten- or fifteen-minute response is needed for complex optimization problems, a supercomputer may not be enough.

User Interface

The experienced Pro/ENGINEER user will find the ANSYS/ProFEA analysis function to be a natural extension of the current design environment. The novice will need to learn both products but will appreciate the structured environment, which reduces the overhead to a reasonable level during the learning process. The familiar user interface, format of built-in help functions, and integrated operation all assist the user toward proficiency in design analysis.

This product takes a subset of the full FEA functionality and moves it close to the designer for first-level design analysis. Packaged with a generous amount of default values and process assumptions, the user quickly moves through the design process.

The built-in assumptions can be customized to accommodate the work environment by one of the local system experts. As the user gains experience with the tool, the process can be tweaked further to gain performance and accuracy.

Because it is linked to Pro/MESH, you do not need to take a snapshot of the geometry and transfer it to the CAD system. Assuming error-free geometry transfer, there are five steps to go through for analysis with ANSYS/ProFEA. With each design update, only three steps are required. Competitive systems may be required to start over with modification of the CAD model then recreate the boundary and load conditions, transfer model, and so on to complete the analysis.

Optimization

Optimization under computer control is one of the most powerful concepts to evolve in the engineering environment. The functional capability of this implementation is one of the best available but could easily fall short of a comprehensive wish list. The current process can only be directed at modification of existing part features or dimensions. A bolt hole pattern must be given as a starting point if this is to be considered. The process cannot invent holes, additional parts, or changes based on manufacturing processes. The part cannot be automatically changed from a bent metal part to a plastic molding.

The feature-and-dimension-driven process does solve one of the most difficult implementation requirements. Design problem definition in terms that can be effectively used by the computer is a fundamental problem in any optimization process. Driving this process from a parameterized model is an effective means of showing design intent and puts a boundary around the optimization process. Experience gained at this level will pave the way for more robust solutions.

The current optimization process is not conducive to table choices as a list of options. An optimized solution may find 0.489 inches as the best hole diameter. The slight increase to half an inch could cause considerable savings in standard drill tooling.

FEA Core Technology

It would be a mistake to suggest that the ProFEA product will always give the precise answer to a design problem. Local stress factors, fatigue, and many other factors may influence the design in a significant way. ProFEA is typically used as a first-order analysis tool and is not designed to address all these potential issues. The process should allow the designer to compare one design to another and pick the better solution. The computerized optimization will iterate this process many times, but the user must recognize that the best pick may be only a good approximation of the actual design problem.

The reality of the design/FE analysis combination forces the user to learn more and more about finite element technology and the inherent constraints in the process. It still requires a talented engineer well over a year to become proficient in making the value judgments to ensure that a full-function FE tool is being used properly and that the results are representative of the actual design.

Consider ANSYS/ProFEA as a power tool for the professional engineer or designer. These people can be found in every department and industry where design is performed. ANSYS/ProFEA is a strong force moving a functional analysis tool into the hands of the working designer. As with any power tool, the uninformed and careless may lose some fingers. The functional range of foolproof automated analysis tools will grow larger over time. In the meantime, engineers and design should check their work.

Mixed Model Analysis

Seasoned FE analysts will tackle design problems with multiple element types. Each element type is handpicked to add an extra level of accuracy or flexibility in matching the design situation. ANSYS/ProFEA is driven automatically from the part model. Special conditions can be used in the model to build quite a sophisticated analysis model. The feature-based part modeling tool can be used to automatically drive shell or solid element creation. Special features in Pro/ENGINEER, such as a web or rib feature, can automatically build a mesh model with shell elements. These are the best element type for parts with a thin constant cross section. Bulky parts are better suited to parabolic tetrahedral elements. These elements are ideal for this task because they reliably will fill almost any volume with viable elements. Mixed element models can be modeled, analyzed, and optimized together. Users should expect a growing list of element types suitable for fully automatic creation and analysis.

Linear Elements

As model size and computing time increase, in terms of disk space, swap space, and processor speed (or run time), some simplification of the tetrahedral elements can be made by replacing the parabolic elements with linear elements. An expert is needed to judge whether this simplification can be made; however, a potential reduction in computation time by a factor of three or four makes this a valuable option. All linear tetrahedral elements are not created equal. ANSYS offers rotational degree of freedom (DOF) at the nodes in addition to translational DOF. This improves the utility of these elements over most competitive linear elements. However, all linear elements are generally expected to be too stiff for close design performance correlation.

Background Information

Swanson Analysis Systems Inc. (SASI) was founded in 1970 by Dr. John A. Swanson to develop, support, and market the ANSYS program, a finite element analysis code widely used in the computer-aided engineering field. The company, headquartered since 1978 at its current location in Houston, Pennsylvania, just outside Pittsburgh, expanded its software offerings in 1992 with the purchase of Compuflo Inc. The acquisition brought the FLOTRAN program, a computational fluid dynamics (CFD) package, into the SASI fold as a complement to the ANSYS program. Employment has grown from a few employees to more than 170 today, half of whom are engineers or technical specialists.

TA Associates, a large investor in growth companies that manages a portfolio of investments in excess of $700 million, acquired a majority ownership of SASI in 1994. As part of the acquisition, Peter J. Smith, formerly a top executive with Digital Equipment Corporation, was named CEO of SASI and charged with leading the company through its next growth phase. The company recently changed its name to ANSYS Inc.

The ANSYS/ProFEA 5.0 software supports the following hardware:

- Various computers from Compaq, Digital, Hewlett-Packard, IBM, Silicon Graphics, and Sun. Operating systems supported include UNIX, OSF/1, and Windows NT.

ANSYS/ProFEA requires Pro/MESH and Pro/ENGINEER from Parametric Technology Corporation.

Supplier contact is as follows:

ANSYS Inc.
Johnson Road, P.O. Box 65
Houston, PA 15342-0065
Phone: 412-746-3304
Fax: 412-746-9494
Internet address: ansysinfo@swanson.com

By Mike Seely and Sharon Tan

For More Information...

Mike Seely, Director .... (408) 437-8178
Internet address .... mseely@dataquest.com
Via fax .... (408) 437-0292

Market Statistics

Dataquest

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Software

CAD/CAM/CAE and GIS Mechanical Forecast Update

Market Statistics

1994

Program: Mechanical Applications Worldwide
Product Code: CMEC-WW-MS-9404
Publication Date: September 5, 1994

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Software

CAD/CAM/CAE and GIS Mechanical Forecast Update

Market Statistics

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Note: All tables show estimated data.

CAD/CAM/CAE and GIS Mechanical Forecast Update

Fluctuating exchange rates masked true market performance in the 1993 CAD/CAM/CAE and GIS market. Japanese CAD/CAM/CAE and GIS total revenue grew a surprising 2.8 percent from 1992 to 1993 when measured in U.S. dollars, contrary to what would be expected in the worst recession Japan has experienced in 50 years. However, the dollar depreciated against the yen at a rate of 12.3 percent, so when measured in yen, Japanese CAD/CAM/CAE and GIS total revenue declined 9.8 percent from 1992 to 1993.

In the meantime, European CAD/CAM/CAE and GIS total revenue declined 7.8 percent from 1992 to 1993 when measured in U.S. dollars. With the dollar appreciating 10.0 percent against the ECU, European CAD/CAM/CAE and GIS total revenue grew 2.8 percent from 1992 to 1993 when measured in ECU. Table 1 shows the dramatic impact that currency fluctuation has on the CAD/CAM/CAE and GIS.

The yen has been strengthening against the dollar for the past three years, changing in 1993 at a rate twice that of previous years. And the end is not in sight. In contrast, Hong Kong and Singapore had relatively stable currency during 1993, while the currencies in China, Korea, and Taiwan weakened against the dollar. In Europe, 1993 was a year for weakening of local currencies against the dollar after having currencies strengthened against the dollar in 1992.

The midyear indications are that currencies are beginning to stabilize (see Table 2). 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 June exchange rate will apply for the future.

Dataquest's forecast is based on the updated market share data, gathered in March and April of this year. It includes country-level forecast for Asia and Europe.

This document contains Dataquest's detailed forecast information for the CAD/CAM/CAE and GIS industry. Included are the following:

- Five-year historical data
- Five-year forecast data

More detailed data is available through Dataquest's Client Inquiry service, which can provide custom analysis of the multidimensional database.

The CAD/CAM/CAE and GIS *Dataquest Perspective* (CCAM-WW-DP-9404), available in September, contains additional tables and analysis and is a companion piece to this book.

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

	1992	1993	Forecast 1998	Growth (%) 1992-1993	Growth (%) 1993-1998
Europe (U.S.$ Million)					
Software Revenue	1,693.8	1,608.7	2,231.4	-5.0	6.8
Hardware Revenue	3,037.8	2,701.7	3,388.8	-11.1	4.6
Service Revenue	1,106.6	1,072.2	1,381.4	-3.1	5.2
Total Factory Revenue	5,838.2	5,382.6	7,001.6	-7.8	5.4
ECU/U.S.$ Exchange Rate	*0.7686*	*0.8566*	*0.8419**	*11.4*	*-0.3*
Europe (ECU Million)					
Software Revenue	1,301.8	1,378.0	1,878.6	5.9	6.4
Hardware Revenue	2,334.9	2,314.3	2,853.0	-0.9	4.3
Service Revenue	850.5	918.5	1,163.0	8.0	4.8
Total Factory Revenue	4,487.3	4,610.8	5,894.6	2.8	5.0
Japan (U.S.$ Million)					
Software Revenue	1,270.4	1,371.2	2,010.2	7.9	8.0
Hardware Revenue	2,420.1	2,397.0	2,759.8	-1.0	2.9
Service Revenue	617.4	665.5	887.7	7.8	5.9
Total Factory Revenue	4,317.8	4,438.8	5,657.8	2.8	5.0
Yen/U.S.$ Exchange Rate	*126.34*	*110.85*	*101.56**	*-12.3*	*-1.7*
Japan (Yen Million)					
Software Revenue	160,506	152,001	204,155	-5.3	6.1
Hardware Revenue	305,752	265,706	280,289	-13.1	1.1
Service Revenue	78,000	73,768	90,158	-5.4	4.1
Total Factory Revenue	545,508	492,037	574,603	-9.8	3.2
North America (U.S.$ Million)					
Software Revenue	1,562.5	1,754.6	3,085.6	12.3	12.0
Hardware Revenue	2,672.1	2,824.5	4,477.9	5.7	9.7
Service Revenue	931.5	1,092.3	1,904.2	17.3	11.8
Total Factory Revenue	5,166.6	5,671.3	9,467.7	9.8	10.8
Worldwide (U.S.$ Million)					
Software Revenue	4,717.1	5,021.5	7,956.1	6.5	9.6
Hardware Revenue	8,424.4	8,308.7	11,367.1	-1.4	6.5
Service Revenue	2,776.3	2,989.5	4,496.3	7.7	8.5
Total Factory Revenue	15,928.3	16,325.7	23,819.0	2.5	7.8

*Assuming a stable currency, the 1998 exchange rate is the June 1994 exchange rate.
Source: Dataquest (September 1994)

Table 2
Foreign Currency/U.S. Dollar

		Actual				Current	Current	Year-to-Year Change (%)				
		1990	1991	1992	1993	1994	1995-1998	1990-1991	1991-1992	1992-1993	1993-1994	1994-1995
European Community	ECU	NA	0.8079	0.7686	0.8566	0.8561	0.8419		-5	11	0	-2
France	Franc	5.4277	5.6183	5.2571	5.6641	5.6343	5.5346	4	-6	8	-1	-2
Germany	Mark	1.6111	1.6523	1.5513	1.6543	1.6485	1.6163	3	-6	7	0	-2
Italy	Lira	1195.03	1235.03	1220.85	1575.05	1610.71	1584.79	3	-1	29	2	-2
Netherlands	Guilder	1.81	1.86	1.75	1.86	1.85	1.8126	3	-6	6	0	-2
Spain	Peseta	101.70	103.48	101.50	127.10	135.40	133.39	2	-2	25	7	-1
Sweden	Krona	5.9137	6.0314	5.7770	7.8003	7.7955	7.7340	2	-4	35	0	-1
United Kingdom	Pound	0.5599	0.5658	0.5652	0.6665	0.6604	0.6549	1	0	18	-1	-1
China	Renminbi	4.7912	5.3340	5.5076	5.7580	8.5534	8.6895	11	3	5	49	2
Hong Kong	Dollar	7.7900	7.7712	7.7399	7.7351	7.7271	7.7280	0	0	0	0	0
Japan	Yen	144.05	134.59	126.34	110.85	103.08	101.56	-7	-6	-12	-7	-1
Korea	Won	242.70	730.67	782.41	799.42	806.49	805.80	201	7	2	1	0
Singapore	Dollar	1.8129	1.7277	1.6284	1.6155	1.5481	1.5300	-5	-6	-1	-4	-1
Taiwan	Dollar	26.64	26.49	24.93	26.15	26.77	26.98	-1	-6	5	2	1

NA = Not applicable

Source: Dataquest (September 1994)

A new forecasting process for each application is being used to improve revenue and unit shipment control by region and by platform. This new process may cause some mismatch in market share tables and forecast tables. Please use the forecast tables to understand the year-to-year changes. Use the market share tables to compare company-to-company performance.

Forecast Methodology

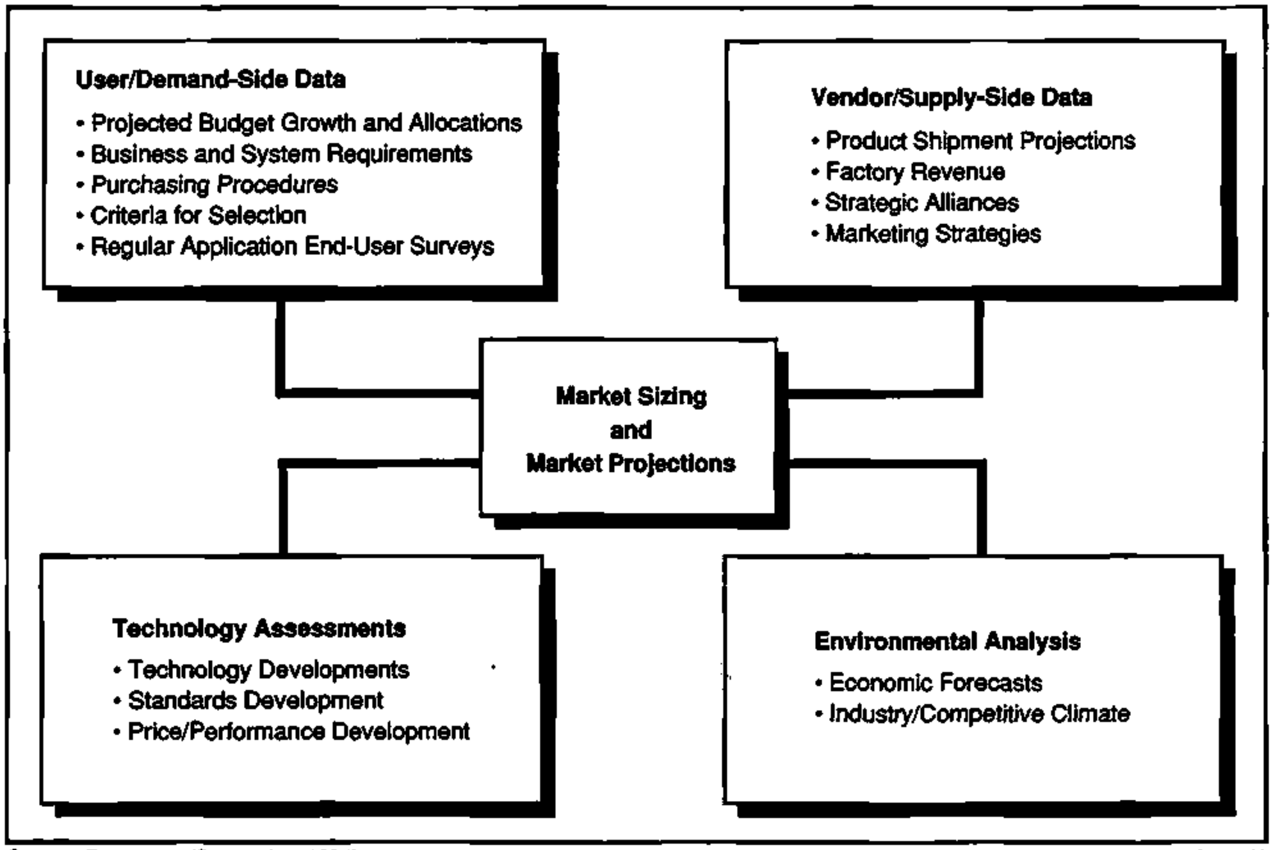
Fundamental to the way Dataquest conducts its research is the underlying philosophy that the best data and analyses come from a well-balanced program. This program includes the following: balance between primary and secondary collection techniques; balance between supply-side and demand-side analysis; 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 macro environment, which can have major influences on both supply-side and demand-side forecasting. In addition to demographics, analysts look at gross national product (GNP) growth, interest rate fluctuation, business expectations, and capital spending plans. In the geopolitical arena, the group looks at trade issues, political stability or lack thereof, tariffs, nontariff barriers, and such factors as the effect on Europe of the events of 1994.

Figure 1 shows the CAD/CAM/CAE and GIS forecasting model. The overall forecasting process uses a combination of techniques such as time series and technological modeling. Market estimates and forecasts are derived using the following research techniques:

- "Bottom-up" aggregation—This method involves adding all relevant vendor contributions to arrive at total market estimates for all historical data.
- Segment forecasting—For each application segment tracked by the CAD/CAM/CAE and GIS group, individual forecasts are derived following the basic information model defined previously. Specifically, each design phase covered within each application is segmented by product, region, and platform. 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. Installed base is also evaluated. Rates of product retirement are primarily based on input from end users in our ongoing survey programs. Dataquest analysts also factor in the acceptance or ability for users to consume new technology.

Figure 1
CAD/CAM/CAE and GIS Forecasting Model



Source: Dataquest (September 1994) G3000529

- 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.

Segmentation Definitions

This section lists the definitions specific to this document. The following paragraphs define the segments.

Applications

Mechanical

The mechanical segment refers to computer-aided tools used by engineers, designers, analysts, technicians, and draftspeople working predominantly in the discrete manufacturing industries, but includes government and education. Users of mechanical CAD/CAM/CAE tools work in all departments across the typical organization, with a majority found in product design, advanced engineering, and manufacturing engineering. Common design applications include conceptual design, industrial design, structural or thermal analysis, detail design, and electromechanical design (the mechanical part of design with electrical or electronic components and mechanisms). Common manufacturing applications include tool and fixture design, numerical control part programming, off-line robotics programming, and interface to quality-control systems. Management tools for database control and distribution are included in this segment, as well as user-defined application programming.

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 is composed of 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 process of designing 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 ECAE 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), design verification tools (DRC/ERC/logic-to-layout), compilers, and module development tools.
- PCB/hybrid/MCM—This segment covers products used to create the placement and routing of the traces and components laid out on a printed circuit board. Also included in this category are thermal analysis tools.

Regions

The following paragraphs define the regions.

North America

North America includes United States, Mexico, and Canada.

Europe

Europe includes the United Kingdom, Scandinavia, Benelux, France, Germany, Italy, Spain, and Rest of Europe (which includes Austria, Switzerland, and eastern Europe)

Asia

Asia includes Japan, Singapore, Taiwan, Korea, China, and Hong Kong.

Rest of World

Rest of World includes all other countries and regions, including Australia, New Zealand, Oceania, Africa, Central America, South America, and the Middle East.

Platforms

The following paragraphs define the platforms.

Technical Workstation

A technical workstation is a single-user computer distinguished from a personal computer by its features and by the user's potential range of expansion on the platform. Features include a virtual, multitasking operating system (UNIX, VMS, or Domain); the computer is designed by the manufacturer to run high-performance graphics applications in a multiuser/multitasking environment.

Host-Dependent

Host-dependent is a shared logic system in which the external workstations' functions are dependent on a host computer.

Server

A server is a computer that transparently provides its resources for use by other computer systems. It is a system on a network that provides specific functionality to other computer systems: the clients. Functions include file storage, database access, and compute capability. Dataquest tracks the following major categories of servers used for CAD/CAM/CAE and GIS applications:

- Compute servers—These systems provide capabilities for solving numerical problems (for example, simulations, statistical calculations, and simultaneous partial differential equations). System features usually include high-speed computational capabilities (for example, vector and parallel processing) and large memories.
- Print servers—These systems provide access to printers, specialized printing applications software, and print-spooling resources to a network.
- File servers—These systems provide mass storage capability to clients on a network. Services can range from temporary storage of working files to long-term backup and archive systems.
- Database servers—These systems manage databases as a shared resource to a network. These servers handle such functions as physical data storage, data security, and high-level queries and can access stored information at the record level.

Personal Computer

A personal computer is a single-user computer distinguished from a technical workstation by its features and by the user's potential range of expansion on the platform. Features found in technical workstations (such as a virtual operating system, networking, high-performance graphics, multiuser/multitasking capability) are optional rather than integrated by the manufacturer.

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. (In the case of technical workstations and personal computers, CPU revenue contains the terminal revenue.)
- 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 of a 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-dependent platform, as terminal revenue is contained within CPU revenue for technical workstations and PCs.
- Software revenue is revenue derived from the sale of bundled (part of a turnkey system) and unbundled software.
- Service revenue is defined as revenue derived from the service and support of CAD/CAM/CAE or GIS systems. Service revenue can be calculated in the tables by subtracting hardware and software revenue from total revenue.
- Total factory revenue is defined as the amount of money received by a manufacturer for its goods measured in U.S. dollars and is the sum of hardware, software, and service revenue. Total factory revenue does not include revenue that a company may receive from products sold to another company for resale (OEM revenue).

Table 3
CAD/CAM/CAE/GIS History and Forecast Update

Application: Mechanical
Region: Worldwide
Platform: All Platforms

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	204,241	206,893	248,442	282,000	286,391	306,100	326,900	347,100	368,600	387,700	9	6
Unit Shipments or Seats	227,107	223,921	271,250	303,287	304,002	321,300	340,900	359,900	380,700	399,200	8	6
CPU Installed Base	494,735	660,153	839,145	1,018,312	1,165,399	1,275,900	1,383,100	1,505,900	1,626,500	1,726,200	24	8
Installed Seats	609,499	785,708	977,920	1,164,526	1,311,079	1,415,600	1,514,500	1,627,600	1,736,600	1,825,100	21	7
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	68.0	63.7	53.7	50.2	43.4	40.0	37.8	35.8	34.3	33.2	-11	-5
Hardware-Only ASP	8.9	9.2	7.7	9.4	9.7	10.1	10.2	10.3	10.3	10.4	2	1
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	3,764	3,981	3,955	4,401	4,177	4,283	4,390	4,509	4,660	4,809	3	3
CPU Revenue	2,855	3,070	3,148	3,621	3,529	3,671	3,809	3,958	4,129	4,293	5	4
Terminal Revenue	438	381	328	302	242	220	203	187	179	173	-14	-7
Peripheral Revenue (Turnkey)	470	529	478	478	405	392	379	364	352	344	-4	-3
Software Revenue	1,557	1,892	2,021	2,170	2,295	2,450	2,620	2,783	2,954	3,125	10	6
Bundled	930	1,115	1,093	1,159	1,118	1,115	1,128	1,126	1,119	1,112	5	-0
Unbundled	627	777	928	1,011	1,176	1,335	1,492	1,657	1,835	2,013	17	11
Service Revenue	999	1,197	1,186	1,408	1,390	1,438	1,507	1,572	1,655	1,735	9	5
Total Factory Revenue	6,319	7,071	7,162	7,979	7,862	8,170	8,517	8,864	9,269	9,669	6	4
Increase over Prior Year (%)	11	12	1	11	-1	4	4	4	5	4		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.
Source: Dataquest (August 1994)

Table 4
CAD/CAM/CAE/GIS History and Forecast Update

Application: Mechanical
Region: Worldwide
Platform: Technical Workstation

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	48,062	56,728	65,644	79,360	87,517	97,900	107,700	117,600	127,900	138,500	16	10
Unit Shipments or Seats	48,062	56,728	65,644	79,360	87,518	97,900	107,700	117,600	127,900	138,500	16	10
CPU Installed Base	106,143	157,111	211,921	273,701	334,634	396,600	457,600	517,600	577,600	628,600	33	13
Installed Seats	106,143	157,111	211,921	273,701	334,634	396,600	457,600	517,600	577,600	628,600	33	13
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	52.5	47.4	45.5	49.1	46.7	44.5	42.3	40.4	38.9	37.7	-3	-4
Hardware-Only ASP	21.5	23.8	20.6	23.4	23.3	22.3	21.4	20.5	19.7	19.0	2	-4
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	1,527	1,694	1,774	2,220	2,328	2,427	2,499	2,570	2,656	2,746	11	3
CPU Revenue	1,240	1,376	1,469	1,867	2,028	2,135	2,218	2,301	2,396	2,493	13	4
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	287	318	304	353	300	292	281	269	260	253	1	-3
Software Revenue	803	1,026	1,185	1,371	1,535	1,691	1,828	1,961	2,094	2,229	18	8
Bundled	528	625	692	828	819	838	851	851	846	840	12	1
Unbundled	274	401	493	543	716	853	978	1,109	1,247	1,389	27	14
Service Revenue	540	638	661	934	1,009	1,057	1,110	1,158	1,217	1,275	17	5
Total Factory Revenue	2,869	3,358	3,620	4,525	4,872	5,175	5,437	5,689	5,967	6,250	14	5
Increase over Prior Year (%)	47	17	8	25	8	6	5	5	5	5		

NA = Not applicable

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.

Source: Dataquest (August 1994)

Table 5
CAD/CAM/CAE/GIS History and Forecast Update

Application: Mechanical
Region: Worldwide
Platform: Host-Dependent

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	7,652	7,969	5,801	4,586	4,238	3,900	3,900	3,900	4,000	4,200	-14	-0
Unit Shipments or Seats	30,518	24,997	28,609	25,873	21,848	19,100	17,900	16,700	16,100	15,700	-8	-6
CPU Installed Base	27,661	33,775	36,849	37,906	38,045	37,300	35,900	34,600	33,900	33,400	8	-3
Installed Seats	142,425	159,329	175,624	184,120	183,725	177,000	167,400	156,300	144,000	132,200	7	-6
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	324.8	388.6	299.3	279.6	206.6	191.1	175.4	161.6	147.9	136.4	-11	-8
Hardware-Only ASP	153.3	129.6	268.3	327.2	283.3	265.4	251.1	236.6	223.0	210.8	17	-6
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	1,566	1,633	1,412	1,144	809	706	658	610	582	566	-15	-7
CPU Revenue	1,006	1,111	975	777	519	448	419	389	372	362	-15	-7
Terminal Revenue	438	381	328	302	242	220	203	187	179	173	-14	-7
Peripheral Revenue (Turnkey)	122	141	109	64	48	38	36	34	32	31	-21	-8
Software Revenue	433	527	375	266	231	191	177	162	153	146	-15	-9
Bundled	313	408	276	198	163	132	123	114	107	103	-15	-9
Unbundled	120	119	100	68	68	59	54	49	46	43	-13	-9
Service Revenue	403	505	417	330	215	184	175	163	157	154	-15	-6
Total Factory Revenue	2,403	2,665	2,205	1,740	1,255	1,082	1,010	936	892	866	-15	-7
Increase over Prior Year (%)	-15	11	-17	-21	-28	-14	-7	-7	-5	-3		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.

Source: Dataquest (August 1994)

Table 6
CAD/CAM/CAE/GIS History and Forecast Update

Application: Mechanical
Region: Worldwide
Platform: Server

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	NA	NA	3,188	6,104	6,758	8,500	9,900	11,500	13,000	14,400	NA	16
Unit Shipments or Seats	NA	NA	3,188	6,104	6,758	8,500	9,900	11,500	13,000	14,400	NA	16
CPU Installed Base	NA	NA	3,188	9,291	15,683	23,200	30,800	38,800	45,400	51,900	NA	27
Installed Seats	NA	NA	3,188	9,291	15,683	23,200	30,800	38,800	45,400	51,900	NA	27
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	NA	NA	69.1	82.1	67.9	63.9	60.9	58.8	57.3	56.0	NA	-4
Hardware-Only ASP	NA	NA	48.4	52.5	55.6	55.6	54.5	53.9	53.4	53.0	NA	-1
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	NA	NA	150	321	359	446	506	580	648	711	NA	15
CPU Revenue	NA	NA	137	311	349	436	496	570	639	703	NA	15
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	NA	NA	12	10	10	10	10	9	9	8	NA	-3
Software Revenue	NA	NA	39	54	65	75	86	97	106	113	NA	12
Bundled	NA	NA	26	32	36	42	48	52	56	58	NA	10
Unbundled	NA	NA	13	22	28	33	39	45	50	55	NA	14
Service Revenue	NA	NA	59	90	105	131	150	173	195	216	NA	15
Total Factory Revenue	NA	NA	248	466	529	652	743	850	949	1,040	NA	14
Increase over Prior Year (%)	NA	NA	NA	88	14	23	14	14	12	10		

NA = Not applicable
Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.
Source: Dataquest (August 1994)

Table 7
CAD/CAM/CAE/GIS History and Forecast Update

Application: Mechanical
Region: Worldwide
Platform: Personal Computer

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	148,527	142,197	173,809	191,950	187,878	195,800	205,400	214,000	223,700	230,600	6	4
Unit Shipments or Seats	148,527	142,197	173,809	191,950	187,878	195,800	205,400	214,000	223,700	230,600	6	4
CPU Installed Base	360,931	469,268	587,187	697,413	777,037	818,800	858,800	914,900	969,500	1,012,400	21	5
Installed Seats	360,931	469,268	587,187	697,413	777,037	818,800	858,800	914,900	969,500	1,012,400	21	5
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	21.0	20.1	15.4	13.6	13.1	12.6	12.1	11.7	11.4	11.2	-11	-3
Hardware-Only ASP	3.8	3.6	2.8	3.1	2.9	2.9	3.0	3.0	3.0	2.9	-7	0
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	671	654	619	717	681	704	728	749	774	786	0	3
CPU Revenue	609	584	566	666	633	653	676	697	722	735	1	3
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	62	71	53	51	49	51	52	52	52	51	-6	1
Software Revenue	321	339	422	479	464	493	528	563	602	636	10	7
Bundled	88	82	99	100	99	103	107	109	110	111	3	2
Unbundled	233	258	323	378	364	389	422	454	492	526	12	8
Service Revenue	55	54	49	53	61	65	72	78	85	91	3	8
Total Factory Revenue	1,047	1,047	1,089	1,249	1,206	1,262	1,328	1,390	1,461	1,513	4	5
Increase over Prior Year (%)	17	0	4	15	-3	5	5	5	5	4		

NA = Not applicable
Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.
Source: Dataquest (August 1994)

Table 8
CAD/CAM/CAE/GIS History and Forecast Update

Application: Mechanical
Region: North America
Platform: **All Platforms**

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	74,581	72,256	74,622	91,728	106,601	117,200	126,800	134,900	141,800	146,900	9	7
Unit Shipments or Seats	82,000	79,914	83,649	98,762	111,307	121,200	130,500	138,300	145,100	150,100	8	6
CPU Installed Base	202,942	254,373	297,984	347,091	400,353	446,500	497,500	556,300	611,500	653,700	19	10
Installed Seats	254,403	308,741	354,829	403,130	452,246	493,100	538,700	592,300	641,900	679,300	15	8
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	77.3	81.4	60.0	57.9	46.1	42.2	39.6	37.7	36.2	35.0	-12	-5
Hardware-Only ASP	9.6	9.9	9.4	8.9	8.8	9.0	9.1	9.2	9.2	9.2	-2	1
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	1,184	1,179	1,075	1,146	1,184	1,254	1,328	1,387	1,438	1,470	0	4
CPU Revenue	908	888	837	964	1,062	1,147	1,229	1,294	1,350	1,384	4	5
Terminal Revenue	161	166	143	97	62	54	50	47	45	44	-21	-6
Peripheral Revenue (Turnkey)	114	124	95	84	60	54	50	46	43	42	-15	-7
Software Revenue	463	560	527	576	687	761	830	892	950	995	10	8
Bundled	196	238	188	199	180	166	160	153	149	146	-2	-4
Unbundled	268	322	339	377	507	595	671	739	801	850	17	11
Service Revenue	335	353	308	384	415	446	480	510	542	565	5	6
Total Factory Revenue	1,983	2,092	1,910	2,106	2,285	2,461	2,639	2,788	2,930	3,030	4	6
Increase over Prior Year (%)	14	6	-9	10	8	8	7	6	5	3		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.
Source: Dataquest (August 1994)

Table 9
CAD/CAM/CAE/GIS History and Forecast Update

Application: Mechanical
Region: North America
Platform: Technical Workstation

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	15,552	16,348	19,032	24,305	30,652	35,600	40,000	44,300	48,800	52,600	18	11
Unit Shipments or Seats	15,552	16,348	19,032	24,305	30,652	35,600	40,000	44,300	48,800	52,600	18	11
CPU Installed Base	38,350	52,053	66,827	84,754	106,486	130,600	155,900	181,900	208,400	231,300	29	17
Installed Seats	38,350	52,053	66,827	84,754	106,486	130,600	155,900	181,900	208,400	231,300	29	17
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	51.1	47.3	40.1	41.6	36.4	34.3	32.4	30.8	29.5	28.5	-8	-5
Hardware-Only ASP	21.7	21.0	18.8	20.3	21.3	20.5	19.6	18.9	18.1	17.4	-0	-4
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	468	442	439	547	671	734	785	829	873	905	9	6
CPU Revenue	394	373	383	487	629	698	752	799	846	879	12	7
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	74	70	56	60	42	36	33	29	27	26	-13	-9
Software Revenue	227	297	313	354	447	511	564	612	659	695	18	9
Bundled	115	132	121	144	130	121	116	110	107	104	3	-4
Unbundled	112	165	192	210	317	390	448	502	552	591	30	13
Service Revenue	192	181	166	253	306	337	365	390	418	438	12	7
Total Factory Revenue	887	921	918	1,154	1,424	1,582	1,714	1,831	1,950	2,038	13	7
Increase over Prior Year (%)	54	4	-0	26	23	11	8	7	6	5		

NA = Not applicable

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.

Source: Dataquest (August 1994)

Table 10
CAD/CAM/CAE/GIS History and Forecast Update

Application: Mechanical
Region: North America
Platform: Host-Dependent

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	2,480	2,667	1,450	988	832	800	800	800	800	800	-24	-1
Unit Shipments or Seats	9,899	10,325	10,477	8,022	5,538	4,700	4,400	4,200	4,100	4,100	-14	-6
CPU Installed Base	11,867	13,250	13,188	12,428	11,595	10,600	9,600	8,700	8,100	7,600	-1	-8
Installed Seats	63,328	67,618	70,033	68,466	63,487	57,300	50,800	44,600	38,500	33,100	0	-12
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	483.8	541.8	339.0	389.2	319.7	291.1	267.2	245.0	224.3	206.3	-10	-8
Hardware-Only ASP	146.1	141.1	301.7	294.9	221.2	210.1	199.6	189.6	180.1	171.1	11	-5
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	509	551	410	299	191	162	150	141	137	134	-22	-7
CPU Revenue	314	342	242	188	121	102	94	89	86	85	-21	-7
Terminal Revenue	161	166	143	97	62	54	50	47	45	44	-21	-6
Peripheral Revenue (Turnkey)	33	43	26	14	8	6	6	5	5	5	-30	-8
Software Revenue	135	158	92	71	63	53	48	45	43	41	-17	-8
Bundled	78	103	55	42	34	27	25	23	23	22	-19	-8
Unbundled	57	55	37	29	29	26	24	21	20	19	-15	-8
Service Revenue	128	161	110	92	56	48	44	42	41	40	-19	-6
Total Factory Revenue	772	870	612	461	310	263	242	228	220	216	-20	-7
Increase over Prior Year (%)	-15	13	-30	-25	-33	-15	-8	-6	-3	-2		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.

Source: Dataquest (August 1994)

Table 11
CAD/CAM/CAE/GIS History and Forecast Update

Application: Mechanical
Region: North America
Platform: Server

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	NA	NA	1,382	3,040	3,350	4,000	4,600	5,100	5,400	5,600	NA	11
Unit Shipments or Seats	NA	NA	1,382	3,040	3,350	4,000	4,600	5,100	5,400	5,600	NA	11
CPU Installed Base	NA	NA	1,382	4,422	7,590	11,100	14,500	18,000	20,300	22,200	NA	24
Installed Seats	NA	NA	1,382	4,422	7,590	11,100	14,500	18,000	20,300	22,200	NA	24
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	NA	NA	63.7	64.1	50.4	47.3	44.7	42.5	40.8	39.4	NA	-5
Hardware-Only ASP	NA	NA	50.3	42.7	45.5	44.6	43.7	42.8	41.9	41.1	NA	-2
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	NA	NA	65	128	143	165	187	203	211	214	NA	8
CPU Revenue	NA	NA	61	125	140	162	185	200	209	212	NA	9
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	NA	NA	4	3	3	3	3	2	2	2	NA	-10
Software Revenue	NA	NA	18	23	29	34	40	44	46	47	NA	10
Bundled	NA	NA	10	10	12	14	16	16	16	15	NA	4
Unbundled	NA	NA	8	13	17	20	24	28	30	32	NA	14
Service Revenue	NA	NA	27	34	41	47	55	60	63	65	NA	10
Total Factory Revenue	NA	NA	109	186	213	247	282	306	320	326	NA	9
Increase over Prior Year (%)	NA	NA	NA	70	15	16	14	9	4	2		

NA = Not applicable
Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.
Source: Dataquest (August 1994)

Table 12
CAD/CAM/CAE/GIS History and Forecast Update

Application: Mechanical
Region: North America
Platform: Personal Computer

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	56,550	53,240	52,758	63,395	71,767	76,900	81,400	84,700	86,900	87,800	6	4
Unit Shipments or Seats	56,550	53,240	52,758	63,395	71,767	76,900	81,400	84,700	86,900	87,800	6	4
CPU Installed Base	152,725	189,070	216,587	245,487	274,683	294,200	317,500	347,800	374,700	392,600	16	7
Installed Seats	152,725	189,070	216,587	245,487	274,683	294,200	317,500	347,800	374,700	392,600	16	7
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	11.0	19.7	13.0	12.9	12.7	12.3	11.8	11.4	11.1	10.9	4	-3
Hardware-Only ASP	3.6	3.4	3.0	2.7	2.5	2.5	2.5	2.5	2.5	2.4	-9	-0
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	207	185	161	172	179	193	206	214	218	217	-4	4
CPU Revenue	200	174	151	164	172	186	198	206	209	209	-4	4
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	7	12	10	8	7	8	8	9	9	9	1	3
Software Revenue	101	105	104	128	147	163	178	191	202	211	10	7
Bundled	3	3	2	3	3	3	4	4	4	4	-1	5
Unbundled	98	102	102	125	144	160	174	187	198	207	10	8
Service Revenue	16	11	5	6	12	14	16	18	20	21	-7	13
Total Factory Revenue	324	301	270	305	338	370	400	423	440	450	1	6
Increase over Prior Year (%)	22	-7	-10	13	11	9	8	6	4	2		

NA = Not applicable

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.

Source: Dataquest (August 1994)

Table 13
CAD/CAM/CAE/GIS History and Forecast Update

Application: Mechanical
Region: Europe
Platform: All Platforms

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	70,635	68,539	86,288	97,420	93,010	96,000	100,800	105,800	110,600	114,700	7	4
Unit Shipments or Seats	80,256	74,103	94,937	105,794	99,083	101,400	105,800	110,500	115,000	119,000	5	4
CPU Installed Base	176,037	231,709	293,998	355,075	399,074	428,000	454,800	485,300	512,900	532,900	23	6
Installed Seats	216,161	276,498	345,483	410,973	454,898	481,500	505,100	531,800	555,200	571,000	20	5
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	75.2	69.1	63.4	58.0	42.0	37.6	35.2	33.0	31.4	30.2	-14	-6
Hardware-Only ASP	10.2	10.7	9.0	11.3	11.3	12.0	12.2	12.7	13.2	13.8	3	4
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	1,512	1,520	1,624	1,724	1,449	1,450	1,474	1,527	1,597	1,672	-1	3
CPU Revenue	1,146	1,201	1,321	1,432	1,230	1,247	1,284	1,349	1,426	1,506	2	4
Terminal Revenue	186	130	119	121	97	91	84	80	78	77	-15	-5
Peripheral Revenue (Turnkey)	180	188	184	171	123	112	105	98	93	88	-9	-6
Software Revenue	614	760	865	873	782	792	830	870	912	955	6	4
Bundled	380	474	512	479	409	394	393	384	376	370	2	-2
Unbundled	234	287	353	394	373	398	437	486	536	585	12	9
Service Revenue	443	561	603	640	594	592	609	631	664	699	8	3
Total Factory Revenue	2,569	2,841	3,093	3,238	2,826	2,834	2,912	3,028	3,173	3,325	2	3
Increase over Prior Year (%)	20	11	9	5	-13	0	3	4	5	5		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.
Source: Dataquest (August 1994)

Table 14
CAD/CAM/CAE/GIS History and Forecast Update

Application: Mechanical
Region: Europe
Platform: Technical Workstation

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	20,458	24,054	29,462	33,250	31,424	32,600	34,800	37,300	40,100	43,100	11	7
Unit Shipments or Seats	20,458	24,054	29,462	33,250	31,425	32,600	34,800	37,300	40,100	43,100	11	7
CPU Installed Base	45,532	67,318	92,231	117,981	137,934	155,000	170,000	183,600	197,000	207,400	32	8
Installed Seats	45,532	67,318	92,231	117,981	137,934	155,000	170,000	183,600	197,000	207,400	32	8
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	53.6	49.1	46.5	48.7	42.6	40.0	37.8	35.9	34.5	33.3	-6	-5
Hardware-Only ASP	20.2	25.6	21.4	25.5	25.6	24.5	23.6	22.6	21.7	20.8	6	-4
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	661	737	801	924	808	780	781	791	812	839	5	1
CPU Revenue	550	624	682	796	713	695	702	720	745	776	7	2
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	110	113	119	129	95	85	78	72	67	63	-4	-8
Software Revenue	350	466	567	616	552	563	592	623	658	695	12	5
Bundled	234	303	356	382	331	320	316	307	299	293	9	-2
Unbundled	116	164	211	234	221	243	275	317	358	401	17	13
Service Revenue	262	340	372	453	451	442	450	459	475	493	15	2
Total Factory Revenue	1,273	1,542	1,740	1,993	1,811	1,785	1,822	1,873	1,944	2,027	9	2
Increase over Prior Year (%)	48	21	13	15	-9	-1	2	3	4	4		

NA = Not applicable

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.

Source: Dataquest (August 1994)

Table 15
CAD/CAM/CAE/GIS History and Forecast Update

Application: Mechanical
Region: Europe
Platform: Host-Dependent

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	2,450	2,438	2,040	1,310	1,074	1,100	1,000	1,000	1,100	1,100	-19	0
Unit Shipments or Seats	12,071	8,001	10,688	9,684	7,147	6,400	6,100	5,700	5,500	5,400	-12	-5
CPU Installed Base	9,281	11,380	12,662	12,835	12,412	11,800	11,100	10,500	10,000	9,600	8	-5
Installed Seats	49,405	56,170	64,146	68,733	68,236	65,400	61,400	57,000	52,300	47,800	8	-7
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	459.1	478.9	383.7	438.8	353.6	322.4	296.0	271.4	248.4	228.5	-6	-8
Hardware-Only ASP	166.2	133.8	225.3	302.4	261.7	246.7	234.6	223.4	212.5	202.2	12	-5
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	607	560	554	428	280	255	239	225	217	212	-18	-5
CPU Revenue	381	383	392	286	174	156	147	138	132	129	-18	-6
Terminal Revenue	186	130	119	121	97	91	84	80	78	77	-15	-5
Peripheral Revenue (Turnkey)	39	47	43	21	10	8	8	7	7	7	-29	-8
Software Revenue	157	191	155	88	64	53	49	46	42	41	-20	-9
Bundled	128	159	123	67	43	34	33	30	27	26	-24	-9
Unbundled	29	32	32	21	21	19	17	16	15	15	-8	-7
Service Revenue	162	201	188	129	73	65	61	58	56	55	-18	-6
Total Factory Revenue	926	952	897	644	417	373	349	328	315	308	-18	-6
Increase over Prior Year (%)	-5	3	-6	-28	-35	-11	-6	-6	-4	-2		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.

Source: Dataquest (August 1994)

Table 16
CAD/CAM/CAE/GIS History and Forecast Update

Application: Mechanical
Region: Europe
Platform: Server

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	NA	NA	1,060	2,246	2,537	3,400	4,000	5,000	6,000	7,100	NA	23
Unit Shipments or Seats	NA	NA	1,060	2,246	2,537	3,400	4,000	5,000	6,000	7,100	NA	23
CPU Installed Base	NA	NA	1,060	3,305	5,707	8,800	11,900	15,600	19,100	23,000	NA	32
Installed Seats	NA	NA	1,060	3,305	5,707	8,800	11,900	15,600	19,100	23,000	NA	32
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	NA	NA	78.3	81.8	65.9	62.1	58.6	55.6	53.4	51.5	NA	-5
Hardware-Only ASP	NA	NA	56.0	66.1	68.5	66.7	65.4	64.1	62.9	61.6	NA	-2
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	NA	NA	56	142	158	207	240	293	348	404	NA	21
CPU Revenue	NA	NA	52	138	154	203	236	289	345	400	NA	21
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	NA	NA	5	4	4	4	4	4	3	3	NA	-4
Software Revenue	NA	NA	11	17	18	21	24	28	31	34	NA	14
Bundled	NA	NA	10	14	14	17	19	21	23	24	NA	11
Unbundled	NA	NA	1	3	3	4	5	7	8	10	NA	23
Service Revenue	NA	NA	24	41	47	61	71	87	103	119	NA	20
Total Factory Revenue	NA	NA	91	199	223	289	336	407	483	557	NA	20
Increase over Prior Year (%)	NA	NA	NA	120	12	30	16	21	19	15		

NA = Not applicable

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.

Source: Dataquest (August 1994)

Table 17
CAD/CAM/CAE/GIS History and Forecast Update

Application: Mechanical
Region: Europe
Platform: Personal Computer

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	47,727	42,047	53,727	60,615	57,975	59,000	60,900	62,400	63,400	63,400	5	2
Unit Shipments or Seats	47,727	42,047	53,727	60,615	57,975	59,000	60,900	62,400	63,400	63,400	5	2
CPU Installed Base	121,225	153,010	188,046	220,954	243,020	252,400	261,900	275,600	286,800	292,900	19	4
Installed Seats	121,225	153,010	188,046	220,954	243,020	252,400	261,900	275,600	286,800	292,900	19	4
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	28.6	25.0	24.7	20.1	12.1	11.0	10.6	10.3	10.1	9.9	-19	-4
Hardware-Only ASP	4.2	4.4	3.5	3.3	3.0	3.0	3.0	3.0	3.0	3.0	-8	0
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	244	223	213	230	203	208	214	218	220	216	-4	1
CPU Revenue	215	194	196	213	189	193	199	203	204	201	-3	1
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	30	29	18	17	14	15	15	16	16	15	-17	1
Software Revenue	107	104	132	153	149	155	164	173	181	186	9	5
Bundled	18	12	22	17	21	23	24	26	26	27	3	5
Unbundled	89	91	110	136	128	132	140	148	154	159	10	4
Service Revenue	19	20	20	18	23	24	26	28	30	31	4	7
Total Factory Revenue	370	347	366	401	375	387	405	419	430	433	0	3
Increase over Prior Year (%)	25	-6	5	10	-7	3	5	4	3	1		

NA = Not applicable

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.

Source: Dataquest (August 1994)

Table 18
CAD/CAM/CAE/GIS History and Forecast Update

Application:	Mechanical
Region:	Asia
Platform:	All Platforms

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	55,956	62,959	82,579	87,149	79,070	83,800	88,900	94,600	103,300	112,300	9	7
Unit Shipments or Seats	61,266	66,226	87,102	92,403	85,584	89,300	93,900	99,100	107,300	116,000	9	6
CPU Installed Base	108,686	164,506	233,626	298,333	342,515	372,000	395,000	421,500	452,400	483,800	33	7
Installed Seats	129,719	188,485	261,349	329,570	377,442	408,600	432,000	458,100	487,500	517,000	31	6
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	57.3	53.3	44.3	42.5	43.5	41.0	39.1	37.3	35.9	34.8	-7	-4
Hardware-Only ASP	5.4	5.8	4.0	7.7	10.1	10.7	10.5	10.3	9.9	9.7	17	-1
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	1,009	1,231	1,190	1,457	1,469	1,501	1,506	1,507	1,532	1,573	10	1
CPU Revenue	760	946	941	1,164	1,176	1,211	1,225	1,239	1,273	1,319	12	2
Terminal Revenue	79	73	56	77	79	72	65	57	51	48	0	-10
Peripheral Revenue (Turnkey)	170	212	193	216	214	218	216	212	208	206	6	-1
Software Revenue	462	554	601	683	787	854	911	968	1,035	1,113	14	7
Bundled	343	394	380	459	509	534	553	566	571	572	10	2
Unbundled	118	160	221	225	278	320	359	402	464	541	24	14
Service Revenue	205	269	256	353	351	369	384	396	413	434	14	4
Total Factory Revenue	1,676	2,054	2,046	2,493	2,607	2,723	2,801	2,871	2,980	3,120	12	4
Increase over Prior Year (%)	-3	23	-0	22	5	4	3	2	4	5		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.
Source: Dataquest (August 1994)

Table 19
CAD/CAM/CAE/GIS History and Forecast Update

Application: Mechanical
Region: Asia
Platform: Technical Workstation

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	11,417	15,663	16,025	20,545	23,995	28,200	31,200	34,200	37,200	40,700	20	11
Unit Shipments or Seats	11,417	15,663	16,025	20,545	23,995	28,200	31,200	34,200	37,200	40,700	20	11
CPU Installed Base	20,479	35,412	49,615	66,748	84,972	104,700	124,600	143,900	163,300	180,300	43	16
Installed Seats	20,479	35,412	49,615	66,748	84,972	104,700	124,600	143,900	163,300	180,300	43	16
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	52.6	45.8	48.5	54.0	57.8	54.3	51.3	48.8	46.8	45.2	2	-5
Hardware-Only ASP	25.6	29.1	24.3	28.5	25.3	24.3	23.3	22.3	21.4	20.6	-0	-4
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	379	499	509	717	812	877	897	914	934	966	21	4
CPU Revenue	281	367	383	558	655	712	732	751	773	807	24	4
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	99	132	126	160	158	166	165	164	161	159	12	0
Software Revenue	217	254	288	379	515	595	649	700	751	812	24	10
Bundled	173	184	205	286	343	381	401	417	423	425	19	4
Unbundled	44	69	83	94	173	214	247	283	329	388	41	18
Service Revenue	79	111	113	210	229	254	270	284	300	318	31	7
Total Factory Revenue	675	864	910	1,306	1,557	1,727	1,816	1,899	1,986	2,096	23	6
Increase over Prior Year (%)	38	28	5	44	19	11	5	5	5	6		

NA = Not applicable
Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.
Source: Dataquest (August 1994)

Table 20
CAD/CAM/CAE/GIS History and Forecast Update

Application: Mechanical
Region: Asia
Platform: Host-Dependent

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	2,588	2,752	2,229	2,206	2,279	2,000	2,100	2,000	2,100	2,200	-3	-1
Unit Shipments or Seats	7,899	6,019	6,751	7,460	8,793	7,600	7,100	6,500	6,100	5,900	3	-8
CPU Installed Base	6,120	8,681	10,497	12,109	13,508	14,300	14,700	15,000	15,300	15,700	22	3
Installed Seats	27,153	32,661	38,220	43,346	48,436	50,800	51,800	51,600	50,400	48,800	16	0
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	211.2	284.0	228.8	192.7	149.6	139.6	128.5	118.1	108.5	100.3	-8	-8
Hardware-Only ASP	128.3	78.9	284.3	518.1	492.3	437.6	414.8	393.7	373.3	353.5	40	-6
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	420	493	422	392	325	276	258	232	217	209	-6	-8
CPU Revenue	294	370	328	287	216	181	170	155	146	142	-7	-8
Terminal Revenue	79	73	56	77	79	72	65	57	51	48	0	-10
Peripheral Revenue (Turnkey)	47	50	38	29	29	23	22	20	19	19	-11	-8
Software Revenue	136	174	125	102	101	82	76	69	64	62	-7	-9
Bundled	104	143	96	86	84	68	64	58	55	54	-5	-9
Unbundled	32	30	30	16	17	14	12	10	9	8	-15	-14
Service Revenue	106	136	113	101	81	69	65	60	57	56	-7	-7
Total Factory Revenue	662	802	661	595	507	427	399	361	339	326	-6	-8
Increase over Prior Year (%)	-27	21	-18	-10	-15	-16	-7	-9	-6	-4		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.

Source: Dataquest (August 1994)

Table 21
CAD/CAM/CAE/GIS History and Forecast Update

Application: Mechanical
Region: Asia
Platform: Server

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	NA	NA	669	709	708	900	1,000	1,100	1,200	1,300	NA	13
Unit Shipments or Seats	NA	NA	669	709	708	900	1,000	1,100	1,200	1,300	NA	13
CPU Installed Base	NA	NA	669	1,379	2,044	2,900	3,600	4,300	4,800	5,300	NA	21
Installed Seats	NA	NA	669	1,379	2,044	2,900	3,600	4,300	4,800	5,300	NA	21
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	NA	NA	67.2	120.6	109.6	105.2	99.3	94.3	90.4	87.1	NA	-4
Hardware-Only ASP	NA	NA	28.7	56.0	62.6	66.1	64.8	63.6	62.3	61.1	NA	-0
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	NA	NA	24	46	51	65	67	71	74	77	NA	9
CPU Revenue	NA	NA	21	43	48	63	65	68	71	74	NA	9
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	NA	NA	3	3	2	2	3	3	3	3	NA	2
Software Revenue	NA	NA	10	13	15	16	19	21	24	26	NA	11
Bundled	NA	NA	5	7	8	9	10	13	14	16	NA	14
Unbundled	NA	NA	4	5	7	8	8	9	10	11	NA	8
Service Revenue	NA	NA	7	14	15	19	20	22	23	25	NA	11
Total Factory Revenue	NA	NA	41	72	81	100	106	114	121	128	NA	10
Increase over Prior Year (%)	NA	NA	NA	77	12	24	6	7	6	6		

NA = Not applicable
Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.
Source: Dataquest (August 1994)

Table 22
CAD/CAM/CAE/GIS History and Forecast Update

Application: Mechanical
Region: Asia
Platform: Personal Computer

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	41,951	44,544	63,655	63,689	52,087	52,700	54,600	57,300	62,800	68,100	6	6
Unit Shipments or Seats	41,951	44,544	63,655	63,689	52,087	52,700	54,600	57,300	62,800	68,100	6	6
CPU Installed Base	82,088	120,413	172,844	218,097	241,990	250,200	252,100	258,200	269,000	282,600	31	3
Installed Seats	82,088	120,413	172,844	218,097	241,990	250,200	252,100	258,200	269,000	282,600	31	3
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	19.8	19.2	14.3	12.6	13.5	13.2	12.7	12.3	12.0	11.8	-9	-3
Hardware-Only ASP	3.3	2.9	1.9	3.6	3.9	3.9	3.9	3.9	3.9	3.9	4	0
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	210	239	234	302	282	282	284	290	307	322	8	3
CPU Revenue	185	209	209	277	257	255	258	265	282	297	8	3
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	25	30	25	25	25	27	26	25	25	25	1	-0
Software Revenue	109	126	178	190	155	160	168	178	195	212	9	6
Bundled	66	66	73	80	75	76	77	78	78	78	3	1
Unbundled	42	60	105	110	81	84	91	100	117	134	18	11
Service Revenue	20	22	22	28	26	27	28	30	33	35	7	7
Total Factory Revenue	338	387	435	520	463	469	480	497	535	570	8	4
Increase over Prior Year (%)	3	15	12	20	-11	1	2	4	7	7		

NA = Not applicable

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.

Source: Dataquest (August 1994)

Table 23
CAD/CAM/CAE/GIS History and Forecast Update

Application: Mechanical
Region: Rest of World
Platform: All Platforms

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	3,070	3,139	4,952	5,703	7,711	9,100	10,400	11,800	13,000	13,900	26	13
Unit Shipments or Seats	3,584	3,678	5,563	6,328	8,029	9,400	10,700	12,100	13,200	14,100	22	12
CPU Installed Base	7,069	9,566	13,537	17,813	23,457	29,400	35,800	42,800	49,700	55,800	35	19
Installed Seats	9,215	11,983	16,259	20,853	26,492	32,400	38,600	45,500	52,000	57,800	30	17
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	60.5	47.2	35.5	61.3	43.5	39.9	37.3	35.1	33.4	31.9	-8	-6
Hardware-Only ASP	12.3	11.7	9.6	6.9	5.0	4.9	4.9	4.8	4.8	4.8	-20	-1
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	59	52	65	75	74	77	83	88	92	95	6	5
CPU Revenue	41	36	49	60	62	66	71	76	80	83	11	6
Terminal Revenue	12	11	11	7	4	4	4	4	4	4	-24	-2
Peripheral Revenue (Turnkey)	6	5	6	7	8	8	8	8	8	8	6	0
Software Revenue	18	18	28	38	39	43	49	54	58	62	21	10
Bundled	10	9	13	22	21	22	23	24	24	25	20	3
Unbundled	8	9	15	16	18	22	26	30	34	37	24	15
Service Revenue	15	14	19	30	31	32	33	35	36	38	19	4
Total Factory Revenue	92	84	113	142	144	152	165	176	186	194	12	6
Increase over Prior Year (%)	26	-9	34	26	1	6	8	7	6	4		

Note: In 1991, server was added as a platform This reclassification reduced 1991 growth rates for the other platforms.

Source: Dataquest (August 1994)

Table 24
CAD/CAM/CAE/GIS History and Forecast Update

Application: Mechanical
Region: Rest of World
Platform: Technical Workstation

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	636	662	1,125	1,261	1,447	1,500	1,700	1,800	1,900	2,000	23	7
Unit Shipments or Seats	636	662	1,125	1,261	1,447	1,500	1,700	1,800	1,900	2,000	23	7
CPU Installed Base	1,782	2,328	3,247	4,218	5,242	6,200	7,200	8,100	8,900	9,600	31	13
Installed Seats	1,782	2,328	3,247	4,218	5,242	6,200	7,200	8,100	8,900	9,600	31	13
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	46.4	35.1	34.7	46.3	40.0	37.6	35.5	33.8	32.4	31.3	-4	-5
Hardware-Only ASP	12.7	21.7	21.2	19.5	21.6	20.7	19.9	19.1	18.3	17.6	14	-4
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	18	16	25	31	36	36	36	36	36	36	18	-0
CPU Revenue	14	13	22	27	31	31	31	31	32	32	21	0
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	4	3	4	5	5	5	5	5	5	4	7	-3
Software Revenue	9	8	16	22	21	22	23	25	26	27	25	5
Bundled	6	6	9	16	16	16	17	17	18	18	25	3
Unbundled	2	3	7	6	5	6	7	7	8	9	22	11
Service Revenue	8	7	10	19	23	23	24	24	25	25	32	2
Total Factory Revenue	35	31	52	72	80	81	84	85	87	88	23	2
Increase over Prior Year (%)	34	-11	68	40	11	1	3	2	2	1		

NA = Not applicable
Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.
Source: Dataquest (August 1994)

Table 25
CAD/CAM/CAE/GIS History and Forecast Update

Application: Mechanical
Region: Rest of World
Platform: Host-Dependent

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	134	113	82	82	53	100	100	100	100	100	-21	14
Unit Shipments or Seats	649	652	693	707	370	300	300	300	300	300	-13	-4
CPU Installed Base	394	464	502	535	531	500	500	500	500	500	8	-1
Installed Seats	2,540	2,880	3,224	3,575	3,566	3,500	3,300	3,100	2,800	2,500	9	-7
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	600.6	610.0	372.3	398.9	379.0	345.1	316.8	290.4	265.9	244.6	-11	-8
Hardware-Only ASP	177.8	214.1	324.4	287.2	212.3	201.7	191.6	182.1	173.0	164.3	5	-5
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	31	29	25	25	13	12	12	12	11	11	-20	-3
CPU Revenue	17	16	13	17	8	8	8	8	7	7	-16	-4
Terminal Revenue	12	11	11	7	4	4	4	4	4	4	-24	-2
Peripheral Revenue (Turnkey)	2	1	1	1	1	0	0	0	0	0	-27	-6
Software Revenue	5	5	4	6	4	3	3	3	3	3	-8	-6
Bundled	4	4	2	4	3	2	2	2	2	2	-9	-7
Unbundled	2	1	1	2	1	1	1	1	1	1	-8	-2
Service Revenue	7	7	6	8	4	4	4	4	3	3	-13	-4
Total Factory Revenue	43	41	35	39	21	19	19	19	18	17	-17	-4
Increase over Prior Year (%)	8	-5	-14	11	-47	-7	-1	-2	-4	-5		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.
Source: Dataquest (August 1994)

Table 26
CAD/CAM/CAE/GIS History and Forecast Update

Application: Mechanical
Region: Rest of World
Platform: Server

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	NA	NA	77	109	162	200	300	300	400	400	NA	20
Unit Shipments or Seats	NA	NA	77	109	162	200	300	300	400	400	NA	20
CPU Installed Base	NA	NA	77	186	341	500	700	1,000	1,200	1,400	NA	33
Installed Seats	NA	NA	77	186	341	500	700	1,000	1,200	1,400	NA	33
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	NA	NA	63.2	69.1	60.5	56.9	53.8	51.1	49.0	47.3	NA	-5
Hardware-Only ASP	NA	NA	54.9	51.6	53.9	52.9	51.8	50.8	49.8	48.8	NA	-2
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	NA	NA	4	5	8	9	11	13	15	17	NA	18
CPU Revenue	NA	NA	3	5	7	9	11	13	15	17	NA	19
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	NA	NA	0	0	0	0	0	0	0	0	NA	-0
Software Revenue	NA	NA	1	1	2	3	3	4	5	5	NA	19
Bundled	NA	NA	1	1	2	2	2	3	3	3	NA	14
Unbundled	NA	NA	0	1	1	1	1	2	2	2	NA	30
Service Revenue	NA	NA	2	2	3	3	4	5	6	6	NA	19
Total Factory Revenue	NA	NA	7	8	13	15	19	22	26	29	NA	18
Increase over Prior Year (%)	NA	NA	NA	24	50	22	21	19	16	14		

NA = Not applicable

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.

Source: Dataquest (August 1994)

Table 27
CAD/CAM/CAE/GIS History and Forecast Update

Application: Mechanical
Region: Rest of World
Platform: Personal Computer

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	2,299	2,364	3,668	4,251	6,049	7,300	8,400	9,600	10,600	11,400	27	14
Unit Shipments or Seats	2,299	2,364	3,668	4,251	6,049	7,300	8,400	9,600	10,600	11,400	27	14
CPU Installed Base	4,893	6,775	9,711	12,874	17,343	22,100	27,400	33,300	39,100	44,300	37	21
Installed Seats	4,893	6,775	9,711	12,874	17,343	22,100	27,400	33,300	39,100	44,300	37	21
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	9.5	6.0	6.0	19.1	16.6	16.1	15.4	14.9	14.6	14.3	15	-3
Hardware-Only ASP	4.0	2.9	2.9	2.8	2.5	2.5	2.5	2.5	2.5	2.4	-11	-0
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	10	7	11	13	17	20	23	27	29	30	15	13
CPU Revenue	9	7	10	12	15	18	21	24	26	28	13	13
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	0	0	1	1	2	2	2	2	3	3	47	10
Software Revenue	4	5	7	9	12	15	18	22	24	27	32	17
Bundled	0	0	1	1	1	1	2	2	2	2	36	11
Unbundled	4	5	6	8	11	14	17	20	22	25	31	17
Service Revenue	1	0	1	1	1	1	2	2	2	3	12	22
Total Factory Revenue	14	12	19	22	30	37	43	50	56	60	20	15
Increase over Prior Year (%)	97	-15	53	20	35	22	18	15	11	8		

NA = Not applicable

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.

Source: Dataquest (August 1994)

For More Information...

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

Dataquest®

a company of The Dun & Bradstreet Corporation

Dataquest®

a company of
The Dun & Bradstreet Corporation

Corporate Headquarters
Dataquest Incorporated
1290 Ridder Park Drive
San Jose, California 95131-2398
United States
Phone: 1-408-437-8000
Facsimile: 1-408-437-0292

Dataquest Incorporated
550 Cochituate Road
Framingham, Massachusetts 01701-9324
United States
Phone: 1-508-370-5555
Facsimile: 1-508-370-6262

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

Dataquest Korea
Trade Tower, Suite 3806
159 Samsung-dong
Kangnam-gu, Seoul 135-729
Korea
Phone: 82-2-551-1331
Facsimile: 82-2-551-1330

Dataquest Taiwan
3/F, No. 87 Sung Chiang Road
Taipei
Taiwan, R.O.C.
Phone: 886-2-509-5390
Facsimile: 886-2-509-5660

European Headquarters
Dataquest Europe Limited
Holmers Farm Way
High Wycombe, Buckinghamshire
HP12 4UL
England
Phone: 44-494-422722
Facsimile: 44-494-422742

Dataquest GmbH
Kronstadter Strasse 9
81677 München
Germany
Phone: 49-89-930-9090
Facsimile: 49-89-930-3277

Dataquest Europe SA
Tour Franklin
Cedex 11
92042 Paris-La-Défense
France
Phone: 33-1-41-25-18-00
Facsimile: 33-1-41-25-18-18

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

Representative Agencies in
Bangkok, Hong Kong,
Kronberg, North Sydney,
Singapore, and Tel Aviv

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Software

CAD/CAM/CAE and GIS Mechanical Market Share Update

Market Statistics

1994

Program: Mechanical Applications Worldwide
Product Code: CMEC-WW-MS-9403
Publication Date: July 11, 1994

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Note: All tables show estimated data.

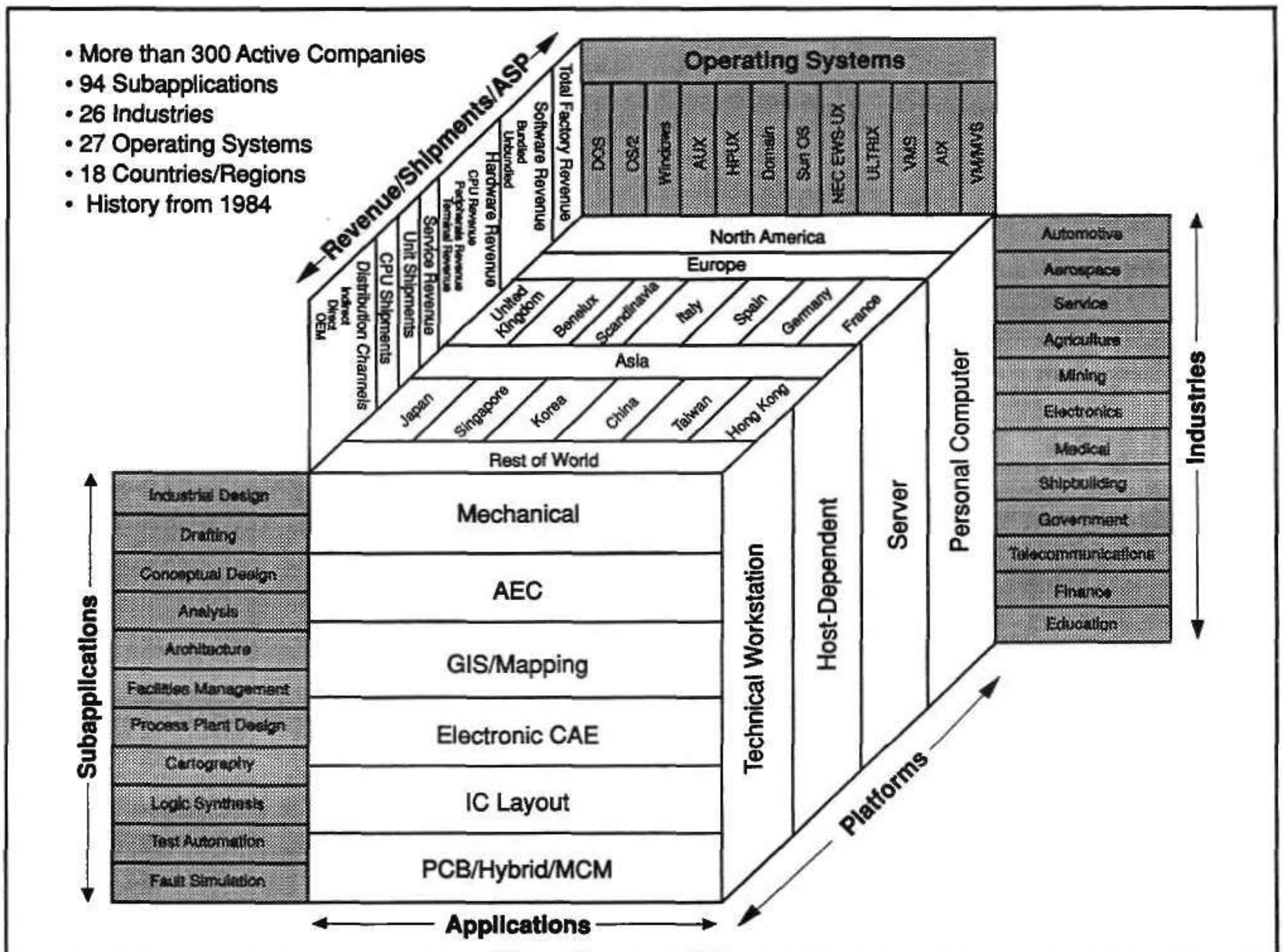
CAD/CAM/CAE and GIS Mechanical Market Share Update

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.

Figure 1
CAD/CAM/CAE/GIS Market Database



Source: Dataquest (February 1994)

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Table 1
CAD/CAM/CAE/GIS 1992-1993 Market Summary

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

Source: Dataquest (July 1994)

A companion article analyzing major shifts in the 1993 market was published in our *Dataquest Perspective,* dated June 27, 1994.

Table 1 summarizes the performance in various segments of the CAD/CAM/CAE/GIS markets in 1993 versus 1992. With the devaluation of the dollar against the yen (¥126.34/$ in 1992 versus ¥110.85/$ in 1993) and the appreciation of the dollar against the ECU (ECU 0.7686/$ in 1992 versus ECU 0.8566/$ in 1993), actual growth is not as it appears when denominated in U.S. dollars. With 75 percent of the Asian market in Japan, denominating in yen gives a rough indication of real growth in the Asian market, which was a negative 7.9 percent.

About This Document

This document contains Dataquest's detailed market share information on the CAD/CAM/CAE/GIS industry. We no longer publish worldwide all-application market statistics for the entire CAD/CAM/CAE/GIS industry. This data is available by calling Suzanne Snygg at (408) 437-8241. The category "Other Companies" is the aggregation of small companies. More detailed data on these markets may be requested through our Client Inquiry service.

Segmentation Definitions

This section lists the definitions specific to this document. The following paragraphs define the segments.

Applications

Mechanical

The mechanical segment refers to computer-aided tools used by engineers, designers, analysts, technicians, and draftspeople working predominantly in the discrete manufacturing industries, but includes government and education. Users of mechanical CAD/CAM/CAE tools work in all departments across the typical organization, with a majority found in product design, advanced engineering, and manufacturing engineering. Common design applications include conceptual design, industrial design, structural or thermal analysis, detail design, and electromechanical design (the mechanical part of design with electrical or electronic components and mechanisms). Common manufacturing applications include tool and fixture design, numerical control part programming, off-line robotics programming, and interface to quality-control systems. Management tools for database control and distribution are included in this segment, as well as user-defined application programming.

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 is composed of 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 process of designing 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 products). Schematic capture and simulation are examples of electronic CAE applications.
- 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), design verification tools (DRC/ERC/logic-to-layout), compilers, and module development tools.
- PCB/Hybrid/MCM—This segment covers products used to create the placement and routing of the traces and components laid out on a printed circuit board. Also included in this category are thermal analysis tools.

Regions

The following paragraphs define the regions.

North America

North America includes United States, Mexico, and Canada.

Europe

Europe includes the United Kingdom, Scandinavia, Benelux, France, Germany, Italy, Spain, and Rest of Europe. Market share data is available for each of these countries.

Asia

Asia includes Japan, Singapore, Taiwan, Korea, China, and Hong Kong. Market share data is available for each of these countries.

Rest of World

Rest of World includes all other countries including Australia, New Zealand, Oceania, Africa, Central America, South America, and the Middle East.

Platforms

The following paragraphs define the platforms.

Technical Workstation

A technical workstation is a single-user computer distinguished from a personal computer by its features and by the user's potential range of expansion on the platform. Features include a virtual, multitasking operating system (UNIX, VMS, or Domain); the computer is designed by the manufacturer to run high-performance graphics applications in a multiuser/multitasking environment.

Host-Dependent

Host-dependent is a shared logic system in which the external workstations' functions are dependent on a host computer.

Server

A server is a computer that transparently provides its resources for use by other computer systems. It is a system on a network that provides specific functionality to other computer systems: the clients. Functions include file storage, database access, and compute capability. Dataquest tracks the following major categories of servers used for CAD/CAM/CAE and GIS applications:

- Compute Servers—These systems provide capabilities for solving numerical problems (for example, simulations, statistical calculations, and simultaneous partial differential equations). System features usually include high-speed computational capabilities (for example, vector and parallel processing) and large memories.
- Print Servers—These systems provide access to printers, specialized printing applications software, and print-spooling resources to a network.
- File Servers—These systems provide mass storage capability to clients on a network. Services can range from temporary storage of working files to long-term backup and archive systems.
- Database Servers—These systems manage databases as a shared resource to a network. These servers handle such functions as physical data storage, data security, and high-level queries and can access stored information at the record level.

Personal Computer

A personal computer is a single-user computer distinguished from a technical workstation by its features and by the user's potential range of expansion on the platform. Features found in technical workstations (such as a virtual operating system, networking, high-performance graphics, multiuser/multitasking capability) are optional rather than integrated by the manufacturer.

Metrics

The following paragraphs define measurements.

- Total factory revenue is defined as 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 software revenue, hardware revenue, and service revenue.
- Unit shipment is defined as the number of seats delivered (number of possible simultaneous users of product delivered) excluding OEM shipments.

- Hardware revenue is revenue derived from sales of CPUs (including operating systems), terminals (for host-dependent systems), and peripherals.
- Software revenue is revenue derived from the sale of bundled (part of a turnkey system) and unbundled application software.
- Service revenue is defined as all revenue derived from the service and support of CAD/CAM/CAE/GIS systems. Service revenue can be calculated in the tables by subtracting hardware and software revenue from total revenue.
  - Maintenance fees for hardware and software
  - Management and operations services—help desk, education and training, disaster recovery, vaulting, and configuration management.
  - Service bureau—project work, including construction of database, data conversion, product design, analysis, or manufacturing.
  - Application development—design and development of customized software applications or the modification, enhancement, or customization of existing software applications, adding new functionality.
  - Consulting revenue—assessment of CAD/CAM/CAE/GIS business and information technology needs and the formulation of a plan based on needs identification.
  - Implementation and integration services—planning, implementation, migration, and integration of software products (software network support and integration, account integration management, data center design, and construction).

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.) The following are examples of the job titles of people contacted for information:

- President and CEO
- Vice president and general manager
- Vice president of marketing
- Vice president, strategic product planning
- Director of strategic planning

- Director of marketing
- Director of market development
- Manager, CAD/CAM/CAE/GIS marketing programs
- Market research analyst

The Audit Process

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

- Revenue published by major industry participants
- Estimates made by knowledgeable and reliable industry spokespersons
- Government data or trade association data
- Published product literature and price lists
- Interviews with knowledgeable manufacturers, distributors, and users
- Relevant economic data
- Information and data from online data banks
- Articles in both the general and trade press
- Annual reports, SEC documents, credit reports
- Company publications and press releases
- Reports from financial analysts
- User studies
- Reseller and supplier reports and reports from a vendor's competitors

In addition, Dataquest sums vendor revenue across other industries covered by Dataquest to make sure that revenue is not credited twice; Dataquest also 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 above tools 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—particularly useful when comparing regions or applications.

Publishing Schedule

We publish both market share and forecasting twice each year, allowing for timely distribution of data and thorough analysis and forecasting. Our annual delivery schedule is as follows:

- Market share data is available January 31. All tables will be published and distributed to clients by March 31.
- Forecasting from the market share tables provides a five-year forecast period, available after March 31. The books will be shipped by May 31.
- Final updated market share tables, based on additional data collection and analysis, will be completed by May 31. 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. Books will be shipped by July 31.
- We provide complete final forecast tables by July 31. These tables take into consideration changes in the market share during the previous six months. Books will be shipped by September 30.

Database Changes

Tables 2 through 5 show changes made to the database since last year's market share update. PC clone manufacturers are no longer tracked individually. We continue to show PC sales by IBM, Hewlett-Packard, and Digital, which also sell other platforms. The 1993 sales of GeoVision Systems to SHL Systemhouse, Computervision-GIS to Unisys, Racal-Redac to Zuken, Chronologic to Viewlogic, ASG to Softdesk, CDC's mechanical software product to ICEM Technologies, PDA to MacNeal-Schwendler, and Logic Modeling Corporation to Synopsys; the merger of Sysdeco and SysScan; and the change of GDS to Convergent Group will be recognized in market reporting for 1994.

Table 2
Companies Renamed

Company Name	Renamed to:
Alper Systems	Sysdeco Ltd.
Areon	Kreon
CADAM	Altium
Catalpa	Catalpa groupe Missler
Geotrace Technologies	Cadlynx
Logic Control	Logic Systems Designers
RIB/RZB	RIB Bausoftware
Sener Sistemas Marinos	Sener Inginiera y Sistemas
STI Strassle	Strassle Informationssysteme
Test Systems Strategies	Summitt

Source: Dataquest (July 1994)

Table 3
Companies (or CAD Portions Thereof) Sold/Merged

Company Name	Acquired by, Merged with, Technology Sold to:
ANACAD & Electrical Eng. Software	ANACAD-EES
Aries Technology	MacNeal-Schwendler
CAD Language Systems	Compass Design Automation
CAD/CAM Group	Data I/O
Comdisco	Cadence
DAT Standard info ssystemes	ISD Software
EEsof	Hewlett-Packard
Expertest	Sunrise Test
Fides Industrielle Automation	Strassle
HP Cade	Hewlett-Packard
Inca	Zycad
Infocel	Understanding Systems
PiE Design	Quickturn Design Systems
Quad Design Technology	Viewlogic
Wisdom Systems	ICAD

Source: Dataquest (July 1994)

Table 4
Companies Deleted

Company Removed from Database:
European
Asicom
Club Informatico SA
DATAID Technologies
DECISA
Micrograph
Olivetti*
Research Machines*
North American
Bechtel
CADLYNX
Compaq*
Dell Computer*
Engineering Systems Corporation
GeoQuest
Mega CADD
NCR Microelectronics
Object Design
Objectivity
Ontos
Quicklogic
The CAD Group
Ultimap

*We no longer follow individual PC clone makers.
Source: Dataquest (July 1994)

Table 5
Companies Added

Company Added to Database:
European
APIC Systemes
ISD Software
SPEED
Ultimate Technology
North American
AT&T
Aptix
ARC SYS
EAGLE Point
Earth Resource Mapping
Graftek
Graphic Data Systems (GDS)
Model Technology
Systems Science Inc.
Tactics Int'l Ltd.
VLSI Libraries
Asian
Adam Net
Kozo
Okura
Tachnodia
TECHSPERT
Toshiba Engineering
Yokogawa Digital Computer

Source: Dataquest (July 1994)

Table 6
1993 CAD/CAM/CAE/GIS Market Share Update

Application:	Mechanical
Platform:	All Platforms
Region:	Worldwide
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
IBM	1,331.0	767.9	325.5	43,265	16.9%	18.4%	14.2%	14.3%
Hewlett-Packard	634.9	437.2	70.8	25,059	8.1%	10.5%	3.1%	8.3%
Digital	498.2	395.2	.1	19,094	6.3%	9.5%	.0%	6.3%
Computervision	465.3	115.7	147.5	6,143	5.9%	2.8%	6.4%	2.0%
Sun Microsystems	346.1	277.9	.0	12,837	4.4%	6.7%	.0%	4.2%
Silicon Graphics	335.1	300.1	.0	10,285	4.3%	7.2%	.0%	3.4%
EDS Unigraphics	274.7	80.3	129.2	4,735	3.5%	1.9%	5.6%	1.6%
NEC	245.8	165.4	58.4	11,515	3.1%	4.0%	2.5%	3.8%
Fujitsu	219.9	128.9	67.4	8,751	2.8%	3.1%	2.9%	2.9%
Nihon Unisys	218.2	129.2	44.5	1,014	2.8%	3.1%	1.9%	.3%
Parametric Technology	184.1	.0	151.0	0	2.3%	.0%	6.6%	.0%
Intergraph	179.0	51.5	70.5	2,218	2.3%	1.2%	3.1%	.7%
SDRC	177.0	.0	120.7	0	2.3%	.0%	5.3%	.0%
Autodesk	160.2	.0	160.2	0	2.0%	.0%	7.0%	.0%
Hitachi	143.6	67.5	61.8	6,076	1.8%	1.6%	2.7%	2.0%
Toshiba—No OEM	113.3	56.7	45.3	3,663	1.4%	1.4%	2.0%	1.2%
Hitachi Zosen Info Systems	89.8	76.1	4.4	865	1.1%	1.8%	.2%	.3%
Matra Datavision	88.4	29.7	49.8	1,596	1.1%	.7%	2.2%	.5%
Control Data Systems	82.2	42.2	16.8	1,177	1.0%	1.0%	.7%	.4%
MacNeal-Schwendler	76.2	.0	74.1	0	1.0%	.0%	3.2%	.0%
Applicon	70.0	23.1	27.4	792	.9%	.6%	1.2%	.3%

(Continued)

Table 6 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application:	Mechanical
Platform:	All Platforms
Region:	Worldwide
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Siemens Nixdorf Info systeme	64.3	31.7	12.1	2,993	.8%	.8%	.5%	1.0%
Apple Computer	59.5	59.6	.0	14,158	.8%	1.4%	.0%	4.7%
Mitsubishi Electric	50.3	39.3	6.3	795	.6%	.9%	.3%	.3%
Kubota Computer	45.0	34.2	7.2	515	.6%	.8%	.3%	.2%
Hakuto	43.1	25.4	17.6	1,006	.5%	.6%	.8%	.3%
Sharp System Products—No OEM	43.0	20.7	22.3	398	.5%	.5%	1.0%	.1%
Mutoh Industries—No OEM	42.5	26.4	12.8	1,146	.5%	.6%	.6%	.4%
PDA Engineering	41.9	.0	39.4	0	.5%	.0%	1.7%	.0%
Technodia	37.9	30.3	.4	425	.5%	.7%	.0%	.1%
Investronica SA	31.5	19.7	8.3	1,077	.4%	.5%	.4%	.4%
Cimatron	30.9	13.6	14.0	1,040	.4%	.3%	.6%	.3%
Graftek	30.7	12.6	11.6	938	.4%	.3%	.5%	.3%
Cisigraph	30.3	8.2	16.0	452	.4%	.2%	.7%	.1%
Swanson Analysis	30.1	.0	26.7	0	.4%	.0%	1.2%	.0%
ASCAD/ASCAM	28.2	16.7	8.7	436	.4%	.4%	.4%	.1%
Delcam International	28.1	9.7	12.2	363	.4%	.2%	.5%	.1%
Gerber Systems	26.8	12.6	11.5	433	.3%	.3%	.5%	.1%
Alias Research	26.5	.0	24.4	0	.3%	.0%	1.1%	.0%
Straessle Informationssysteme	25.7	4.1	15.7	421	.3%	.1%	.7%	.1%
Tokyo Electron—No OEM	25.6	8.7	11.3	124	.3%	.2%	.5%	.0%
CAD Lab	24.7	7.6	11.4	580	.3%	.2%	.5%	.2%

(Continued)

Table 6 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: All Platforms
Region: Worldwide
Units: Millions of U.S. Dollars/Actual Units

Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Market Share: Total Factory Revenue	Market Share: Hardware Revenue	Market Share: Software Revenue	Market Share: Hardware Units Shipped
Cimlinc	23.5	1.0	11.7	55	.3%	.0%	.5%	.0%
Andor	23.1	5.1	17.1	421	.3%	.1%	.7%	.1%
Toyo Information Systems-No OEM	23.0	13.7	6.9	258	.3%	.3%	.3%	.1%
Mitsui Engineering	22.1	15.3	4.5	178	.3%	.4%	.2%	.1%
Marcus Computer Systeme	22.1	11.3	7.6	400	.3%	.3%	.3%	.1%
Kozo Keikaku Engineering	21.6	1.3	5.8	40	.3%	.0%	.3%	.0%
ADRA Systems	21.0	.3	16.2	20	.3%	.0%	.7%	.0%
ISD Software	20.6	4.3	13.0	682	.3%	.1%	.6%	.2%
Wiechers Datentechnik	18.2	3.9	10.7	327	.2%	.1%	.5%	.1%
ICAD	17.5	.0	14.1	0	.2%	.0%	.6%	.0%
Radan Computational	17.4	5.9	8.7	349	.2%	.1%	.4%	.1%
Sony	16.6	16.6	.0	823	.2%	.4%	.0%	.3%
Digital Kienzle	16.4	8.2	4.6	248	.2%	.2%	.2%	.1%
Auto-Trol	16.1	5.5	6.5	199	.2%	.1%	.3%	.1%
Graphtec Engineering	15.3	7.5	7.0	404	.2%	.2%	.3%	.1%
Rasna Corporation	14.2	.0	12.8	0	.2%	.0%	.6%	.0%
MARC	14.1	.0	13.4	0	.2%	.0%	.6%	.0%
Tebis	13.7	3.6	2.1	92	.2%	.1%	.1%	.0%
Mechanical Dynamics	13.3	.0	10.8	0	.2%	.0%	.5%	.0%
MCS	12.0	.5	10.2	66	.2%	.0%	.4%	.0%
CADKEY	11.8	.0	10.9	0	.1%	.0%	.5%	.0%

(Continued)

Table 6 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: All Platforms
Region: Worldwide
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Adam Net	11.5	6.6	3.6	14	.1%	.2%	.2%	.0%
Isicad CAD/CAM Systeme	11.5	4.0	4.6	195	.1%	.1%	.2%	.1%
Omron	11.5	5.7	4.6	255	.1%	.1%	.2%	.1%
Exapt	10.9	5.2	3.8	210	.1%	.1%	.2%	.1%
Point Control	10.1	.0	8.0	0	.1%	.0%	.3%	.0%
ICL	10.0	5.8	3.4	287	.1%	.1%	.1%	.1%
Framasoft + CSI	9.7	.3	4.4	20	.1%	.0%	.2%	.0%
CAMAX Systems Inc.	9.6	.9	6.1	88	.1%	.0%	.3%	.0%
PAFEC	8.6	2.6	4.9	107	.1%	.1%	.2%	.0%
Design Automation	8.6	1.8	6.5	295	.1%	.0%	.3%	.1%
ItalCad	8.4	2.4	3.5	185	.1%	.1%	.2%	.1%
Han Dataport	8.4	2.3	4.3	255	.1%	.1%	.2%	.1%
CADIX	8.3	3.6	4.1	46	.1%	.1%	.2%	.0%
Engineering Mechanics	8.1	.6	7.0	42	.1%	.0%	.3%	.0%
Wacom	8.1	1.6	5.7	261	.1%	.0%	.2%	.1%
Sumitomo Denko Workstation	7.9	7.9	.0	855	.1%	.2%	.0%	.3%
CNC Software	7.3	.0	7.3	0	.1%	.0%	.3%	.0%
Ricoh—No OEM	7.2	.0	6.1	0	.1%	.0%	.3%	.0%
Algor Interactive Systems	6.5	.0	5.7	0	.1%	.0%	.2%	.0%
Ziegler Informatics	6.1	.0	6.1	0	.1%	.0%	.3%	.0%
Serbi	5.1	.6	4.5	200	.1%	.0%	.2%	.1%

(Continued)

Table 6 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: All Platforms
Region: Worldwide
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
CADSI	4.9	.6	3.8	30	.1%	.0%	.2%	.0%
Moda CAD	4.7	1.0	3.3	46	.1%	.0%	.1%	.0%
Technische Computer Systeme	4.6	.9	3.3	87	.1%	.0%	.1%	.0%
American Small Business Comp.	4.6	.0	4.6	0	.1%	.0%	.2%	.0%
Whessoe Computing Systems	4.4	.0	4.4	0	.1%	.0%	.2%	.0%
CAD Distribution	4.1	.1	3.6	22	.1%	.0%	.2%	.0%
Pathtrace Engineering Systems	3.9	.8	2.1	101	.1%	.0%	.1%	.0%
Anilam Electronics	3.9	.7	2.8	46	.0%	.0%	.1%	.0%
Micrografx	3.6	.0	3.6	0	.0%	.0%	.2%	.0%
Vero International Software	3.4	.0	3.1	0	.0%	.0%	.1%	.0%
FEA	3.3	.7	.9	198	.0%	.0%	.0%	.1%
RoboCAD Solutions	3.3	.0	2.6	0	.0%	.0%	.1%	.0%
Foresight Resources	3.1	.0	2.9	0	.0%	.0%	.1%	.0%
debis Systemhaus	3.1	.7	2.0	22	.0%	.0%	.1%	.0%
Superdraft	2.9	1.3	1.3	208	.0%	.0%	.1%	.1%
Century Research Center	2.9	1.5	1.1	14	.0%	.0%	.0%	.0%
CATALPA groupe Missler	2.8	1.2	1.2	84	.0%	.0%	.1%	.0%
Kloeckner-Moeller	2.8	.6	1.9	0	.0%	.0%	.1%	.0%
Caroline Informatique	2.7	.5	1.4	27	.0%	.0%	.1%	.0%
FEGS	2.2	.0	.9	0	.0%	.0%	.0%	.0%
ISKA	2.1	.9	.9	39	.0%	.0%	.0%	.0%

(Continued)

Table 6 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application:	Mechanical
Platform:	All Platforms
Region:	Worldwide
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	**Total Factory Revenue**	**Hardware Revenue**	**Software Revenue**	**Hardware Units Shipped**	**Total Factory Revenue**	**Hardware Revenue**	**Software Revenue**	**Hardware Units Shipped**
Computational Mechanics	2.1	.0	2.1	0	.0%	.0%	.1%	.0%
SPATIAL Technology	2.1	.0	.0	0	.0%	.0%	.0%	.0%
CAD Centre	2.0	.0	1.7	0	.0%	.0%	.1%	.0%
Uchida Yoko	2.0	1.2	.7	53	.0%	.0%	.0%	.0%
CAMTEK	1.8	.4	1.2	159	.0%	.0%	.1%	.1%
Softronics	1.6	.3	1.3	123	.0%	.0%	.1%	.0%
Evolution Computing	1.5	.0	1.5	0	.0%	.0%	.1%	.0%
Ashlar	1.4	.0	.0	0	.0%	.0%	.0%	.0%
Valisys	1.3	.0	.0	0	.0%	.0%	.0%	.0%
Claris	1.2	.0	1.2	0	.0%	.0%	.1%	.0%
GRAPHSOFT	1.2	.0	1.2	0	.0%	.0%	.1%	.0%
Kreon	1.0	.5	.2	19	.0%	.0%	.0%	.0%
Zuken	1.0	.3	.5	6	.0%	.0%	.0%	.0%
Other Companies	513.0	481.0	17.6	107,822	6.5%	11.5%	.8%	35.5%
All Companies	7,862.7	4,176.5	2,294.7	303,364	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	5,734.8	3,052.1	1,579.3	246,330	72.9%	73.1%	68.8%	81.2%
All Asian-Based Companies	1,532.8	909.3	445.9	40,649	19.5%	21.8%	19.4%	13.4%
All European-Based Companies	595.1	215.1	269.5	16,385	7.6%	5.2%	11.7%	5.4%
All Hardware Companies	2,335.7	2,059.2	.0	218,526	29.7%	49.3%	.0%	72.0%
All Turnkey & SW Companies	5,527.0	2,117.3	2,294.7	84,838	70.3%	50.7%	100.0%	28.0%

Source: Dataquest (July 1994)

Table 7
1993 CAD/CAM/CAE/GIS Market Share Update

Application:	Mechanical
Platform:	Technical Workstation
Region:	Worldwide
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	**Total Factory Revenue**	**Hardware Revenue**	**Software Revenue**	**Hardware Units Shipped**	**Total Factory Revenue**	**Hardware Revenue**	**Software Revenue**	**Hardware Units Shipped**
IBM	648.0	368.2	166.7	10,283	13.3%	15.8%	10.9%	11.7%
Hewlett-Packard	597.0	403.4	70.8	14,859	12.3%	17.3%	4.6%	17.0%
Computervision	454.1	114.7	138.4	5,947	9.3%	4.9%	9.0%	6.8%
Silicon Graphics	313.9	282.1	.0	10,049	6.4%	12.1%	.0%	11.5%
Sun Microsystems	234.3	185.1	.0	10,460	4.8%	8.0%	.0%	11.9%
EDS Unigraphics	229.0	66.5	108.1	4,187	4.7%	2.9%	7.0%	4.8%
SDRC	175.2	.0	119.5	0	3.6%	.0%	7.8%	.0%
Parametric Technology	174.9	.0	143.4	0	3.6%	.0%	9.3%	.0%
Intergraph	157.6	44.6	61.3	1,688	3.2%	1.9%	4.0%	1.9%
NEC	122.9	76.3	35.6	3,463	2.5%	3.3%	2.3%	4.0%
Fujitsu	117.2	63.3	38.5	2,673	2.4%	2.7%	2.5%	3.1%
Hitachi	109.5	51.5	47.1	2,167	2.2%	2.2%	3.1%	2.5%
Digital	99.1	77.2	.1	4,161	2.0%	3.3%	.0%	4.7%
Nihon Unisys	87.3	48.0	23.6	353	1.8%	2.1%	1.5%	.4%
Matra Datavision	86.6	29.0	48.8	1,407	1.8%	1.2%	3.2%	1.6%
Hitachi Zosen Info Systems	85.8	72.5	4.4	865	1.8%	3.1%	.3%	1.0%
Applicon	70.0	23.1	27.4	792	1.4%	1.0%	1.8%	.9%
Toshiba—No OEM	68.0	34.0	27.2	755	1.4%	1.5%	1.8%	.9%
Siemens Nixdorf Info systeme	51.4	19.5	12.1	773	1.1%	.8%	.8%	.9%
Control Data Systems	49.7	23.7	14.0	786	1.0%	1.0%	.9%	.9%
Sharp System Products—No OEM	43.0	20.7	22.3	398	.9%	.9%	1.5%	.5%

(Continued)

Table 7 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application:	Mechanical
Platform:	Technical Workstation
Region:	Worldwide
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Mitsubishi Electric	38.7	32.9	2.7	363	.8%	1.4%	.2%	.4%
Technodia	37.9	30.3	.4	425	.8%	1.3%	.0%	.5%
PDA Engineering	37.7	.0	35.5	0	.8%	.0%	2.3%	.0%
Kubota Computer	36.0	27.3	5.8	343	.7%	1.2%	.4%	.4%
ASCAD/ASCAM	27.3	16.1	8.5	413	.6%	.7%	.6%	.5%
Cisigraph	27.3	7.4	14.4	431	.6%	.3%	.9%	.5%
Delcam International	26.9	9.3	11.7	329	.6%	.4%	.8%	.4%
Gerber Systems	26.8	12.6	11.5	433	.6%	.5%	.7%	.5%
Alias Research	26.5	.0	24.4	0	.5%	.0%	1.6%	.0%
Straessle Informationssysteme	25.7	4.1	15.7	421	.5%	.2%	1.0%	.5%
Tokyo Electron—No OEM	25.6	8.7	11.3	124	.5%	.4%	.7%	.1%
Graftek	24.6	9.7	9.5	608	.5%	.4%	.6%	.7%
Cimlinc	22.3	.9	11.2	53	.5%	.0%	.7%	.1%
Marcus Computer Systeme	22.1	11.3	7.6	400	.5%	.5%	.5%	.5%
Mitsui Engineering	20.4	14.1	4.2	141	.4%	.6%	.3%	.2%
Toyo Information Systems-No OEM	19.3	11.8	5.8	237	.4%	.5%	.4%	.3%
CAD Lab	19.3	5.9	8.9	315	.4%	.3%	.6%	.4%
Swanson Analysis	19.0	.0	17.2	0	.4%	.0%	1.1%	.0%
ISD Software	18.5	4.3	11.0	682	.4%	.2%	.7%	.8%
Cimatron	18.3	8.1	8.3	389	.4%	.3%	.5%	.4%
ICAD	17.5	.0	14.1	0	.4%	.0%	.9%	.0%

(Continued)

Table 7 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application:	Mechanical
Platform:	Technical Workstation
Region:	Worldwide
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Radan Computational	17.2	5.9	8.6	332	.4%	.3%	.6%	.4%
Sony	16.6	16.6	.0	823	.3%	.7%	.0%	.9%
Digital Kienzle	16.4	8.2	4.6	248	.3%	.4%	.3%	.3%
Mutoh Industries—No OEM	16.2	6.8	6.1	219	.3%	.3%	.4%	.3%
Auto-Trol	16.1	5.5	6.5	199	.3%	.2%	.4%	.2%
Graphtec Engineering	15.3	7.5	7.0	404	.3%	.3%	.5%	.5%
ADRA Systems	15.1	.3	11.5	20	.3%	.0%	.7%	.0%
MacNeal-Schwendler	13.6	.0	11.6	0	.3%	.0%	.8%	.0%
Isicad CAD/CAM Systeme	11.5	4.0	4.6	195	.2%	.2%	.3%	.2%
Omron	11.5	5.7	4.6	255	.2%	.2%	.3%	.3%
Rasna Corporation	11.2	.0	10.1	0	.2%	.0%	.7%	.0%
MARC	10.6	.0	10.1	0	.2%	.0%	.7%	.0%
ICL	10.0	5.8	3.4	287	.2%	.3%	.2%	.3%
Mechanical Dynamics	9.6	.0	7.8	0	.2%	.0%	.5%	.0%
CAMAX Systems Inc.	9.6	.9	6.1	88	.2%	.0%	.4%	.1%
Kozo Keikaku Engineering	9.1	.9	2.7	10	.2%	.0%	.2%	.0%
Autodesk	8.9	.0	8.9	0	.2%	.0%	.6%	.0%
Framasoft + CSI	8.7	.3	3.9	20	.2%	.0%	.3%	.0%
ItalCad	8.4	2.4	3.5	185	.2%	.1%	.2%	.2%
CADIX	8.3	3.6	4.1	46	.2%	.2%	.3%	.1%
PAFEC	7.5	2.6	3.8	107	.2%	.1%	.2%	.1%

(Continued)

Table 7 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: Technical Workstation
Region: Worldwide
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Sumitomo Denko Workstation	7.4	7.4	.0	813	.2%	.3%	.0%	.9%
Han Dataport	7.4	2.0	3.8	216	.2%	.1%	.2%	.2%
Ricoh—No OEM	7.2	.0	6.1	0	.1%	.0%	.4%	.0%
MCS	6.2	.2	5.3	16	.1%	.0%	.3%	.0%
Adam Net	5.8	.9	3.6	11	.1%	.0%	.2%	.0%
Engineering Mechanics	4.9	.6	3.8	42	.1%	.0%	.2%	.0%
CADSI	4.0	.5	3.1	16	.1%	.0%	.2%	.0%
Exapt	3.3	1.6	1.2	112	.1%	.1%	.1%	.1%
Technische Computer Systeme	2.8	.6	1.8	30	.1%	.0%	.1%	.0%
Hakuto	2.6	1.6	1.0	31	.1%	.1%	.1%	.0%
debis Systemhaus	2.3	.5	1.5	11	.0%	.0%	.1%	.0%
FEGS	2.2	.0	.9	0	.0%	.0%	.1%	.0%
ISKA	2.1	.9	.9	39	.0%	.0%	.1%	.0%
CAD Centre	2.0	.0	1.7	0	.0%	.0%	.1%	.0%
SPATIAL Technology	1.9	.0	.0	0	.0%	.0%	.0%	.0%
Wiechers Datentechnik	1.8	.7	.8	44	.0%	.0%	.1%	.1%
Uchida Yoko	1.8	1.1	.6	44	.0%	.0%	.0%	.1%
Century Research Center	1.7	.9	.6	12	.0%	.0%	.0%	.0%
Caroline Informatique	1.7	.3	.9	9	.0%	.0%	.1%	.0%
CATALPA groupe Missler	1.7	.7	.8	19	.0%	.0%	.0%	.0%
Wacom	1.3	.3	1.0	22	.0%	.0%	.1%	.0%

(Continued)

Table 7 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: Technical Workstation
Region: Worldwide
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
FEA	1.3	.3	.3	20	.0%	.0%	.0%	.0%
Valisys	1.2	.0	.0	0	.0%	.0%	.0%	.0%
Computational Mechanics	1.1	.0	1.1	0	.0%	.0%	.1%	.0%
Point Control	1.0	.0	.8	0	.0%	.0%	.1%	.0%
Zuken	1.0	.3	.5	6	.0%	.0%	.0%	.0%
Other Companies	28.0	11.4	15.0	479	.6%	.5%	1.0%	.5%
All Companies	4,868.9	2,327.5	1,535.1	87,596	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	3,504.9	1,624.1	1,064.9	64,914	72.0%	69.8%	69.4%	74.1%
All Asian-Based Companies	941.6	555.8	278.9	15,434	19.3%	23.9%	18.2%	17.6%
All European-Based Companies	422.5	147.6	191.4	7,248	8.7%	6.3%	12.5%	8.3%
All Hardware Companies	1,086.5	933.5	.0	40,117	22.3%	40.1%	.0%	45.8%
All Turnkey & SW Companies	3,782.5	1,394.0	1,535.1	47,480	77.7%	59.9%	100.0%	54.2%

Source: Dataquest (July 1994)

Table 8
1993 CAD/CAM/CAE/GIS Market Share Update

Application:	Mechanical
Platform:	Host-Dependent
Region:	Worldwide
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
IBM	466.8	267.5	93.9	7,994	37.2%	33.1%	40.6%	36.5%
Digital	150.6	117.5	.0	0	12.0%	14.5%	.0%	.0%
Nihon Unisys	130.9	81.2	21.0	662	10.4%	10.0%	9.1%	3.0%
NEC	61.4	45.5	10.5	127	4.9%	5.6%	4.5%	.6%
Fujitsu	59.0	27.1	23.6	889	4.7%	3.4%	10.2%	4.1%
MacNeal-Schwendler	45.2	.0	45.2	0	3.6%	.0%	19.5%	.0%
Control Data Systems	29.3	16.8	2.4	358	2.3%	2.1%	1.1%	1.6%
Hitachi	11.3	5.3	4.9	2,744	.9%	.7%	2.1%	12.5%
Toshiba—No OEM	7.9	4.0	3.2	106	.6%	.5%	1.4%	.5%
Exapt	7.6	3.6	2.7	98	.6%	.4%	1.2%	.4%
Mitsubishi Electric	6.5	3.1	1.8	18	.5%	.4%	.8%	.1%
Graftek	5.6	2.8	2.0	316	.4%	.4%	.9%	1.4%
Swanson Analysis	4.3	.0	3.4	0	.3%	.0%	1.5%	.0%
PDA Engineering	4.2	.0	3.9	0	.3%	.0%	1.7%	.0%
Hitachi Zosen Info Systems	4.0	3.6	.0	0	.3%	.4%	.0%	.0%
Toyo Information Systems-No OEM	3.7	2.0	1.2	21	.3%	.2%	.5%	.1%
MARC	3.5	.0	3.4	0	.3%	.0%	1.4%	.0%
Mechanical Dynamics	2.8	.0	2.3	0	.2%	.0%	1.0%	.0%
Intergraph	2.3	.0	2.1	0	.2%	.0%	.9%	.0%
SDRC	1.8	.0	1.2	0	.1%	.0%	.5%	.0%
Kozo Keikaku Engineering	1.7	.0	.3	0	.1%	.0%	.1%	.0%

(Continued)

Table 8 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: Host-Dependent
Region: Worldwide
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Century Research Center	1.2	.6	.5	2	.1%	.1%	.2%	.0%
Other Companies	243.4	228.3	2.2	8,537	19.4%	28.2%	.9%	39.0%
All Companies	1,255.0	808.8	231.3	21,872	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	957.0	632.8	159.8	17,204	76.3%	78.2%	69.1%	78.7%
All Asian-Based Companies	287.7	172.3	66.8	4,569	22.9%	21.3%	28.9%	20.9%
All European-Based Companies	10.3	3.7	4.7	99	.8%	.5%	2.0%	.5%
All Hardware Companies	404.7	356.3	.0	8,761	32.2%	44.0%	.0%	40.1%
All Turnkey & SW Companies	850.3	452.5	231.3	13,111	67.8%	56.0%	100.0%	59.9%

Source: Dataquest (July 1994)

Table 9
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: Server
Region: Worldwide
Units: Millions of U.S. Dollars/Actual Units

Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Market Share: Total Factory Revenue	Market Share: Hardware Revenue	Market Share: Software Revenue	Market Share: Hardware Units Shipped
Digital	208.9	162.9	.0	2,218	39.5%	45.4%	.0%	32.8%
Sun Microsystems	111.8	92.8	.0	2,377	21.1%	25.8%	.0%	35.2%
IBM	81.8	46.0	19.2	883	15.5%	12.8%	29.7%	13.1%
EDS Unigraphics	45.7	13.8	21.1	548	8.6%	3.8%	32.7%	8.1%
Silicon Graphics	21.2	18.0	.0	236	4.0%	5.0%	.0%	3.5%
MacNeal-Schwendler	16.3	.0	16.3	0	3.1%	.0%	25.3%	.0%
Intergraph	11.9	4.8	3.6	143	2.3%	1.3%	5.5%	2.1%
Kubota Computer	6.7	5.1	1.1	55	1.3%	1.4%	1.7%	.8%
Hewlett-Packard	6.0	5.0	.0	103	1.1%	1.4%	.0%	1.5%
Adam Net	5.8	5.8	.0	2	1.1%	1.6%	.0%	.0%
Control Data Systems	3.3	1.8	.3	33	.6%	.5%	.5%	.5%
Cisigraph	3.0	.8	1.6	20	.6%	.2%	2.4%	.3%
Computervision	2.4	1.0	.3	27	.5%	.3%	.4%	.4%
Cimlinc	1.2	.0	.6	2	.2%	.0%	.9%	.0%
Kozo Keikaku Engineering	1.1	.0	.2	0	.2%	.0%	.3%	.0%
Other Companies	1.9	1.3	.3	114	.4%	.4%	.5%	1.7%
All Companies	529.1	359.1	64.5	6,762	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	511.5	346.7	61.5	6,626	96.7%	96.5%	95.2%	98.0%
All Asian-Based Companies	14.0	11.4	1.3	100	2.7%	3.2%	2.0%	1.5%
All European-Based Companies	3.6	1.1	1.8	37	.7%	.3%	2.8%	.5%
All Hardware Companies	356.0	286.0	.0	5,146	67.3%	79.6%	.0%	76.1%
All Turnkey & SW Companies	173.2	73.1	64.5	1,617	32.7%	20.4%	100.0%	23.9%

Source: Dataquest (July 1994)

Table 10
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: Personal Computer
Region: Worldwide
Units: Millions of U.S. Dollars/Actual Units

Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Market Share: Total Factory Revenue	Market Share: Hardware Revenue	Market Share: Software Revenue	Market Share: Hardware Units Shipped
Autodesk	151.3	.0	151.3	0	12.5%	.0%	32.6%	.0%
IBM	134.5	86.3	45.8	24,105	11.1%	12.7%	9.9%	12.9%
NEC	61.4	43.7	12.3	7,925	5.1%	6.4%	2.7%	4.2%
Apple Computer	59.5	59.6	.0	14,158	4.9%	8.7%	.0%	7.6%
Fujitsu	43.7	38.4	5.3	5,189	3.6%	5.6%	1.1%	2.8%
Hakuto	40.5	23.9	16.6	975	3.3%	3.5%	3.6%	.5%
Digital	39.6	37.6	.0	12,716	3.3%	5.5%	.0%	6.8%
Toshiba—No OEM	37.4	18.7	15.0	2,802	3.1%	2.7%	3.2%	1.5%
Hewlett-Packard	31.9	28.7	.0	10,098	2.6%	4.2%	.0%	5.4%
Investronica SA	31.5	19.7	8.3	1,077	2.6%	2.9%	1.8%	.6%
Mutoh Industries—No OEM	26.3	19.6	6.7	927	2.2%	2.9%	1.5%	.5%
Andor	23.1	5.1	17.1	421	1.9%	.7%	3.7%	.2%
Hitachi	22.8	10.7	9.8	1,165	1.9%	1.6%	2.1%	.6%
Wiechers Datentechnik	16.4	3.3	9.8	282	1.4%	.5%	2.1%	.2%
Tebis	13.7	3.6	2.1	92	1.1%	.5%	.4%	.0%
Siemens Nixdorf Infosysteme	12.8	12.2	.0	2,220	1.1%	1.8%	.0%	1.2%
Cimatron	12.6	5.5	5.7	651	1.0%	.8%	1.2%	.3%
CADKEY	11.3	.0	10.5	0	.9%	.0%	2.3%	.0%
Kozo Keikaku Engineering	9.7	.4	2.5	31	.8%	.1%	.5%	.0%
Parametric Technology	9.2	.0	7.5	0	.8%	.0%	1.6%	.0%
Point Control	9.1	.0	7.2	0	.8%	.0%	1.6%	.0%

(Continued)

Table 10 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application:	Mechanical
Platform:	Personal Computer
Region:	Worldwide
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Computervision	8.8	.0	8.8	170	.7%	.0%	1.9%	.1%
Design Automation	8.6	1.8	6.5	295	.7%	.3%	1.4%	.2%
CNC Software	7.3	.0	7.3	0	.6%	.0%	1.6%	.0%
Intergraph	7.2	2.1	3.6	387	.6%	.3%	.8%	.2%
Swanson Analysis	6.9	.0	6.2	0	.6%	.0%	1.3%	.0%
Wacom	6.8	1.4	4.7	239	.6%	.2%	1.0%	.1%
Ziegler Informatics	6.1	.0	6.1	0	.5%	.0%	1.3%	.0%
ADRA Systems	5.9	.0	4.7	0	.5%	.0%	1.0%	.0%
MCS	5.8	.2	4.9	49	.5%	.0%	1.1%	.0%
Algor Interactive Systems	5.5	.0	4.8	0	.5%	.0%	1.0%	.0%
CAD Lab	5.4	1.7	2.5	266	.4%	.2%	.5%	.1%
Serbi	5.1	.6	4.5	200	.4%	.1%	1.0%	.1%
Mitsubishi Electric	5.0	3.3	1.7	414	.4%	.5%	.4%	.2%
Moda CAD	4.7	1.0	3.3	46	.4%	.1%	.7%	.0%
American Small Business Comp.	4.6	.0	4.6	0	.4%	.0%	1.0%	.0%
CAD Distribution	3.9	.1	3.4	21	.3%	.0%	.7%	.0%
Pathtrace Engineering Systems	3.9	.8	2.1	101	.3%	.1%	.4%	.1%
Anilam Electronics	3.9	.7	2.8	46	.3%	.1%	.6%	.0%
Micrografx	3.6	.0	3.6	0	.3%	.0%	.8%	.0%
Vero International Software	3.4	.0	3.1	0	.3%	.0%	.7%	.0%
Whessoe Computing Systems	3.3	.0	3.3	0	.3%	.0%	.7%	.0%

(Continued)

Table 10 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: Personal Computer
Region: Worldwide
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
RoboCAD Solutions	3.3	.0	2.6	0	.3%	.0%	.6%	.0%
Engineering Mechanics	3.2	.0	3.2	0	.3%	.0%	.7%	.0%
Foresight Resources	3.1	.0	2.9	0	.3%	.0%	.6%	.0%
Rasna Corporation	3.0	.0	2.7	0	.2%	.0%	.6%	.0%
Superdraft	2.9	1.3	1.3	208	.2%	.2%	.3%	.1%
Kloeckner-Moeller	2.8	.6	1.9	0	.2%	.1%	.4%	.0%
Kubota Computer	2.3	1.7	.4	117	.2%	.3%	.1%	.1%
ISD Software	2.1	.0	2.1	0	.2%	.0%	.4%	.0%
Technische Computer Systeme	1.9	.3	1.4	57	.2%	.0%	.3%	.0%
FEA	1.8	.4	.4	178	.1%	.1%	.1%	.1%
Matra Datavision	1.8	.8	1.0	189	.1%	.1%	.2%	.1%
CAMTEK	1.7	.4	1.2	157	.1%	.1%	.2%	.1%
Mitsui Engineering	1.7	1.2	.3	37	.1%	.2%	.1%	.0%
Softronics	1.6	.3	1.3	123	.1%	.0%	.3%	.1%
Evolution Computing	1.5	.0	1.5	0	.1%	.0%	.3%	.0%
Ashlar	1.4	.0	.0	0	.1%	.0%	.0%	.0%
Delcam International	1.2	.4	.5	34	.1%	.1%	.1%	.0%
Claris	1.2	.0	1.2	0	.1%	.0%	.3%	.0%
GRAPHSOFT	1.2	.0	1.2	0	.1%	.0%	.2%	.0%
PAFEC	1.1	.0	1.1	0	.1%	.0%	.2%	.0%
CATALPA groupe Missler	1.1	.5	.5	65	.1%	.1%	.1%	.0%

(Continued)

Table 10 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: Personal Computer
Region: Worldwide
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
MacNeal-Schwendler	1.1	.0	1.0	0	.1%	.0%	.2%	.0%
Caroline Informatique	1.0	.2	.5	19	.1%	.0%	.1%	.0%
Kreon	1.0	.5	.2	19	.1%	.1%	.1%	.0%
Other Companies	250.5	242.0	7.3	98,864	20.7%	35.5%	1.6%	52.8%
All Companies	1,209.6	681.1	463.7	187,133	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	761.4	448.6	293.2	157,587	62.9%	65.9%	63.2%	84.2%
All Asian-Based Companies	289.5	169.8	99.0	20,545	23.9%	24.9%	21.3%	11.0%
All European-Based Companies	158.7	62.7	71.6	9,001	13.1%	9.2%	15.4%	4.8%
All Hardware Companies	488.6	483.5	.0	164,503	40.4%	71.0%	.0%	87.9%
All Turnkey & SW Companies	721.0	197.6	463.7	22,631	59.6%	29.0%	100.0%	12.1%

Source: Dataquest (July 1994)

Table 11
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: All Platforms
Region: North America
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
IBM	368.0	233.1	75.5	17,370	16.1%	19.6%	11.0%	15.5%
Sun Microsystems	237.0	190.2	.0	9,371	10.3%	16.0%	.0%	8.4%
Hewlett-Packard	215.8	156.7	18.7	11,669	9.4%	13.2%	2.7%	10.4%
Silicon Graphics	181.3	159.4	.0	6,211	7.9%	13.4%	.0%	5.6%
EDS Unigraphics	167.7	48.8	78.7	3,172	7.3%	4.1%	11.5%	2.8%
Digital	152.7	121.0	.1	6,808	6.7%	10.2%	.0%	6.1%
Parametric Technology	116.9	.0	95.9	0	5.1%	.0%	14.0%	.0%
Intergraph	102.0	23.8	45.9	1,156	4.5%	2.0%	6.7%	1.0%
Computervision	85.3	27.4	18.9	1,171	3.7%	2.3%	2.8%	1.0%
Autodesk	75.3	.0	75.3	0	3.3%	.0%	11.0%	.0%
SDRC	54.9	.0	37.4	0	2.4%	.0%	5.4%	.0%
MacNeal-Schwendler	36.1	.0	35.4	0	1.6%	.0%	5.2%	.0%
Control Data Systems	29.8	15.6	5.9	464	1.3%	1.3%	.9%	.4%
Applicon	28.7	9.5	11.2	339	1.3%	.8%	1.6%	.3%
Apple Computer	27.9	27.9	.0	7,337	1.2%	2.3%	.0%	6.6%
PDA Engineering	25.1	.0	23.6	0	1.1%	.0%	3.4%	.0%
Graftek	23.8	9.8	9.0	608	1.0%	.8%	1.3%	.5%
Alias Research	17.2	.0	15.9	0	.8%	.0%	2.3%	.0%
Gerber Systems	16.1	7.6	6.9	260	.7%	.6%	1.0%	.2%
Swanson Analysis	15.1	.0	13.4	0	.7%	.0%	2.0%	.0%
Cimlinc	13.1	.6	6.6	31	.6%	.0%	1.0%	.0%

(Continued)

Table 11 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: All Platforms
Region: North America
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Rasna Corporation	11.2	.0	10.1	0	.5%	.0%	1.5%	.0%
ICAD	10.9	.0	8.9	0	.5%	.0%	1.3%	.0%
Auto-Trol	10.9	3.7	4.4	134	.5%	.3%	.6%	.1%
ADRA Systems	10.5	.0	8.3	0	.5%	.0%	1.2%	.0%
CADKEY	9.4	.0	8.7	0	.4%	.0%	1.3%	.0%
MCS	7.6	.3	6.4	41	.3%	.0%	.9%	.0%
Point Control	7.1	.0	5.6	0	.3%	.0%	.8%	.0%
Kubota Computer	6.8	5.1	1.1	77	.3%	.4%	.2%	.1%
CAMAX Systems Inc.	6.2	.6	4.0	57	.3%	.1%	.6%	.1%
Matra Datavision	6.1	2.0	3.5	99	.3%	.2%	.5%	.1%
Mechanical Dynamics	6.1	.0	5.0	0	.3%	.0%	.7%	.0%
Engineering Mechanics	6.1	.4	5.3	31	.3%	.0%	.8%	.0%
Algor Interactive Systems	5.5	.0	4.8	0	.2%	.0%	.7%	.0%
CNC Software	4.9	.0	4.9	0	.2%	.0%	.7%	.0%
Cimatron	4.4	1.9	2.0	150	.2%	.2%	.3%	.1%
Delcam International	4.1	1.4	1.8	53	.2%	.1%	.3%	.0%
American Small Business Comp.	4.1	.0	4.1	0	.2%	.0%	.6%	.0%
Moda CAD	3.1	.6	2.2	30	.1%	.1%	.3%	.0%
CADSI	3.1	.4	2.4	18	.1%	.0%	.4%	.0%
Cisigraph	3.0	.8	1.6	45	.1%	.1%	.2%	.0%
MARC	2.8	.0	2.7	0	.1%	.0%	.4%	.0%

(Continued)

Table 11 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application:	Mechanical
Platform:	All Platforms
Region:	North America
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Foresight Resources	2.6	.0	2.4	0	.1%	.0%	.4%	.0%
Investronica SA	2.2	1.4	.6	75	.1%	.1%	.1%	.1%
Micrografx	2.1	.0	2.1	0	.1%	.0%	.3%	.0%
Pathtrace Engineering Systems	2.0	.4	1.1	51	.1%	.0%	.2%	.0%
SPATIAL Technology	1.4	.0	.0	0	.1%	.0%	.0%	.0%
Ashlar	1.2	.0	.0	0	.1%	.0%	.0%	.0%
GRAPHSOFT	1.2	.0	1.2	0	.1%	.0%	.2%	.0%
Evolution Computing	1.1	.0	1.1	0	.0%	.0%	.2%	.0%
Valisys	1.1	.0	.0	0	.0%	.0%	.0%	.0%
Other Companies	151.3	141.4	6.6	44,874	6.6%	11.9%	1.0%	40.2%
All Companies	2,289.8	1,191.7	686.7	111,704	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	2,258.2	1,178.4	672.7	111,138	98.6%	98.9%	98.0%	99.5%
All Asian-Based Companies	7.5	5.1	1.7	77	.3%	.4%	.2%	.1%
All European-Based Companies	24.2	8.1	12.4	489	1.1%	.7%	1.8%	.4%
All Hardware Companies	970.0	842.0	.0	97,179	42.4%	70.7%	.0%	87.0%
All Turnkey & SW Companies	1,319.8	349.7	686.7	14,526	57.6%	29.3%	100.0%	13.0%

Source: Dataquest (July 1994)

Table 12
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: Technical Workstation
Region: North America
Units: Millions of U.S. Dollars/Actual Units

Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Market Share: Total Factory Revenue	Market Share: Hardware Revenue	Market Share: Software Revenue	Market Share: Hardware Units Shipped
Hewlett-Packard	194.8	138.1	18.7	5,752	13.6%	20.3%	4.2%	18.5%
Silicon Graphics	175.9	154.8	.0	6,142	12.3%	22.8%	.0%	19.8%
Sun Microsystems	163.3	129.0	.0	7,702	11.4%	19.0%	.0%	24.8%
IBM	144.9	97.1	29.4	3,318	10.1%	14.3%	6.6%	10.7%
EDS Unigraphics	141.7	41.0	66.7	2,829	9.9%	6.0%	14.9%	9.1%
Parametric Technology	111.1	.0	91.1	0	7.8%	.0%	20.4%	.0%
Intergraph	89.3	19.9	40.1	832	6.3%	2.9%	9.0%	2.7%
Computervision	81.3	27.1	15.7	1,090	5.7%	4.0%	3.5%	3.5%
SDRC	54.3	.0	37.0	0	3.8%	.0%	8.3%	.0%
Digital	29.8	23.2	.1	1,480	2.1%	3.4%	.0%	4.8%
Applicon	28.7	9.5	11.2	339	2.0%	1.4%	2.5%	1.1%
PDA Engineering	22.6	.0	21.3	0	1.6%	.0%	4.8%	.0%
Graftek	19.1	7.5	7.3	394	1.3%	1.1%	1.6%	1.3%
Control Data Systems	17.9	8.7	4.9	310	1.3%	1.3%	1.1%	1.0%
Alias Research	17.2	.0	15.9	0	1.2%	.0%	3.5%	.0%
Gerber Systems	16.1	7.6	6.9	260	1.1%	1.1%	1.5%	.8%
Cimlinc	12.5	.5	6.2	29	.9%	.1%	1.4%	.1%
ICAD	10.9	.0	8.9	0	.8%	.0%	2.0%	.0%
Auto-Trol	10.9	3.7	4.4	134	.8%	.5%	1.0%	.4%
Swanson Analysis	9.9	.0	9.0	0	.7%	.0%	2.0%	.0%
Rasna Corporation	9.0	.0	8.1	0	.6%	.0%	1.8%	.0%
ADRA Systems	7.6	.0	5.9	0	.5%	.0%	1.3%	.0%
CAMAX Systems Inc.	6.2	.6	4.0	57	.4%	.1%	.9%	.2%

(Continued)

Table 12 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: Technical Workstation
Region: North America
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Matra Datavision	6.0	1.9	3.4	87	.4%	.3%	.8%	.3%
Kubota Computer	5.4	4.1	.9	51	.4%	.6%	.2%	.2%
MacNeal-Schwendler	4.7	.0	4.0	0	.3%	.0%	.9%	.0%
Mechanical Dynamics	4.4	.0	3.6	0	.3%	.0%	.8%	.0%
Delcam International	4.0	1.4	1.7	48	.3%	.2%	.4%	.2%
MCS	3.9	.2	3.3	10	.3%	.0%	.7%	.0%
Autodesk	3.8	.0	3.8	0	.3%	.0%	.8%	.0%
Engineering Mechanics	3.7	.4	2.8	31	.3%	.1%	.6%	.1%
Cimatron	2.9	1.3	1.3	65	.2%	.2%	.3%	.2%
Cisigraph	2.7	.7	1.4	43	.2%	.1%	.3%	.1%
CADSI	2.5	.3	2.0	10	.2%	.0%	.4%	.0%
MARC	2.1	.0	2.0	0	.1%	.0%	.4%	.0%
SPATIAL Technology	1.3	.0	.0	0	.1%	.0%	.0%	.0%
Valisys	1.0	.0	.0	0	.1%	.0%	.0%	.0%
Other Companies	5.1	.4	4.0	34	.4%	.1%	.9%	.1%
All Companies	1,428.2	678.7	447.0	31,049	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	1,405.0	669.3	436.3	30,750	98.4%	98.6%	97.6%	99.0%
All Asian-Based Companies	6.1	4.1	1.5	51	.4%	.6%	.3%	.2%
All European-Based Companies	17.1	5.4	9.2	248	1.2%	.8%	2.1%	.8%
All Hardware Companies	535.2	452.2	.0	21,264	37.5%	66.6%	.0%	68.5%
All Turnkey & SW Companies	893.0	226.5	447.0	9,786	62.5%	33.4%	100.0%	31.5%

Source: Dataquest (July 1994)

Table 13
1993 CAD/CAM/CAE/GIS Market Share Update

Application:	**Mechanical**
Platform:	**Host-Dependent**
Region:	**North America**
Units:	**Millions of U.S. Dollars/Actual Units**

					Market Share			
Company	**Total Factory Revenue**	**Hardware Revenue**	**Software Revenue**	**Hardware Units Shipped**	**Total Factory Revenue**	**Hardware Revenue**	**Software Revenue**	**Hardware Units Shipped**
IBM	165.5	94.4	33.1	3,204	53.3%	49.5%	52.3%	57.9%
Digital	45.2	35.2	.0	0	14.6%	18.5%	.0%	.0%
MacNeal-Schwendler	19.9	.0	19.9	0	6.4%	.0%	31.4%	.0%
Control Data Systems	10.7	6.3	.9	140	3.5%	3.3%	1.3%	2.5%
Graftek	4.4	2.2	1.5	205	1.4%	1.1%	2.4%	3.7%
PDA Engineering	2.5	.0	2.4	0	.8%	.0%	3.7%	.0%
Intergraph	2.0	.0	1.8	0	.7%	.0%	2.9%	.0%
Swanson Analysis	1.7	.0	1.3	0	.5%	.0%	2.1%	.0%
Mechanical Dynamics	1.3	.0	1.0	0	.4%	.0%	1.6%	.0%
Other Companies	57.2	52.7	1.4	1,989	18.4%	27.6%	2.2%	35.9%
All Companies	310.4	190.8	63.3	5,538	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	310.2	190.8	63.1	5,538	99.9%	100.0%	99.7%	100.0%
All Asian-Based Companies	.0	.0	.0	0	.0%	.0%	.0%	.0%
All European-Based Companies	.2	.0	.2	0	.1%	.0%	.3%	.0%
All Hardware Companies	106.0	92.1	.0	2,070	34.2%	48.3%	.0%	37.4%
All Turnkey & SW Companies	204.4	98.7	63.3	3,467	65.8%	51.7%	100.0%	62.6%

Source: Dataquest (July 1994)

Table 14
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: Server
Region: North America
Units: Millions of U.S. Dollars/Actual Units

Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Market Share: Total Factory Revenue	Market Share: Hardware Revenue	Market Share: Software Revenue	Market Share: Hardware Units Shipped
Sun Microsystems	73.7	61.2	.0	1,669	34.6%	42.8%	.0%	49.8%
Digital	65.8	51.4	.0	815	30.9%	35.9%	.0%	24.3%
EDS Unigraphics	26.0	7.8	11.9	343	12.2%	5.5%	41.0%	10.3%
IBM	15.7	9.7	3.5	220	7.4%	6.8%	11.8%	6.6%
MacNeal-Schwendler	10.8	.0	10.8	0	5.1%	.0%	37.2%	.0%
Intergraph	6.6	2.7	2.0	86	3.1%	1.9%	6.8%	2.6%
Silicon Graphics	5.4	4.6	.0	69	2.6%	3.2%	.0%	2.1%
Hewlett-Packard	4.0	3.3	.0	72	1.9%	2.3%	.0%	2.1%
Control Data Systems	1.2	.7	.1	13	.6%	.5%	.4%	.4%
Kubota Computer	1.0	.8	.2	8	.5%	.5%	.5%	.2%
Other Companies	2.5	.9	.6	54	1.2%	.7%	2.2%	1.6%
All Companies	212.8	142.9	29.2	3,350	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	211.5	142.1	28.8	3,340	99.4%	99.4%	98.9%	99.7%
All Asian-Based Companies	1.0	.8	.2	8	.5%	.5%	.5%	.2%
All European-Based Companies	.3	.1	.2	2	.1%	.1%	.5%	.1%
All Hardware Companies	152.3	123.5	.0	2,717	71.6%	86.4%	.0%	81.1%
All Turnkey & SW Companies	60.5	19.4	29.2	633	28.4%	13.6%	100.0%	18.9%

Source: Dataquest (July 1994)

Table 15
1993 CAD/CAM/CAE/GIS Market Share Update

Application:	Mechanical
Platform:	Personal Computer
Region:	North America
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Autodesk	71.6	.0	71.6	0	21.1%	.0%	48.6%	.0%
IBM	41.9	31.9	9.5	10,628	12.4%	17.8%	6.4%	14.8%
Apple Computer	27.9	27.9	.0	7,337	8.2%	15.6%	.0%	10.2%
Hewlett-Packard	17.1	15.4	.0	5,845	5.1%	8.6%	.0%	8.1%
Digital	11.9	11.3	.0	4,513	3.5%	6.3%	.0%	6.3%
CADKEY	9.0	.0	8.3	0	2.7%	.0%	5.7%	.0%
Point Control	6.4	.0	5.0	0	1.9%	.0%	3.4%	.0%
Parametric Technology	5.8	.0	4.8	0	1.7%	.0%	3.3%	.0%
CNC Software	4.9	.0	4.9	0	1.4%	.0%	3.3%	.0%
Algor Interactive Systems	4.7	.0	4.1	0	1.4%	.0%	2.8%	.0%
American Small Business Comp.	4.1	.0	4.1	0	1.2%	.0%	2.8%	.0%
Intergraph	4.1	1.2	2.0	238	1.2%	.7%	1.4%	.3%
MCS	3.6	.1	3.1	31	1.1%	.1%	2.1%	.0%
Swanson Analysis	3.5	.0	3.1	0	1.0%	.0%	2.1%	.0%
Computervision	3.1	.0	3.1	72	.9%	.0%	2.1%	.1%
Moda CAD	3.1	.6	2.2	30	.9%	.3%	1.5%	.0%
ADRA Systems	2.9	.0	2.4	0	.9%	.0%	1.6%	.0%
Foresight Resources	2.6	.0	2.4	0	.8%	.0%	1.7%	.0%
Engineering Mechanics	2.4	.0	2.4	0	.7%	.0%	1.7%	.0%
Rasna Corporation	2.2	.0	2.0	0	.7%	.0%	1.4%	.0%
Investronica SA	2.2	1.4	.6	75	.7%	.8%	.4%	.1%

(Continued)

Table 15 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: Personal Computer
Region: North America
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Micrografx	2.1	.0	2.1	0	.6%	.0%	1.4%	.0%
Pathtrace Engineering Systems	2.0	.4	1.1	51	.6%	.2%	.7%	.1%
Cimatron	1.6	.7	.7	84	.5%	.4%	.5%	.1%
Ashlar	1.2	.0	.0	0	.3%	.0%	.0%	.0%
GRAPHSOFT	1.2	.0	1.2	0	.3%	.0%	.8%	.0%
Evolution Computing	1.1	.0	1.1	0	.3%	.0%	.8%	.0%
Other Companies	94.3	88.3	5.5	42,863	27.9%	49.3%	3.7%	59.7%
All Companies	338.4	179.2	147.2	71,767	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	331.5	176.3	144.4	71,511	98.0%	98.4%	98.0%	99.6%
All Asian-Based Companies	.3	.3	.1	18	.1%	.1%	.0%	.0%
All European-Based Companies	6.6	2.7	2.8	239	1.9%	1.5%	1.9%	.3%
All Hardware Companies	176.5	174.2	.0	71,128	52.2%	97.2%	.0%	99.1%
All Turnkey & SW Companies	161.9	5.0	147.2	640	47.8%	2.8%	100.0%	.9%

Source: Dataquest (July 1994)

Table 16
1993 CAD/CAM/CAE/GIS Market Share Update

Application:	Mechanical
Platform:	All Platforms
Region:	Europe
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
IBM	635.9	381.0	136.4	18,754	22.1%	25.6%	17.4%	18.6%
Hewlett-Packard	306.6	208.6	35.8	10,409	10.7%	14.0%	4.6%	10.3%
Computervision	278.9	62.8	86.3	3,847	9.7%	4.2%	11.0%	3.8%
Digital	274.7	217.8	.0	9,804	9.6%	14.6%	.0%	9.7%
Silicon Graphics	105.2	92.1	.0	2,789	3.7%	6.2%	.0%	2.8%
Sun Microsystems	86.7	69.5	.0	2,848	3.0%	4.7%	.0%	2.8%
Matra Datavision	76.7	25.9	43.1	1,414	2.7%	1.7%	5.5%	1.4%
EDS Unigraphics	70.0	20.8	33.2	1,062	2.4%	1.4%	4.2%	1.1%
Siemens Nixdorf Info systeme	62.9	30.9	12.0	2,924	2.2%	2.1%	1.5%	2.9%
Intergraph	62.7	22.7	19.9	877	2.2%	1.5%	2.5%	.9%
Autodesk	52.9	.0	52.9	0	1.8%	.0%	6.8%	.0%
SDRC	51.3	.0	35.0	0	1.8%	.0%	4.5%	.0%
Parametric Technology	49.3	.0	40.4	0	1.7%	.0%	5.2%	.0%
Control Data Systems	45.3	23.1	9.3	622	1.6%	1.6%	1.2%	.6%
Applicon	38.5	12.7	15.0	424	1.3%	.9%	1.9%	.4%
ASCAD/ASCAM	28.2	16.7	8.7	436	1.0%	1.1%	1.1%	.4%
CAD Lab	24.7	7.6	11.4	580	.9%	.5%	1.5%	.6%
Straessle Informationssysteme	23.6	3.9	14.3	405	.8%	.3%	1.8%	.4%
Investronica SA	23.6	14.8	6.2	808	.8%	1.0%	.8%	.8%
Marcus Computer Systeme	22.1	11.3	7.6	400	.8%	.8%	1.0%	.4%
MacNeal-Schwendler	21.8	.0	20.8	0	.8%	.0%	2.7%	.0%

(Continued)

Table 16 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: All Platforms
Region: Europe
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Cisigraph	21.3	5.8	11.3	319	.7%	.4%	1.4%	.3%
ISD Software	20.6	4.3	13.0	682	.7%	.3%	1.7%	.7%
Cimatron	20.3	9.0	9.2	686	.7%	.6%	1.2%	.7%
Wiechers Datentechnik	18.1	3.9	10.5	324	.6%	.3%	1.3%	.3%
Digital Kienzle	16.4	8.2	4.6	248	.6%	.5%	.6%	.2%
Radan Computational	16.1	5.5	8.1	324	.6%	.4%	1.0%	.3%
Delcam International	14.8	5.1	6.4	191	.5%	.3%	.8%	.2%
Tebis	13.3	3.5	2.0	89	.5%	.2%	.3%	.1%
Apple Computer	12.6	12.6	.0	2,646	.4%	.8%	.0%	2.6%
PDA Engineering	12.6	.0	11.8	0	.4%	.0%	1.5%	.0%
Isicad CAD/CAM Systeme	11.5	4.0	4.6	195	.4%	.3%	.6%	.2%
Exapt	10.9	5.2	3.8	210	.4%	.4%	.5%	.2%
ICL	10.0	5.8	3.4	287	.3%	.4%	.4%	.3%
Framasoft + CSI	9.0	.3	4.0	20	.3%	.0%	.5%	.0%
Swanson Analysis	8.7	.0	7.8	0	.3%	.0%	1.0%	.0%
PAFEC	8.6	2.6	4.9	107	.3%	.2%	.6%	.1%
Han Dataport	8.4	2.3	4.3	255	.3%	.2%	.6%	.3%
ItalCad	8.4	2.4	3.5	185	.3%	.2%	.5%	.2%
Cimlinc	8.2	.3	4.1	19	.3%	.0%	.5%	.0%
Ziegler Informatics	6.0	.0	6.0	0	.2%	.0%	.8%	.0%
ADRA Systems	5.7	.3	4.1	20	.2%	.0%	.5%	.0%

(Continued)

Table 16 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: All Platforms
Region: Europe
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Gerber Systems	5.4	2.5	2.3	87	.2%	.2%	.3%	.1%
Serbi	5.1	.6	4.5	200	.2%	.0%	.6%	.2%
Auto-Trol	4.5	1.5	1.8	55	.2%	.1%	.2%	.1%
CAD Distribution	4.1	.1	3.6	22	.1%	.0%	.5%	.0%
Alias Research	4.0	.0	3.7	0	.1%	.0%	.5%	.0%
Technische Computer Systeme	3.9	.8	2.8	74	.1%	.1%	.4%	.1%
MARC	3.5	.0	3.4	0	.1%	.0%	.4%	.0%
RoboCAD Solutions	3.3	.0	2.6	0	.1%	.0%	.3%	.0%
FEA	3.3	.7	.9	196	.1%	.0%	.1%	.2%
Whessoe Computing Systems	3.2	.0	3.2	0	.1%	.0%	.4%	.0%
debis Systemhaus	3.1	.7	2.0	22	.1%	.0%	.3%	.0%
Kloeckner-Moeller	2.8	.6	1.9	0	.1%	.0%	.2%	.0%
CATALPA groupe Missler	2.8	1.2	1.2	84	.1%	.1%	.2%	.1%
Caroline Informatique	2.7	.5	1.4	27	.1%	.0%	.2%	.0%
Mechanical Dynamics	2.5	.0	2.0	0	.1%	.0%	.3%	.0%
MCS	2.5	.1	2.1	14	.1%	.0%	.3%	.0%
Anilam Electronics	2.5	.5	1.8	0	.1%	.0%	.2%	.0%
Vero International Software	2.4	.0	2.2	0	.1%	.0%	.3%	.0%
Superdraft	2.3	1.0	1.0	164	.1%	.1%	.1%	.2%
ICAD	2.3	.0	1.9	0	.1%	.0%	.2%	.0%
ISKA	2.1	.9	.9	39	.1%	.1%	.1%	.0%

(Continued)

Table 16 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: All Platforms
Region: Europe
Units: Millions of U.S. Dollars/Actual Units

Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Market Share: Total Factory Revenue	Market Share: Hardware Revenue	Market Share: Software Revenue	Market Share: Hardware Units Shipped
Rasna Corporation	2.1	.0	1.9	0	.1%	.0%	.2%	.0%
FEGS	2.0	.0	.8	0	.1%	.0%	.1%	.0%
CAMTEK	1.8	.4	1.2	159	.1%	.0%	.2%	.2%
Pathtrace Engineering Systems	1.8	.4	1.0	46	.1%	.0%	.1%	.0%
Softronics	1.6	.3	1.3	123	.1%	.0%	.2%	.1%
Micrografx	1.5	.0	1.5	0	.1%	.0%	.2%	.0%
Graftek	1.5	.7	.6	192	.1%	.0%	.1%	.2%
Point Control	1.4	.0	1.1	0	.0%	.0%	.1%	.0%
Engineering Mechanics	1.2	.1	1.1	6	.0%	.0%	.1%	.0%
Moda CAD	1.1	.2	.8	10	.0%	.0%	.1%	.0%
CAMAX Systems Inc.	1.1	.1	.7	10	.0%	.0%	.1%	.0%
CADSI	1.0	.1	.8	7	.0%	.0%	.1%	.0%
Other Companies	184.7	171.4	6.5	33,900	6.4%	11.5%	.8%	33.7%
All Companies	2,873.8	1,488.5	782.0	100,647	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	2,347.1	1,296.5	546.8	85,647	81.7%	87.1%	69.9%	85.1%
All Asian-Based Companies	.0	.0	.0	0	.0%	.0%	.0%	.0%
All European-Based Companies	526.7	192.0	235.3	15,000	18.3%	12.9%	30.1%	14.9%
All Hardware Companies	910.1	790.0	.0	71,203	31.7%	53.1%	.0%	70.7%
All Turnkey & SW Companies	1,963.8	698.5	782.0	29,445	68.3%	46.9%	100.0%	29.3%

Source: Dataquest (July 1994)

Table 17
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: Technical Workstation
Region: Europe
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
IBM	357.9	215.6	74.3	5,657	19.3%	25.5%	13.5%	17.2%
Hewlett-Packard	293.3	196.7	35.8	6,936	15.8%	23.2%	6.5%	21.0%
Computervision	272.5	62.2	81.1	3,735	14.7%	7.3%	14.7%	11.3%
Silicon Graphics	89.5	78.7	.0	2,621	4.8%	9.3%	.0%	7.9%
Matra Datavision	75.2	25.2	42.3	1,247	4.1%	3.0%	7.7%	3.8%
Sun Microsystems	59.7	47.2	.0	2,340	3.2%	5.6%	.0%	7.1%
EDS Unigraphics	56.0	16.5	26.7	911	3.0%	1.9%	4.8%	2.8%
Intergraph	55.8	20.1	17.3	706	3.0%	2.4%	3.1%	2.1%
Digital	53.4	41.7	.0	2,132	2.9%	4.9%	.0%	6.5%
SDRC	50.8	.0	34.7	0	2.7%	.0%	6.3%	.0%
Siemens Nixdorf Info systeme	50.3	19.0	12.0	753	2.7%	2.2%	2.2%	2.3%
Parametric Technology	46.8	.0	38.4	0	2.5%	.0%	7.0%	.0%
Applicon	38.5	12.7	15.0	424	2.1%	1.5%	2.7%	1.3%
Control Data Systems	27.4	13.0	7.8	414	1.5%	1.5%	1.4%	1.3%
ASCAD/ASCAM	27.3	16.1	8.5	413	1.5%	1.9%	1.5%	1.3%
Straessle Informationssysteme	23.6	3.9	14.3	405	1.3%	.5%	2.6%	1.2%
Marcus Computer Systeme	22.1	11.3	7.6	400	1.2%	1.3%	1.4%	1.2%
CAD Lab	19.3	5.9	8.9	315	1.0%	.7%	1.6%	1.0%
Cisigraph	19.2	5.2	10.1	305	1.0%	.6%	1.8%	.9%
ISD Software	18.5	4.3	11.0	682	1.0%	.5%	2.0%	2.1%
Digital Kienzle	16.4	8.2	4.6	248	.9%	1.0%	.8%	.8%

(Continued)

Table 17 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application:	Mechanical
Platform:	Technical Workstation
Region:	Europe
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Radan Computational	16.0	5.5	8.0	309	.9%	.6%	1.4%	.9%
Delcam International	14.2	4.9	6.2	173	.8%	.6%	1.1%	.5%
Isicad CAD/CAM Systeme	11.5	4.0	4.6	195	.6%	.5%	.8%	.6%
PDA Engineering	11.3	.0	10.6	0	.6%	.0%	1.9%	.0%
Cimatron	11.2	4.9	5.1	228	.6%	.6%	.9%	.7%
ICL	10.0	5.8	3.4	287	.5%	.7%	.6%	.9%
ItalCad	8.4	2.4	3.5	185	.5%	.3%	.6%	.6%
Framasoft + CSI	8.1	.3	3.6	20	.4%	.0%	.7%	.1%
Cimlinc	7.7	.3	3.9	18	.4%	.0%	.7%	.1%
PAFEC	7.5	2.6	3.8	107	.4%	.3%	.7%	.3%
Han Dataport	7.4	2.0	3.8	216	.4%	.2%	.7%	.7%
MacNeal-Schwendler	6.5	.0	5.6	0	.4%	.0%	1.0%	.0%
Swanson Analysis	5.4	.0	4.9	0	.3%	.0%	.9%	.0%
Gerber Systems	5.4	2.5	2.3	87	.3%	.3%	.4%	.3%
Auto-Trol	4.5	1.5	1.8	55	.2%	.2%	.3%	.2%
ADRA Systems	4.1	.3	2.8	20	.2%	.0%	.5%	.1%
Alias Research	4.0	.0	3.7	0	.2%	.0%	.7%	.0%
Exapt	3.3	1.6	1.2	112	.2%	.2%	.2%	.3%
MARC	2.6	.0	2.5	0	.1%	.0%	.5%	.0%
Autodesk	2.6	.0	2.6	0	.1%	.0%	.5%	.0%
Technische Computer Systeme	2.4	.5	1.6	26	.1%	.1%	.3%	.1%

(Continued)

Table 17 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: Technical Workstation
Region: Europe
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
ICAD	2.3	.0	1.9	0	.1%	.0%	.3%	.0%
debis Systemhaus	2.3	.5	1.5	11	.1%	.1%	.3%	.0%
ISKA	2.1	.9	.9	39	.1%	.1%	.2%	.1%
FEGS	2.0	.0	.8	0	.1%	.0%	.1%	.0%
Mechanical Dynamics	1.8	.0	1.5	0	.1%	.0%	.3%	.0%
Wiechers Datentechnik	1.8	.6	.8	44	.1%	.1%	.1%	.1%
Caroline Informatique	1.7	.3	.9	9	.1%	.0%	.2%	.0%
Rasna Corporation	1.7	.0	1.5	0	.1%	.0%	.3%	.0%
CATALPA groupe Missler	1.7	.7	.8	19	.1%	.1%	.1%	.1%
MCS	1.3	.0	1.1	3	.1%	.0%	.2%	.0%
FEA	1.3	.3	.3	19	.1%	.0%	.1%	.1%
Graftek	1.2	.5	.5	124	.1%	.1%	.1%	.4%
CAMAX Systems Inc.	1.1	.1	.7	10	.1%	.0%	.1%	.0%
Other Companies	4.6	.3	3.3	24	.2%	.0%	.6%	.1%
All Companies	1,854.3	846.9	552.0	32,984	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	1,479.0	714.0	385.0	26,403	79.8%	84.3%	69.7%	80.0%
All Asian-Based Companies	.0	.0	.0	0	.0%	.0%	.0%	.0%
All European-Based Companies	375.3	132.9	167.1	6,582	20.2%	15.7%	30.3%	20.0%
All Hardware Companies	399.7	340.1	.0	13,332	21.6%	40.2%	.0%	40.4%
All Turnkey & SW Companies	1,454.6	506.9	552.0	19,652	78.4%	59.8%	100.0%	59.6%

Source: Dataquest (July 1994)

Table 18
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: Host-Dependent
Region: Europe
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
IBM	193.3	111.6	39.2	3,325	46.3%	39.8%	61.6%	46.5%
Digital	81.3	63.4	.0	0	19.5%	22.6%	.0%	.0%
Control Data Systems	16.1	9.2	1.4	190	3.8%	3.3%	2.1%	2.7%
MacNeal-Schwendler	15.3	.0	15.3	0	3.7%	.0%	24.0%	.0%
Exapt	7.6	3.6	2.7	98	1.8%	1.3%	4.2%	1.4%
PDA Engineering	1.3	.0	1.2	0	.3%	.0%	1.8%	.0%
Other Companies	102.7	92.6	3.9	3,534	24.6%	33.0%	6.2%	49.4%
All Companies	417.5	280.4	63.5	7,147	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	407.7	276.7	59.4	7,048	97.7%	98.7%	93.5%	98.6%
All Asian-Based Companies	.0	.0	.0	0	.0%	.0%	.0%	.0%
All European-Based Companies	9.8	3.7	4.1	99	2.3%	1.3%	6.5%	1.4%
All Hardware Companies	186.0	161.6	.0	3,595	44.6%	57.6%	.0%	50.3%
All Turnkey & SW Companies	231.4	118.9	63.5	3,552	55.4%	42.4%	100.0%	49.7%

Source: Dataquest (July 1994)

Table 19
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: Server
Region: Europe
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Digital	118.5	92.4	.0	1,174	53.2%	58.6%	.0%	46.3%
IBM	35.5	20.0	8.1	396	15.9%	12.7%	45.5%	15.6%
Sun Microsystems	27.0	22.4	.0	507	12.1%	14.2%	.0%	20.0%
Silicon Graphics	15.8	13.4	.0	168	7.1%	8.5%	.0%	6.6%
EDS Unigraphics	14.0	4.3	6.5	151	6.3%	2.7%	36.6%	5.9%
Intergraph	4.4	1.8	1.3	48	2.0%	1.1%	7.4%	1.9%
Cisigraph	2.1	.6	1.1	14	1.0%	.4%	6.3%	.6%
Control Data Systems	1.8	1.0	.2	18	.8%	.6%	1.1%	.7%
Computervision	1.4	.6	.2	14	.6%	.3%	1.0%	.6%
Hewlett-Packard	1.3	1.1	.0	21	.6%	.7%	.0%	.8%
Other Companies	1.1	.3	.4	26	.5%	.2%	2.2%	1.0%
All Companies	222.8	157.8	17.8	2,537	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	220.2	157.0	16.5	2,506	98.8%	99.5%	92.5%	98.8%
All Asian-Based Companies	.0	.0	.0	0	.0%	.0%	.0%	.0%
All European-Based Companies	2.7	.8	1.3	31	1.2%	.5%	7.5%	1.2%
All Hardware Companies	166.5	132.8	.0	1,939	74.7%	84.1%	.0%	76.5%
All Turnkey & SW Companies	56.4	25.0	17.8	597	25.3%	15.9%	100.0%	23.5%

Source: Dataquest (July 1994)

Table 20
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: Personal Computer
Region: Europe
Units: Millions of U.S. Dollars/Actual Units

Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Market Share: Total Factory Revenue	Market Share: Hardware Revenue	Market Share: Software Revenue	Market Share: Hardware Units Shipped
Autodesk	50.2	.0	50.2	0	13.2%	.0%	33.8%	.0%
IBM	49.3	33.8	14.8	9,376	13.0%	16.6%	9.9%	16.2%
Investronica SA	23.6	14.8	6.2	808	6.2%	7.3%	4.2%	1.4%
Digital	21.4	20.3	.0	6,498	5.6%	10.0%	.0%	11.2%
Wiechers Datentechnik	16.2	3.2	9.7	280	4.3%	1.6%	6.5%	.5%
Tebis	13.3	3.5	2.0	89	3.5%	1.7%	1.3%	.2%
Apple Computer	12.6	12.6	.0	2,646	3.3%	6.2%	.0%	4.6%
Siemens Nixdorf Info systeme	12.6	12.0	.0	2,171	3.3%	5.9%	.0%	3.7%
Hewlett-Packard	12.0	10.8	.0	3,453	3.2%	5.3%	.0%	6.0%
Cimatron	9.1	4.0	4.2	458	2.4%	2.0%	2.8%	.8%
Ziegler Informatics	6.0	.0	6.0	0	1.6%	.0%	4.1%	.0%
CAD Lab	5.4	1.7	2.5	266	1.4%	.8%	1.7%	.5%
Serbi	5.1	.6	4.5	200	1.4%	.3%	3.0%	.3%
Computervision	5.0	.0	5.0	98	1.3%	.0%	3.3%	.2%
CAD Distribution	3.9	.1	3.4	21	1.0%	.1%	2.3%	.0%
RoboCAD Solutions	3.3	.0	2.6	0	.9%	.0%	1.7%	.0%
Kloeckner-Moeller	2.8	.6	1.9	0	.7%	.3%	1.3%	.0%
Anilam Electronics	2.5	.5	1.8	0	.7%	.2%	1.2%	.0%
Intergraph	2.5	.8	1.3	123	.7%	.4%	.8%	.2%
Parametric Technology	2.5	.0	2.0	0	.6%	.0%	1.4%	.0%

(Continued)

Table 20 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: Personal Computer
Region: Europe
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Whessoe Computing Systems	2.5	.0	2.5	0	.6%	.0%	1.6%	.0%
Vero International Software	2.4	.0	2.2	0	.6%	.0%	1.5%	.0%
Swanson Analysis	2.4	.0	2.1	0	.6%	.0%	1.4%	.0%
Superdraft	2.3	1.0	1.0	164	.6%	.5%	.7%	.3%
ISD Software	2.1	.0	2.1	0	.5%	.0%	1.4%	.0%
Pathtrace Engineering Systems	1.8	.4	1.0	46	.5%	.2%	.7%	.1%
FEA	1.8	.4	.4	176	.5%	.2%	.3%	.3%
CAMTEK	1.7	.4	1.2	157	.5%	.2%	.8%	.3%
Softronics	1.6	.3	1.3	123	.4%	.2%	.9%	.2%
ADRA Systems	1.6	.0	1.3	0	.4%	.0%	.9%	.0%
Technische Computer Systeme	1.6	.3	1.2	48	.4%	.1%	.8%	.1%
Micrografx	1.5	.0	1.5	0	.4%	.0%	1.0%	.0%
Matra Datavision	1.5	.7	.8	167	.4%	.3%	.6%	.3%
Point Control	1.3	.0	1.0	0	.3%	.0%	.7%	.0%
MCS	1.2	.0	1.0	10	.3%	.0%	.7%	.0%
PAFEC	1.1	.0	1.1	0	.3%	.0%	.8%	.0%
CATALPA groupe Missler	1.1	.5	.5	65	.3%	.2%	.3%	.1%
Moda CAD	1.1	.2	.8	10	.3%	.1%	.5%	.0%

(Continued)

Table 20 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: Personal Computer
Region: Europe
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Caroline Informatique	1.0	.2	.5	19	.3%	.1%	.3%	.0%
Other Companies	88.4	79.9	7.2	30,506	23.3%	39.3%	4.8%	52.6%
All Companies	379.2	203.4	148.7	57,979	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	240.2	148.8	85.9	49,691	63.3%	73.2%	57.8%	85.7%
All Asian-Based Companies	.0	.0	.0	0	.0%	.0%	.0%	.0%
All European-Based Companies	139.0	54.5	62.8	8,288	36.7%	26.8%	42.2%	14.3%
All Hardware Companies	157.8	155.6	.0	52,336	41.6%	76.5%	.0%	90.3%
All Turnkey & SW Companies	221.4	47.8	148.7	5,644	58.4%	23.5%	100.0%	9.7%

Source: Dataquest (July 1994)

Table 21
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: All Platforms
Region: Asia
Units: Millions of U.S. Dollars/Actual Units

Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Market Share: Total Factory Revenue	Market Share: Hardware Revenue	Market Share: Software Revenue	Market Share: Hardware Units Shipped
IBM	280.1	128.4	101.6	5,753	11.0%	9.0%	12.9%	6.9%
NEC	245.8	165.4	58.4	11,515	9.6%	11.6%	7.4%	13.9%
Fujitsu	219.9	128.9	67.4	8,751	8.6%	9.1%	8.6%	10.5%
Nihon Unisys	218.2	129.2	44.5	1,014	8.5%	9.1%	5.7%	1.2%
Hitachi	143.6	67.5	61.8	6,076	5.6%	4.7%	7.8%	7.3%
Toshiba—No OEM	113.3	56.7	45.3	3,663	4.4%	4.0%	5.8%	4.4%
Hewlett-Packard	102.4	65.3	14.9	2,430	4.0%	4.6%	1.9%	2.9%
Hitachi Zosen Info Systems	89.8	76.1	4.4	865	3.5%	5.4%	.6%	1.0%
Computervision	78.1	16.3	39.3	755	3.1%	1.1%	5.0%	.9%
SDRC	70.8	.0	48.3	0	2.8%	.0%	6.1%	.0%
Digital	60.6	48.2	.0	2,029	2.4%	3.4%	.0%	2.4%
Mitsubishi Electric	50.3	39.3	6.3	795	2.0%	2.8%	.8%	1.0%
Silicon Graphics	48.6	48.6	.0	1,286	1.9%	3.4%	.0%	1.5%
Hakuto	43.1	25.4	17.6	1,006	1.7%	1.8%	2.2%	1.2%
Sharp System Products—No OEM	43.0	20.7	22.3	398	1.7%	1.5%	2.8%	.5%
Mutoh Industries—No OEM	42.5	26.4	12.8	1,146	1.7%	1.9%	1.6%	1.4%
Kubota Computer	38.2	29.1	6.1	438	1.5%	2.0%	.8%	.5%
Technodia	37.9	30.3	.4	425	1.5%	2.1%	.0%	.5%
EDS Unigraphics	31.5	9.2	14.8	397	1.2%	.6%	1.9%	.5%
Tokyo Electron—No OEM	25.6	8.7	11.3	124	1.0%	.6%	1.4%	.1%
Autodesk	25.6	.0	25.6	0	1.0%	.0%	3.3%	.0%

(Continued)

Table 21 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: All Platforms
Region: Asia
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Andor	23.1	5.1	17.1	421	.9%	.4%	2.2%	.5%
Toyo Information Systems-No OEM	23.0	13.7	6.9	258	.9%	1.0%	.9%	.3%
Mitsui Engineering	22.1	15.3	4.5	178	.9%	1.1%	.6%	.2%
Kozo Keikaku Engineering	21.6	1.3	5.8	40	.8%	.1%	.7%	.0%
Sun Microsystems	20.4	16.5	.0	548	.8%	1.2%	.0%	.7%
Parametric Technology	17.9	.0	14.7	0	.7%	.0%	1.9%	.0%
MacNeal-Schwendler	16.8	.0	16.4	0	.7%	.0%	2.1%	.0%
Sony	16.6	16.6	.0	823	.7%	1.2%	.0%	1.0%
Apple Computer	16.0	16.0	.0	3,377	.6%	1.1%	.0%	4.1%
Graphtec Engineering	15.3	7.5	7.0	404	.6%	.5%	.9%	.5%
Adam Net	11.5	6.6	3.6	14	.5%	.5%	.5%	.0%
Omron	11.5	5.7	4.6	255	.4%	.4%	.6%	.3%
Intergraph	10.8	3.8	3.6	127	.4%	.3%	.5%	.2%
Design Automation	8.6	1.8	6.5	295	.3%	.1%	.8%	.4%
CADIX	8.3	3.6	4.1	46	.3%	.3%	.5%	.1%
Wacom	8.1	1.6	5.7	261	.3%	.1%	.7%	.3%
Sumitomo Denko Workstation	7.9	7.9	.0	855	.3%	.6%	.0%	1.0%
MARC	7.8	.0	7.4	0	.3%	.0%	.9%	.0%
Ricoh—No OEM	6.5	.0	5.5	0	.3%	.0%	.7%	.0%
Delcam International	6.2	2.1	2.7	80	.2%	.2%	.3%	.1%
Swanson Analysis	5.7	.0	5.0	0	.2%	.0%	.6%	.0%

(Continued)

Table 21 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application:	Mechanical
Platform:	All Platforms
Region:	Asia
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Cisigraph	5.7	1.5	3.0	85	.2%	.1%	.4%	.1%
Control Data Systems	5.4	2.7	1.2	65	.2%	.2%	.1%	.1%
Gerber Systems	5.4	2.5	2.3	87	.2%	.2%	.3%	.1%
Alias Research	5.3	.0	4.9	0	.2%	.0%	.6%	.0%
Matra Datavision	5.0	1.7	2.8	75	.2%	.1%	.4%	.1%
Graftek	5.0	2.1	1.9	129	.2%	.1%	.2%	.2%
Mechanical Dynamics	4.7	.0	3.8	0	.2%	.0%	.5%	.0%
ADRA Systems	4.4	.0	3.5	0	.2%	.0%	.4%	.0%
ICAD	4.2	.0	3.4	0	.2%	.0%	.4%	.0%
Cimatron	3.4	1.5	1.5	113	.1%	.1%	.2%	.1%
PDA Engineering	3.4	.0	3.2	0	.1%	.0%	.4%	.0%
Investronica SA	3.2	2.0	.9	108	.1%	.1%	.1%	.1%
Century Research Center	2.9	1.5	1.1	14	.1%	.1%	.1%	.0%
Applicon	2.8	1.0	1.2	29	.1%	.1%	.1%	.0%
CAMAX Systems Inc.	2.3	.2	1.5	21	.1%	.0%	.2%	.0%
Cimlinc	2.2	.1	1.1	5	.1%	.0%	.1%	.0%
Straessle Informationssysteme	2.1	.2	1.4	9	.1%	.0%	.2%	.0%
Uchida Yoko	2.0	1.2	.7	53	.1%	.1%	.1%	.1%
MCS	1.9	.1	1.6	11	.1%	.0%	.2%	.0%
Anilam Electronics	1.4	.3	1.0	46	.1%	.0%	.1%	.1%
CADKEY	1.4	.0	1.3	0	.1%	.0%	.2%	.0%

(Continued)

Table 21 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application:	Mechanical
Platform:	All Platforms
Region:	Asia
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Radan Computational	1.2	.4	.6	24	.0%	.0%	.1%	.0%
Point Control	1.0	.0	.8	0	.0%	.0%	.1%	.0%
Zuken	1.0	.3	.5	6	.0%	.0%	.1%	.0%
Other Companies	183.8	158.8	17.9	25,248	7.2%	11.2%	2.3%	30.4%
All Companies	2,555.3	1,422.4	786.8	82,972	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	998.8	508.3	326.6	41,832	39.1%	35.7%	41.5%	50.4%
All Asian-Based Companies	1,525.3	904.1	444.3	40,571	59.7%	63.6%	56.5%	48.9%
All European-Based Companies	31.2	10.0	16.0	569	1.2%	.7%	2.0%	.7%
All Hardware Companies	420.4	395.4	.0	43,776	16.5%	27.8%	.0%	52.8%
All Turnkey & SW Companies	2,134.9	1,027.0	786.8	39,196	83.5%	72.2%	100.0%	47.2%

Source: Dataquest (July 1994)

Table 22
1993 CAD/CAM/CAE/GIS Market Share Update

Application:	Mechanical
Platform:	Technical Workstation
Region:	Asia
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
NEC	122.9	76.3	35.6	3,463	8.2%	10.0%	6.9%	15.7%
IBM	118.3	41.6	55.2	861	7.9%	5.4%	10.7%	3.9%
Fujitsu	117.2	63.3	38.5	2,673	7.8%	8.3%	7.5%	12.1%
Hitachi	109.5	51.5	47.1	2,167	7.3%	6.7%	9.1%	9.8%
Hewlett-Packard	99.9	63.0	14.9	1,945	6.6%	8.2%	2.9%	8.8%
Nihon Unisys	87.3		23.6	353	5.8%	6.3%	4.6%	1.6%
Hitachi Zosen Info Systems	85.8	72.5	4.4	865	5.7%	9.5%	.9%	3.9%
Computervision	77.6	16.3	38.8	755	5.2%	2.1%	7.5%	3.4%
SDRC	70.1	.0	47.8	0	4.7%	.0%	9.3%	.0%
Toshiba—No OEM	68.0	34.0	27.2	755	4.5%	4.4%	5.3%	3.4%
Silicon Graphics	48.6	48.6	.0	1,286	3.2%	6.3%	.0%	5.8%
Sharp System Products—No OEM	43.0	20.7	22.3	398	2.9%	2.7%	4.3%	1.8%
Mitsubishi Electric	38.7	32.9	2.7	363	2.6%	4.3%	.5%	1.6%
Technodia	37.9	30.3	.4	425	2.5%	4.0%	.1%	1.9%
Kubota Computer	30.6	23.2	4.9	292	2.0%	3.0%	1.0%	1.3%
EDS Unigraphics	26.6	7.7	12.5	354	1.8%	1.0%	2.4%	1.6%
Tokyo Electron—No OEM	25.6	8.7	11.3	124	1.7%	1.1%	2.2%	.6%
Mitsui Engineering	20.4	14.1	4.2	141	1.4%	1.8%	.8%	.6%
Toyo Information Systems-No OEM	19.3	11.8	5.8	237	1.3%	1.5%	1.1%	1.1%
Parametric Technology	17.0	.0	14.0	0	1.1%	.0%	2.7%	.0%
Sony	16.6	16.6	.0	823	1.1%	2.2%	.0%	3.7%
Mutoh Industries—No OEM	16.2	6.8	6.1	219	1.1%	.9%	1.2%	1.0%
Graphtec Engineering	15.3	7.5	7.0	404	1.0%	1.0%	1.4%	1.8%

(Continued)

Table 22 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application:	Mechanical
Platform:	Technical Workstation
Region:	Asia
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Digital	13.9	10.8	.0	450	.9%	1.4%	.0%	2.0%
Omron	11.5	5.7	4.6	255	.8%	.8%	.9%	1.2%
Sun Microsystems	10.3	8.2	.0	374	.7%	1.1%	.0%	1.7%
Intergraph	9.4	3.4	2.9	102	.6%	.4%	.6%	.5%
Kozo Keikaku Engineering	9.1	.9	2.7	10	.6%	.1%	.5%	.0%
CADIX	8.3	3.6	4.1	46	.6%	.5%	.8%	.2%
Sumitomo Denko Workstation	7.4	7.4	.0	813	.5%	1.0%	.0%	3.7%
Ricoh—No OEM	6.5	.0	5.5	0	.4%	.0%	1.1%	.0%
Delcam International	5.9	2.1	2.6	73	.4%	.3%	.5%	.3%
MARC	5.8	.0	5.5	0	.4%	.0%	1.1%	.0%
Adam Net	5.8	.9	3.6	11	.4%	.1%	.7%	.1%
Gerber Systems	5.4	2.5	2.3	87	.4%	.3%	.4%	.4%
Alias Research	5.3	.0	4.9	0	.4%	.0%	.9%	.0%
Cisigraph	5.1	1.4	2.7	82	.3%	.2%	.5%	.4%
Matra Datavision	4.9	1.7	2.7	66	.3%	.2%	.5%	.3%
ICAD	4.2	.0	3.4	0	.3%	.0%	.7%	.0%
Graftek	4.0	1.6	1.6	83	.3%	.2%	.3%	.4%
Mechanical Dynamics	3.4	.0	2.7	0	.2%	.0%	.5%	.0%
Control Data Systems	3.3	1.5	1.0	43	.2%	.2%	.2%	.2%
Swanson Analysis	3.2	.0	2.9	0	.2%	.0%	.6%	.0%
ADRA Systems	3.2	.0	2.5	0	.2%	.0%	.5%	.0%
PDA Engineering	3.0	.0	2.8	0	.2%	.0%	.6%	.0%
Applicon	2.8	1.0	1.2	29	.2%	.1%	.2%	.1%

(Continued)

Table 22 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: Technical Workstation
Region: Asia
Units: Millions of U.S. Dollars/Actual Units

Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Market Share: Total Factory Revenue	Market Share: Hardware Revenue	Market Share: Software Revenue	Market Share: Hardware Units Shipped
Hakuto	2.6	1.6	1.0	31	.2%	.2%	.2%	.1%
Cimatron	2.3	1.0	1.0	52	.2%	.1%	.2%	.2%
CAMAX Systems Inc.	2.3	.2	1.5	21	.2%	.0%	.3%	.1%
MacNeal-Schwendler	2.2	.0	1.9	0	.1%	.0%	.4%	.0%
Autodesk	2.2	.0	2.2	0	.1%	.0%	.4%	.0%
Cimlinc	2.1	.1	1.1	5	.1%	.0%	.2%	.0%
Straessle Informationssysteme	2.1	.2	1.4	9	.1%	.0%	.3%	.0%
Uchida Yoko	1.8	1.1	.6	44	.1%	.1%	.1%	.2%
Century Research Center	1.7	.9	.6	12	.1%	.1%	.1%	.1%
Wacom	1.3	.3	1.0	22	.1%	.0%	.2%	.1%
Radan Computational	1.2	.4	.6	23	.1%	.1%	.1%	.1%
MCS	1.0	.0	.8	3	.1%	.0%	.2%	.0%
Zuken	1.0	.3	.5	6	.1%	.0%	.1%	.0%
Other Companies	28.3	11.4	14.7	452	1.9%	1.5%	2.8%	2.0%
All Companies	1,506.0	765.3	515.2	22,104	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	547.7	206.9	225.8	6,416	36.4%	27.0%	43.8%	29.0%
All Asian-Based Companies	935.4	551.7	277.4	15,383	62.1%	72.1%	53.8%	69.6%
All European-Based Companies	22.9	6.8	12.0	305	1.5%	.9%	2.3%	1.4%
All Hardware Companies	143.2	134.1	.0	5,189	9.5%	17.5%	.0%	23.5%
All Turnkey & SW Companies	1,362.8	631.2	515.2	16,914	90.5%	82.5%	100.0%	76.5%

Source: Dataquest (July 1994)

Table 23
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: Host-Dependent
Region: Asia
Units: Millions of U.S. Dollars/Actual Units

Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Market Share: Total Factory Revenue	Market Share: Hardware Revenue	Market Share: Software Revenue	Market Share: Hardware Units Shipped
Nihon Unisys	130.9	81.2	21.0	662	25.8%	25.0%	20.8%	7.5%
IBM	95.7	54.6	19.1	1,228	18.9%	16.8%	19.0%	13.9%
NEC	61.4	45.5	10.5	127	12.1%	14.0%	10.4%	1.4%
Fujitsu	59.0	27.1	23.6	889	11.6%	8.4%	23.4%	10.1%
Digital	21.1	16.4	.0	0	4.2%	5.1%	.0%	.0%
Hitachi	11.3	5.3	4.9	2,744	2.2%	1.6%	4.8%	31.1%
MacNeal-Schwendler	9.2	.0	9.2	0	1.8%	.0%	9.1%	.0%
Toshiba—No OEM	7.9	4.0	3.2	106	1.6%	1.2%	3.1%	1.2%
Mitsubishi Electric	6.5	3.1	1.8	18	1.3%	.9%	1.8%	.2%
Hitachi Zosen Info Systems	4.0	3.6	.0	0	.8%	1.1%	.0%	.0%
Toyo Information Systems-No OEM	3.7	2.0	1.2	21	.7%	.6%	1.2%	.2%
MARC	1.9	.0	1.8	0	.4%	.0%	1.8%	.0%
Control Data Systems	1.9	1.0	.2	20	.4%	.3%	.2%	.2%
Kozo Keikaku Engineering	1.7	.0	.3	0	.3%	.0%	.3%	.0%
Swanson Analysis	1.6	.0	1.3	0	.3%	.0%	1.2%	.0%
Century Research Center	1.2	.6	.5	2	.2%	.2%	.4%	.0%
Other Companies	87.6	80.3	2.4	3,000	17.3%	24.7%	2.3%	34.0%
All Companies	506.6	324.7	100.8	8,817	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	218.7	152.3	33.7	4,248	43.2%	46.9%	33.5%	48.2%
All Asian-Based Companies	287.7	172.3	66.8	4,569	56.8%	53.1%	66.3%	51.8%
All European-Based Companies	.3	.0	.2	0	.1%	.0%	.2%	.0%
All Hardware Companies	106.0	96.9	.0	2,970	20.9%	29.8%	.0%	33.7%
All Turnkey & SW Companies	400.6	227.8	100.8	5,847	79.1%	70.2%	100.0%	66.3%

Source: Dataquest (July 1994)

Table 24
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: Server
Region: Asia
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
IBM	25.5	13.5	6.4	204	31.5%	26.7%	41.5%	28.6%
Digital	20.2	15.7	.0	175	24.9%	31.0%	.0%	24.5%
Sun Microsystems	10.0	8.3	.0	174	12.4%	16.4%	.0%	24.5%
Adam Net	5.8	5.8	.0	2	7.1%	11.4%	.0%	.3%
Kubota Computer	5.7	4.4	.9	47	7.1%	8.6%	6.0%	6.6%
MacNeal-Schwendler	5.0	.0	5.0	0	6.2%	.0%	32.7%	.0%
EDS Unigraphics	4.9	1.5	2.3	43	6.1%	2.9%	14.6%	6.0%
Kozo Keikaku Engineering	1.1	.0	.2	0	1.3%	.0%	1.4%	.0%
Other Companies	2.7	1.5	.6	68	3.4%	3.0%	3.7%	9.6%
All Companies	81.0	50.7	15.4	713	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	67.4	40.0	14.0	618	83.2%	78.9%	90.8%	86.6%
All Asian-Based Companies	13.0	10.6	1.1	92	16.1%	20.9%	7.4%	12.8%
All European-Based Companies	.6	.1	.3	4	.7%	.3%	1.8%	.5%
All Hardware Companies	31.4	25.1	.0	404	38.7%	49.5%	.0%	56.6%
All Turnkey & SW Companies	49.6	25.6	15.4	309	61.3%	50.5%	100.0%	43.4%

Source: Dataquest (July 1994)

Table 25
1993 CAD/CAM/CAE/GIS Market Share Update

Application:	Mechanical
Platform:	Personal Computer
Region:	Asia
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
NEC	61.4	43.7	12.3	7,925	13.3%	15.5%	7.9%	15.4%
Fujitsu	43.7	38.4	5.3	5,189	9.5%	13.6%	3.4%	10.1%
IBM	40.6	18.7	20.9	3,459	8.8%	6.6%	13.4%	6.7%
Hakuto	40.5	23.9	16.6	975	8.8%	8.5%	10.7%	1.9%
Toshiba—No OEM	37.4	18.7	15.0	2,802	8.1%	6.6%	9.6%	5.5%
Mutoh Industries—No OEM	26.3	19.6	6.7	927	5.7%	6.9%	4.3%	1.8%
Autodesk	23.5	.0	23.5	0	5.1%	.0%	15.1%	.0%
Andor	23.1	5.1	17.1	421	5.0%	1.8%	11.0%	.8%
Hitachi	22.8	10.7	9.8	1,165	4.9%	3.8%	6.3%	2.3%
Apple Computer	16.0	16.0	.0	3,377	3.5%	5.7%	.0%	6.6%
Kozo Keikaku Engineering	9.7	.4	2.5	31	2.1%	.1%	1.6%	.1%
Design Automation	8.6	1.8	6.5	295	1.9%	.6%	4.2%	.6%
Wacom	6.8	1.4	4.7	239	1.5%	.5%	3.0%	.5%
Digital	5.5	5.3	.0	1,404	1.2%	1.9%	.0%	2.7%
Mitsubishi Electric	5.0	3.3	1.7	414	1.1%	1.2%	1.1%	.8%
Investronica SA	3.2	2.0	.9	108	.7%	.7%	.5%	.2%
Hewlett-Packard	1.9	1.7	.0	477	.4%	.6%	.0%	.9%
Kubota Computer	1.9	1.5	.3	99	.4%	.5%	.2%	.2%
Mitsui Engineering	1.7	1.2	.3	37	.4%	.4%	.2%	.1%
Anilam Electronics	1.4	.3	1.0	46	.3%	.1%	.6%	.1%
CADKEY	1.3	.0	1.2	0	.3%	.0%	.8%	.0%

(Continued)

Table 25 (Continued)
1993 CAD/CAM/CAE/GIS Market Share Update

Application:	Mechanical
Platform:	Personal Computer
Region:	Asia
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
ADRA Systems	1.2	.0	1.0	0	.3%	.0%	.6%	.0%
Cimatron	1.1	.5	.5	61	.2%	.2%	.3%	.1%
Other Companies	77.0	67.9	7.8	21,888	16.7%	24.1%	5.0%	42.6%
All Companies	461.7	281.8	155.4	51,338	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	165.0	109.1	53.1	30,550	35.7%	38.7%	34.1%	59.5%
All Asian-Based Companies	289.2	169.5	98.9	20,528	62.6%	60.2%	63.6%	40.0%
All European-Based Companies	7.5	3.1	3.4	260	1.6%	1.1%	2.2%	.5%
All Hardware Companies	139.9	139.4	.0	35,213	30.3%	49.5%	.0%	68.6%
All Turnkey & SW Companies	321.9	142.4	155.4	16,125	69.7%	50.5%	100.0%	31.4%

Source: Dataquest (July 1994)

Table 26
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: All Platforms
Region: Rest of World
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
IBM	47.0	25.5	12.1	1,387	32.7%	34.4%	30.9%	17.3%
Computervision	23.1	9.2	3.1	370	16.1%	12.5%	7.8%	4.6%
Digital	10.2	8.1	.0	454	7.1%	10.9%	.0%	5.6%
Hewlett-Packard	10.1	6.6	1.4	551	7.1%	8.9%	3.6%	6.8%
Autodesk	6.4	.0	6.4	0	4.5%	.0%	16.4%	.0%
EDS Unigraphics	5.5	1.6	2.6	104	3.8%	2.2%	6.6%	1.3%
Intergraph	3.6	1.3	1.2	59	2.5%	1.7%	3.0%	.7%
Apple Computer	3.0	3.0	.0	799	2.1%	4.1%	.0%	9.9%
Delcam International	3.0	1.0	1.3	38	2.1%	1.4%	3.2%	.5%
Cimatron	2.8	1.2	1.3	91	2.0%	1.7%	3.2%	1.1%
Investronica SA	2.5	1.6	.7	86	1.8%	2.1%	1.7%	1.1%
Sun Microsystems	2.1	1.7	.0	70	1.5%	2.3%	.0%	.9%
Control Data Systems	1.8	.9	.4	26	1.3%	1.2%	1.1%	.3%
MacNeal-Schwendler	1.5	.0	1.5	0	1.1%	.0%	3.8%	.0%
Siemens Nixdorf Info systeme	1.4	.8	.2	69	1.0%	1.1%	.4%	.9%
Vero International Software	1.0	.0	.9	0	.7%	.0%	2.3%	.0%
Other Companies	18.8	11.5	6.3	3,938	13.0%	15.5%	16.1%	49.0%
All Companies	143.8	73.9	39.2	8,040	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	130.8	68.9	33.3	7,713	91.0%	93.2%	84.9%	95.9%
All Asian-Based Companies	.0	.0	.0	0	.0%	.0%	.0%	.0%
All European-Based Companies	13.0	5.0	5.9	327	9.0%	6.8%	15.1%	4.1%
All Hardware Companies	35.2	31.8	.0	6,369	24.5%	43.0%	.0%	79.2%
All Turnkey & SW Companies	108.6	42.1	39.2	1,671	75.5%	57.0%	100.0%	20.8%

Source: Dataquest (July 1994)

Table 27
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: Technical Workstation
Region: Rest of World
Units: Millions of U.S. Dollars/Actual Units

Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Market Share: Total Factory Revenue	Market Share: Hardware Revenue	Market Share: Software Revenue	Market Share: Hardware Units Shipped
IBM	27.0	13.8	7.7	446	33.6%	37.8%	37.0%	30.6%
Computervision	22.6	9.1	2.8	368	28.1%	25.0%	13.2%	25.2%
Hewlett-Packard	9.1	5.7	1.4	225	11.3%	15.5%	6.8%	15.4%
EDS Unigraphics	4.6	1.3	2.2	92	5.8%	3.7%	10.5%	6.3%
Intergraph	3.1	1.1	1.0	47	3.9%	3.1%	4.7%	3.2%
Delcam International	2.8	1.0	1.2	35	3.5%	2.7%	5.8%	2.4%
Digital	2.0	1.5	.0	99	2.5%	4.2%	.0%	6.8%
Cimatron	1.9	.8	.9	43	2.4%	2.3%	4.1%	2.9%
Siemens Nixdorf Info systeme	1.1	.6	.2	20	1.4%	1.5%	.7%	1.4%
Control Data Systems	1.1	.5	.4	18	1.4%	1.4%	1.7%	1.2%
Other Companies	5.0	1.1	3.3	67	6.2%	2.9%	15.6%	4.6%
All Companies	80.4	36.5	20.9	1,459	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	73.2	34.0	17.7	1,346	91.1%	93.0%	84.9%	92.2%
All Asian-Based Companies	.0	.0	.0	0	.0%	.0%	.0%	.0%
All European-Based Companies	7.2	2.6	3.2	113	8.9%	7.0%	15.1%	7.8%
All Hardware Companies	8.4	7.1	.0	331	10.4%	19.5%	.0%	22.7%
All Turnkey & SW Companies	72.0	29.4	20.9	1,127	89.6%	80.5%	100.0%	77.3%

Source: Dataquest (July 1994)

Table 28
1993 CAD/CAM/CAE/GIS Market Share Update

Application:	Mechanical
Platform:	Host-Dependent
Region:	Rest of World
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	**Total Factory Revenue**	**Hardware Revenue**	**Software Revenue**	**Hardware Units Shipped**	**Total Factory Revenue**	**Hardware Revenue**	**Software Revenue**	**Hardware Units Shipped**
IBM	12.3	7.0	2.5	237	59.6%	53.9%	66.0%	64.1%
Digital	3.0	2.4	.0	0	14.6%	18.1%	.0%	.0%
Other Companies	5.3	3.6	1.3	133	25.8%	27.9%	34.0%	35.9%
All Companies	20.6	13.0	3.7	370	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	20.5	13.0	3.6	370	99.4%	100.0%	96.5%	100.0%
All Asian-Based Companies	.0	.0	.0	0	.0%	.0%	.0%	.0%
All European-Based Companies	.1	.0	.1	0	.6%	.0%	3.5%	.0%
All Hardware Companies	6.7	5.8	.0	126	32.4%	44.6%	.0%	34.0%
All Turnkey & SW Companies	13.9	7.2	3.7	244	67.6%	55.4%	100.0%	66.0%

Source: Dataquest (July 1994)

Table 29
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: Server
Region: Rest of World
Units: Millions of U.S. Dollars/Actual Units

Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Market Share: Total Factory Revenue	Market Share: Hardware Revenue	Market Share: Software Revenue	Market Share: Hardware Units Shipped
IBM	5.1	2.7	1.2	62	40.2%	35.5%	55.7%	38.2%
Digital	4.4	3.4	.0	54	34.9%	44.5%	.0%	33.5%
Sun Microsystems	1.2	1.0	.0	26	9.2%	12.5%	.0%	16.1%
Other Companies	2.0	.6	1.0	20	15.7%	7.5%	44.3%	12.1%
All Companies	12.6	7.7	2.2	162	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	12.5	7.7	2.2	162	99.8%	99.9%	99.1%	99.9%
All Asian-Based Companies	.0	.0	.0	0	.0%	.0%	.0%	.0%
All European-Based Companies	.0	.0	.0	0	.2%	.1%	.9%	.1%
All Hardware Companies	5.8	4.6	.0	85	46.1%	59.9%	.0%	52.7%
All Turnkey & SW Companies	6.8	3.1	2.2	77	53.9%	40.1%	100.0%	47.3%

Source: Dataquest (July 1994)

Table 30
1993 CAD/CAM/CAE/GIS Market Share Update

Application: Mechanical
Platform: Personal Computer
Region: Rest of World
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Autodesk	6.1	.0	6.1	0	20.1%	.0%	49.1%	.0%
Apple Computer	3.0	3.0	.0	799	10.0%	18.1%	.0%	13.2%
IBM	2.7	1.9	.7	642	8.9%	11.5%	5.7%	10.6%
Investronica SA	2.5	1.6	.7	86	8.3%	9.4%	5.3%	1.4%
Vero International Software	1.0	.0	.9	0	3.3%	.0%	7.4%	.0%
Other Companies	14.9	10.2	4.0	4,523	49.4%	61.0%	32.5%	74.8%
All Companies	30.3	16.8	12.4	6,049	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	24.6	14.3	9.8	5,836	81.3%	85.4%	79.0%	96.5%
All Asian-Based Companies	.0	.0	.0	0	.0%	.0%	.0%	.0%
All European-Based Companies	5.7	2.4	2.6	214	18.7%	14.6%	21.0%	3.5%
All Hardware Companies	14.4	14.3	.0	5,827	47.6%	85.1%	.0%	96.3%
All Turnkey & SW Companies	15.9	2.5	12.4	222	52.4%	14.9%	100.0%	3.7%

Source: Dataquest (July 1994)

For More Information...

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

Via fax .... (408) 437-0292

Dataquest®

a company of The Dun & Bradstreet Corporation

Dataquest®

a company of
The Dun & Bradstreet Corporation

Corporate Headquarters
Dataquest Incorporated
1290 Ridder Park Drive
San Jose, California 95131-2398
United States
Phone: 01-408-437-8000
Facsimile: 01-408-437-0292

Dataquest Incorporated
550 Cochituate Road
Framingham, Massachusetts 01701-9324
United States
Phone: 01-508-370-5555
Facsimile: 01-508-370-6262

Invitational Computer Conferences (ICC)
3990 Westerly Place, Suite 100
Newport Beach, California 92660
United States
Phone: (714) 476-9117
Facsimile: (714) 476-9969

Dataquest Japan Limited
Shinkawa Sanko Building
1-3-17, Shinkawa, Chuo-ku
Tokyo 104
Japan
Phone: 81-3-5566-0411
Facsimile: 81-3-5566-0425

Dataquest Korea
Trade Tower, Suite 3806
159 Samsung-dong
Kangnam-gu, Seoul 135-729
Korea
Phone: 011-82-2-551-1331
Facsimile: 011-82-2-551-1330

European Headquarters
Dataquest Europe Limited
Roussel House, Broadwater Park
Denham, Uxbridge
Middlesex UB9 5HP
England
Phone: 44-895-835050
Facsimile: 44-895-835260/1

Dataquest GmbH
Kronstadter Strasse 9
8000 Munich 80
Germany
Phone: 011-49-89-930-9090
Facsimile: 011-49-89-930-3277

Dataquest Europe SA
Tour Gallieni 2
36, Avenue du General de Gaulle
93175 Bagnolet Cedex
France
Phone: 011-33-1-48-97-3100
Facsimile: 011-33-1-48-97-3400

Representative Agencies in
Bangkok, Hong Kong,
Kronberg, North Sydney,
Singapore, Taipei, and Tel Aviv

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Software

CAD/CAM/CAE and GIS Mechanical Forecast

Market Statistics

1994

Program: Mechanical Applications Worldwide
Product Code: CMEC-WW-MS-9402
Publication Date: May 2, 1994

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CAD/CAM/CAE and GIS Mechanical Forecast

Market Statistics

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CAD/CAM/CAE and GIS Mechanical Forecast

Fluctuating exchange rates masked true market performance in the 1993 CAD/CAM/CAE and GIS market. Japanese CAD/CAM/CAE and GIS total revenue grew a surprising 3.3 percent from 1992 to 1993 when measured in U.S. dollars, contrary to what would be expected in the worst recession Japan has experienced in 50 years. However, the dollar depreciated against the yen at a rate of 12.3 percent so that when measured in yen, Japanese CAD/CAM/CAE and GIS total revenue declined 9.4 percent from 1992 to 1993.

In the meantime, European CAD/CAM/CAE and GIS total revenue declined 1.4 percent from 1992 to 1993 when measured in U.S. dollars. With the dollar appreciating 10.0 percent against the ECU, European CAD/CAM/CAE and GIS total revenue grew 9.9 percent from 1992 to 1993 when measured in ECU. Table 1 shows the dramatic impact that currency fluctuation has on the CAD/CAM/CAE and GIS.

The yen has been strengthening against the dollar for the past three years, changing in 1993 at a rate twice that of previous years. And the end is not in sight. In contrast, Hong Kong and Singapore had relatively stable currency during 1993, while the currencies in China, Korea, and Taiwan weakened against the dollar. In Europe, 1993 was a year for weakening of local currencies against the dollar after having currencies strengthened against the dollar in 1992.

The early indications are that currencies will follow the same pattern in each country for the coming year (see Table 2). 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 February exchange rate will apply for all future months of 1994.

Dataquest's forecast is based upon the early market share data, gathered primarily before the end of 1993. This data is being verified and updated and will be available May 31 as the Market Share Update. Dataquest will then perform an updated forecast to include country-level information and in-depth analysis. This Forecast Update will be available July 31.

This document contains Dataquest's detailed forecast information for the CAD/CAM/CAE and GIS industry. Included are the following:

- Five-year historical data
- Five-year forecast data

More detailed data is available through Dataquest's client inquiry service, which can provide custom analysis of the multidimensional database.

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

	1992	1993	Forecast 1994	Growth (%) 1992-1993	Growth (%) 1993-1994
Europe (U.S.$ Million)					
Software Revenue	1,708.6	1,755.2	1,863	2.7	6.1
Hardware Revenue	2,778.1	2,628.5	2,624	-5.4	-0.2
Service Revenue	1,087.7	1,118.8	1,133	2.9	1.3
Total Factory Revenue	5,582.6	5,502.6	5,620	-1.4	2.1
ECU/U.S.$ Exchange Rate	*0.7686*	*0.8566*	*0.8879**	*11.4*	*3.7*
Europe (ECU Million)					
Software Revenue	1,313.2	1,503.5	1,654.0	14.5	10.0
Hardware Revenue	2,135.2	2,251.6	2,330	5.4	3.5
Service Revenue	836.0	958.4	1,006	14.6	5.0
Total Factory Revenue	4,290.8	4,713.5	4,990	9.9	5.9
Japan (U.S.$ Million)					
Software Revenue	1,316.5	1,435.1	1,514	9.0	5.5
Hardware Revenue	2,477.7	2,427.8	2,446	-2.0	0.7
Service Revenue	601.1	676.8	702	12.6	3.7
Total Factory Revenue	4,395.3	4,539.6	4,662	3.3	2.7
Yen/U.S.$ Exchange Rate	*126.34*	*110.85*	*106.54**	*-12.3*	*-3.9*
Japan (Yen Million)					
Software Revenue	166,328	159,076	161,314	-4.4	1.4
Hardware Revenue	313,036	269,117	260,569	-14.0	-3.2
Service Revenue	75,947	75,022	74,792	-1.2	-0.3
Total Factory Revenue	555,317	503,216	496,672	-9.4	-1.3
North America (U.S.$ Million)					
Software Revenue	1,629.3	1,804.5	2,008	10.8	11.3
Hardware Revenue	2,920.2	2,951.1	3,184	1.1	7.9
Service Revenue	931.8	1,039.0	1,133	11.5	9.0
Total Factory Revenue	5,482.4	5,794.6	6,325	5.7	9.1
Worldwide (U.S.$ Million)					
Software Revenue	4,835.9	5,189.2	5,614	7.3	8.2
Hardware Revenue	8,501.2	8,323.4	8,607	-2.1	3.4
Service Revenue	2,739.0	2,968.9	3,122	8.4	5.2
Total Factory Revenue	16,086.0	16,481.3	17,342	2.5	5.2

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

The CAD/CAM/CAE and GIS *Dataquest Perspective,* dated April 18, 1994, contains additional tables and analysis and is a companion piece to this book.

Table 2
Exchange Rates

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

Source: Dataquest (April 1994)

A new forecasting process for each application is being used to improve revenue and unit shipment control by region and by platform. This new process may cause some mismatch in market share tables and forecast tables. Please use the forecast tables to understand the year-to-year changes. Use the market share tables to compare company-to-company performance.

Forecast Methodology

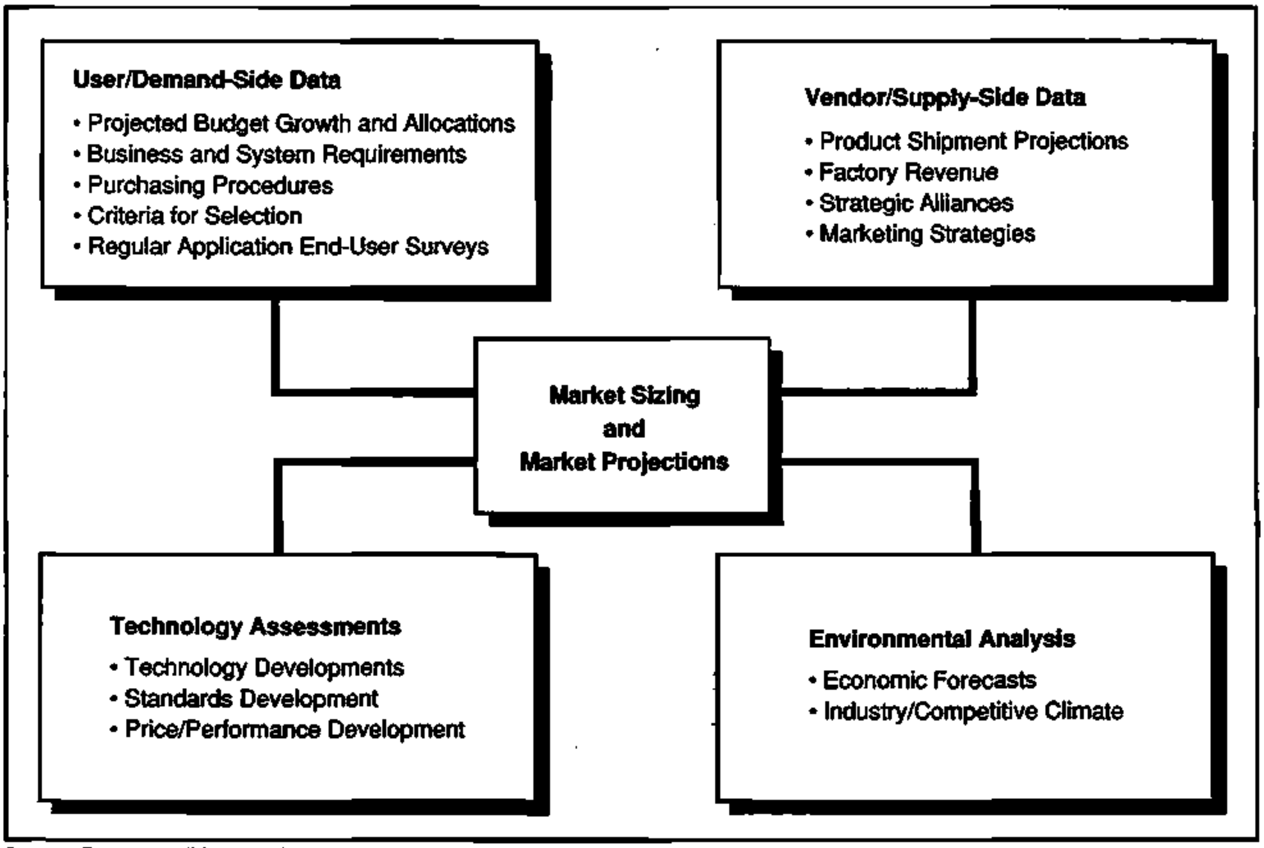
Fundamental to the way Dataquest conducts its research is an underlying philosophy that says the best data and analyses come from a well-balanced program. This program includes the following: balance between primary and secondary collection techniques; balance between supply-side and demand-side analysis; 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 macro environment, which can have major influences on both supply-side and demand-side forecasting. In addition to demographics, analysts look at gross national product (GNP) growth, interest rate fluctuation, business expectations, and capital spending plans. In the geopolitical arena, the group looks at trade issues, political stability or lack thereof, tariffs, nontariff barriers, and such factors as the effect on Europe of the events of 1994.

Figure 1 shows the CAD/CAM/CAE and GIS forecasting model. The overall forecasting process uses a combination of forecasting techniques such as time series and technological modeling. Market estimates and forecasts are derived using the following research techniques:

- "Bottom-up" aggregation—This method involves adding all relevant vendor contributions to arrive at total market estimates for all historical data.
- Segment forecasting—For each application segment tracked by the CAD/CAM/CAE and GIS group, individual forecasts are derived following the basic information model defined previously. Specifically, each design phase covered within each application is segmented by product, region, and platform. 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. Installed base is also evaluated. Rates of product retirement are primarily based on input from end users in our ongoing survey programs. Dataquest analysts also factor in the acceptance or ability for users to consume new technology.

Figure 1
CAD/CAM/CAE and GIS Forecasting Model



Source: Dataquest (May 1993) G3000529

- 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.

Segmentation Definitions

This section lists the definitions specific to this document. The following paragraphs define the segments.

Applications

Mechanical

The mechanical segment refers to computer-aided tools used by engineers, designers, analysts, technicians, and draftspeople working predominantly in the discrete manufacturing industries, but includes government and education. Users of mechanical CAD/CAM/CAE tools work in all departments across the typical organization, with a majority found in product design, advanced engineering, and manufacturing engineering. Common design applications include conceptual design, industrial design, structural or thermal analysis, detail design, and electromechanical design (the mechanical part of design with electrical or electronic components and mechanisms). Common manufacturing applications include tool and fixture design, numerical control part programming, off-line robotics programming, and interface to quality control systems. Management tools for database control and distribution are included in this segment, as well as user-defined application programming.

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 is composed of 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 process of designing 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 ECAE 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), design verification tools (DRC/ERC/logic-to-layout), compilers, and module development tools.
- PCB/hybrid/MCM—This segment covers products used to create the placement and routing of the traces and components laid out on a printed circuit board. Also included in this category are thermal analysis tools.

Regions

The following paragraphs define the regions.

North America

North America includes United States, Mexico, and Canada.

Europe

Europe includes the United Kingdom, Scandinavia, Benelux, France, Germany, Italy, Spain, and Rest of Europe (which includes Austria, Switzerland, and eastern Europe)

Asia

Asia includes Japan, Singapore, Taiwan, Korea, China, and Hong Kong.

Rest of World

Rest of World includes all other countries including Australia, New Zealand, Oceania, Africa, Central America, South America, and the Middle East.

Platforms

The following paragraphs define the platforms.

Technical Workstation

A technical workstation is a single-user computer distinguished from a personal computer by its features and by the user's potential range of expansion on the platform. Features include a virtual, multitasking operating system (UNIX, VMS, or Domain); the computer is designed by the manufacturer to run high-performance graphics applications in a multiuser/multitasking environment.

Host-Dependent

Host-dependent is a shared logic system in which the external workstations' functions are dependent on a host computer.

Server

A server is a computer that transparently provides its resources for use by other computer systems. It is a system on a network that provides specific functionality to other computer systems: the clients. Functions include file storage, database access, and compute capability. Dataquest tracks the following major categories of servers used for CAD/CAM/CAE and GIS applications:

- Compute Servers—These systems provide capabilities for solving numerical problems (for example, simulations, statistical calculations, and simultaneous partial differential equations). System features usually include high-speed computational capabilities (for example, vector and parallel processing) and large memories.
- Print Servers—These systems provide access to printers, specialized printing applications software, and print-spooling resources to a network.
- File Servers—These systems provide mass storage capability to clients on a network. Services can range from temporary storage of working files to long-term backup and archive systems.
- Database Servers—These systems manage databases as a shared resource to a network. These servers handle such functions as physical data storage, data security, and high-level queries and can access stored information at the record level.

Personal Computer

A personal computer is a single-user computer distinguished from a technical workstation by its features and by the user's potential range of expansion on the platform. Features found in technical workstations (such as a virtual operating system, networking, high-performance graphics, multiuser/multitasking capability) are optional rather than integrated by the manufacturer.

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. (In the case of technical workstations and personal computers, CPU revenue contains the terminal revenue.)
- 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 of a 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-dependent platform, as terminal revenue is contained within CPU revenue for technical workstations and PCs.
- Software revenue is revenue derived from the sale of bundled (part of a turnkey system) and unbundled software.
- Service revenue is defined as revenue derived from the service and support of CAD/CAM/CAE or GIS systems. Service revenue can be calculated in the tables by subtracting hardware and software revenue from total revenue.
- Total factory revenue is defined as the amount of money received by a manufacturer for its goods measured in U.S. dollars and is the sum of hardware, software, and service revenue. Total factory revenue does not include revenue that a company may receive from products sold to another company for resale (OEM revenue).

Table 3
CAD/CAM/CAE/GIS History and Forecast

Application: Mechanical
Region: Worldwide
Platform: All Platforms

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	164,418	182,092	216,178	259,804	282,769	303,800	324,900	345,600	363,700	379,700	15	6
Unit Shipments or Seats	187,009	206,215	236,404	276,121	302,936	322,900	342,800	362,100	379,100	394,500	13	5
CPU Installed Base	456,754	594,522	740,588	895,749	1,021,069	1,123,300	1,220,500	1,324,000	1,422,300	1,501,500	22	8
Installed Seats	569,036	726,897	883,601	1,041,235	1,168,459	1,268,800	1,360,900	1,457,600	1,546,000	1,616,700	20	7
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	68.0	57.8	52.4	48.0	42.8	40.1	37.7	35.7	34.2	33.2	-11	-5
Hardware-Only ASP	11.0	10.8	10.6	9.8	9.7	9.7	9.7	9.6	9.6	9.6	-3	-0
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	3,657	3,841	4,061	4,291	4,232	4,318	4,373	4,429	4,512	4,602	4	2
CPU Revenue	2,784	2,976	3,258	3,536	3,520	3,634	3,725	3,814	3,918	4,022	6	3
Terminal Revenue	403	345	316	262	249	237	222	207	198	192	-11	-5
Peripheral Revenue (Turnkey)	470	520	487	492	463	447	426	408	396	389	-0	-3
Software Revenue	1,557	1,856	2,088	2,233	2,391	2,568	2,746	2,916	3,080	3,234	11	6
Bundled	930	1,079	1,152	1,095	1,106	1,117	1,128	1,128	1,122	1,116	4	0
Unbundled	627	777	936	1,138	1,286	1,451	1,618	1,788	1,957	2,118	20	11
Service Revenue	992	1,171	1,220	1,362	1,424	1,484	1,547	1,600	1,673	1,743	9	4
Total Factory Revenue	6,206	6,869	7,369	7,886	8,047	8,370	8,666	8,945	9,264	9,579	7	4
Increase over Prior Year (%)	9	11	7	7	2	4	4	3	4	3		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.

Source: Dataquest (April 1994)

Table 4
CAD/CAM/CAE/GIS History and Forecast

Application: Mechanical
Region: Worldwide
Platform: Technical Workstation

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	50,015	61,852	74,390	91,684	104,552	117,000	129,900	142,900	156,500	170,000	20	10
Unit Shipments or Seats	50,015	61,852	74,390	91,684	104,552	117,000	129,900	142,900	156,500	170,000	20	10
CPU Installed Base	109,058	164,050	226,833	299,309	372,824	447,000	518,800	591,800	662,000	720,600	36	14
Installed Seats	108,060	164,050	226,833	299,309	372,824	447,000	518,800	591,800	662,000	720,600	36	14
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	52.5	44.5	46.0	46.6	42.8	40.7	38.5	36.8	35.7	34.7	-5	-4
Hardware-Only ASP	18.7	21.8	20.1	19.7	18.3	17.5	16.8	16.1	15.5	15.0	-1	-4
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	1,521	1,723	1,927	2,345	2,372	2,456	2,528	2,611	2,718	2,823	12	4
CPU Revenue	1,234	1,407	1,619	1,992	2,035	2,136	2,225	2,322	2,437	2,547	13	5
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	287	316	308	354	337	320	303	289	281	275	4	-4
Software Revenue	803	1,021	1,229	1,396	1,535	1,675	1,817	1,953	2,089	2,221	18	8
Bundled	528	620	732	745	758	759	766	765	760	754	9	-0
Unbundled	274	401	496	651	778	916	1,051	1,188	1,330	1,467	30	14
Service Revenue	538	640	692	916	992	1,046	1,101	1,155	1,224	1,289	17	5
Total Factory Revenue	2,862	3,384	3,848	4,657	4,900	5,177	5,446	5,719	6,032	6,332	14	5
Increase over Prior Year (%)	47	18	14	21	5	6	5	5	5	5		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.

Source: Dataquest (April 1994)

Table 5
CAD/CAM/CAE/GIS History and Forecast

Application: Mechanical
Region: Worldwide
Platform: Host-Dependent

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	7,801	9,434	5,551	4,371	5,133	5,300	5,400	5,400	5,600	5,800	-10	2
Unit Shipments or Seats	30,392	33,557	25,777	20,688	25,300	24,500	23,300	21,900	21,000	20,600	-4	-4
CPU Installed Base	28,554	35,389	38,214	39,053	40,043	41,100	40,900	40,600	41,200	41,800	9	1
Installed Seats	142,300	167,764	181,227	184,539	187,433	186,500	181,300	174,200	164,900	157,000	7	-3
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	324.9	270.6	283.4	265.6	204.1	187.6	172.6	158.5	143.9	132.0	-11	-8
Hardware-Only ASP	130.6	116.7	257.7	271.3	234.4	220.2	208.7	198.7	189.1	179.7	16	-5
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	1,506	1,520	1,297	988	923	882	832	774	735	715	-12	-5
CPU Revenue	982	1,041	884	666	616	590	557	519	491	479	-11	-5
Terminal Revenue	403	345	316	262	249	237	222	207	198	192	-11	-5
Peripheral Revenue (Turnkey)	122	134	97	60	58	55	52	48	46	44	-17	-5
Software Revenue	433	496	330	254	243	229	214	196	184	176	-13	-6
Bundled	313	377	232	179	168	161	151	139	130	125	-14	-6
Unbundled	120	119	99	75	74	69	62	57	53	50	-11	-7
Service Revenue	402	477	390	300	275	265	253	236	225	220	-9	-4
Total Factory Revenue	2,340	2,493	2,018	1,542	1,441	1,376	1,298	1,206	1,144	1,111	-11	-5
Increase over Prior Year (%)	-17	7	-19	-24	-7	-4	-6	-7	-5	-3		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.
Source: Dataquest (April 1994)

Table 6
CAD/CAM/CAE/GIS History and Forecast

Application: Mechanical
Region: Worldwide
Platform: Server

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	NA	NA	5,378	6,590	8,633	10,200	11,800	13,100	14,100	14,800	NA	11
Unit Shipments or Seats	NA	NA	5,378	6,590	8,633	10,200	11,800	13,100	14,100	14,800	NA	11
CPU Installed Base	NA	NA	5,378	11,968	20,205	29,200	38,200	47,100	53,800	59,100	NA	24
Installed Seats	NA	NA	5,378	11,968	20,205	29,200	38,200	47,100	53,800	59,100	NA	24
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	NA	NA	78.9	73.9	56.3	53.1	50.4	48.5	47.4	46.8	NA	-4
Hardware-Only ASP	NA	NA	38.9	38.8	32.5	31.6	30.8	30.1	29.6	29.1	NA	-2
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	NA	NA	232	285	297	328	359	381	397	406	NA	6
CPU Revenue	NA	NA	204	259	276	306	337	360	376	387	NA	7
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	NA	NA	28	26	21	21	21	21	20	19	NA	-2
Software Revenue	NA	NA	109	95	102	120	139	155	168	178	NA	12
Bundled	NA	NA	91	71	70	82	93	102	109	113	NA	10
Unbundled	NA	NA	19	24	31	38	46	53	59	65	NA	16
Service Revenue	NA	NA	90	94	100	112	126	136	145	151	NA	9
Total Factory Revenue	NA	NA	431	474	498	560	624	672	710	736	NA	8
Increase over Prior Year (%)	NA	NA	NA	10	5	12	11	8	6	4		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.
Source: Dataquest (April 1994)

Table 7
CAD/CAM/CAE/GIS History and Forecast

Application: Mechanical
Region: Worldwide
Platform: Personal Computer

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	106,601	110,805	130,859	157,160	164,451	171,300	177,800	184,300	187,600	189,100	11	3
Unit Shipments or Seats	106,601	110,805	130,859	157,160	164,451	171,300	177,800	184,300	187,600	189,100	11	3
CPU Installed Base	319,141	395,083	470,163	545,419	587,997	606,100	622,600	644,500	665,300	680,000	17	3
Installed Seats	318,676	395,083	470,163	545,419	587,997	606,100	622,600	644,500	665,300	680,000	17	3
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	20.9	20.1	15.4	13.7	13.2	12.7	12.0	11.7	11.5	11.4	-11	-3
Hardware-Only ASP	5.0	4.2	3.8	3.6	3.2	3.2	3.1	3.1	3.0	3.0	-11	-1
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	630	598	605	672	640	652	655	663	663	658	0	1
CPU Revenue	569	527	550	619	592	602	605	613	613	609	1	1
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	62	71	54	52	48	50	49	50	50	49	-6	1
Software Revenue	321	339	420	488	512	543	577	613	639	660	12	5
Bundled	88	82	98	100	109	115	118	122	123	124	6	2
Unbundled	233	258	323	388	402	429	459	491	515	536	15	6
Service Revenue	53	54	48	53	57	62	67	72	78	82	2	8
Total Factory Revenue	1,004	991	1,072	1,213	1,208	1,257	1,299	1,348	1,379	1,400	5	3
Increase over Prior Year (%)	12	-1	8	13	-0	4	3	4	2	2		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.
Source: Dataquest (April 1994)

Table 8
CAD/CAM/CAE/GIS History and Forecast

Application: Mechanical
Region: North America
Platform: All Platforms

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	65,651	65,802	68,434	86,183	103,873	117,300	128,500	137,800	146,200	152,500	12	8
Unit Shipments or Seats	73,590	75,082	76,067	91,033	110,818	123,900	134,600	143,400	151,500	157,600	11	7
CPU Installed Base	193,657	238,245	274,761	316,334	357,769	400,400	449,300	503,400	553,800	594,000	17	11
Installed Seats	245,639	294,756	332,354	370,927	410,413	450,300	496,100	546,800	593,200	630,200	14	9
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	77.3	73.4	57.0	52.6	39.6	37.0	34.5	32.7	31.5	30.6	-15	-5
Hardware-Only ASP	10.7	10.1	10.4	10.4	10.4	10.3	10.2	10.0	9.9	9.7	-1	-1
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	1,158	1,113	1,050	1,198	1,297	1,400	1,469	1,518	1,567	1,596	3	4
CPU Revenue	893	845	840	1,007	1,113	1,224	1,306	1,367	1,422	1,456	6	6
Terminal Revenue	151	143	114	100	108	105	98	92	89	86	-8	-4
Peripheral Revenue (Turnkey)	114	124	97	91	76	71	65	60	57	54	-10	-6
Software Revenue	463	560	549	623	721	820	902	970	1,034	1,083	12	8
Bundled	196	238	203	182	168	166	162	156	152	149	-4	-2
Unbundled	268	322	346	441	553	654	740	814	882	935	20	11
Service Revenue	332	347	321	371	412	456	492	520	551	575	6	7
Total Factory Revenue	1,953	2,020	1,920	2,192	2,431	2,676	2,864	3,009	3,152	3,254	6	6
Increase over Prior Year (%)	12	3	-5	14	11	10	7	5	5	3		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.

Source: Dataquest (April 1994)

Table 9
CAD/CAM/CAE/GIS History and Forecast

Application: Mechanical
Region: North America
Platform: Technical Workstation

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	16,345	18,036	22,903	29,613	38,069	45,300	51,700	57,500	63,500	68,700	24	13
Unit Shipments or Seats	16,345	18,036	22,903	29,613	38,069	45,300	51,700	57,500	63,500	68,700	24	13
CPU Installed Base	39,108	54,401	72,626	95,096	122,851	154,400	187,200	222,200	256,400	285,400	33	18
Installed Seats	39,108	54,401	72,626	95,096	122,851	154,400	187,200	222,200	256,400	285,400	33	18
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	51.1	43.7	40.7	39.5	33.2	31.4	29.5	28.0	27.0	26.2	-10	-5
Hardware-Only ASP	17.3	19.3	17.7	17.5	16.5	15.8	15.2	14.6	14.0	13.4	-1	-4
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	451	447	493	602	679	757	815	861	908	942	11	7
CPU Revenue	377	378	436	541	624	707	770	820	871	906	13	8
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	74	70	56	61	54	50	45	40	38	36	-7	-8
Software Revenue	227	297	328	383	465	541	605	658	710	750	20	10
Bundled	115	132	131	119	120	118	113	108	104	102	1	-3
Unbundled	112	165	198	263	345	423	492	551	606	648	32	13
Service Revenue	188	180	181	241	284	321	351	377	404	426	11	8
Total Factory Revenue	866	925	1,002	1,225	1,428	1,619	1,771	1,896	2,023	2,118	13	8
Increase over Prior Year (%)	51	7	8	22	17	13	9	7	7	5		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.
Source: Dataquest (April 1994)

Table 10
CAD/CAM/CAE/GIS History and Forecast

Application: Mechanical
Region: North America
Platform: Host-Dependent

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	2,724	2,862	1,254	1,013	1,512	1,500	1,500	1,500	1,600	1,600	-14	1
Unit Shipments or Seats	10,664	12,142	8,886	5,863	8,458	8,100	7,500	7,100	6,900	6,800	-6	-4
CPU Installed Base	12,112	13,689	13,431	12,690	12,507	12,300	11,900	11,700	11,900	12,100	1	-1
Installed Seats	64,093	70,200	71,025	67,284	65,151	62,200	58,700	55,100	51,300	48,300	0	-6
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	483.8	368.6	312.8	380.7	238.9	217.5	199.7	183.0	167.6	154.2	-16	-8
Hardware-Only ASP	120.5	117.5	279.8	240.1	193.7	184.0	174.8	166.1	157.7	149.9	13	-5
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	492	489	327	266	291	280	260	244	236	231	-12	-5
CPU Revenue	308	303	191	156	175	167	155	146	141	138	-13	-5
Terminal Revenue	151	143	114	100	108	105	98	92	89	86	-8	-4
Peripheral Revenue (Turnkey)	33	43	23	10	8	8	7	7	6	6	-29	-5
Software Revenue	135	158	84	62	64	61	55	51	48	47	-17	-6
Bundled	78	103	46	27	23	21	19	18	18	17	-26	-6
Unbundled	57	55	38	35	41	39	36	33	31	29	-8	-7
Service Revenue	130	153	100	76	76	73	68	64	63	62	-13	-4
Total Factory Revenue	756	801	511	404	431	413	383	359	347	339	-13	-5
Increase over Prior Year (%)	-17	6	-36	-21	7	-4	-7	-6	-3	-2		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.

Source: Dataquest (April 1994)

Table 11
CAD/CAM/CAE/GIS History and Forecast

Application: Mechanical
Region: North America
Platform: Server

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	NA	NA	2,302	3,899	4,931	5,900	7,000	7,700	8,100	8,400	NA	11
Unit Shipments or Seats	NA	NA	2,302	3,899	4,931	5,900	7,000	7,700	8,100	8,400	NA	11
CPU Installed Base	NA	NA	2,302	6,200	10,897	16,200	21,600	26,800	30,600	33,500	NA	25
Installed Seats	NA	NA	2,302	6,200	10,897	16,200	21,600	26,800	30,600	33,500	NA	25
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	NA	NA	60.4	69.7	45.8	43.0	40.7	38.8	37.7	36.9	NA	-4
Hardware-Only ASP	NA	NA	35.8	37.0	30.5	29.9	29.3	28.7	28.1	27.6	NA	-2
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	NA	NA	83	157	148	172	196	210	216	219	NA	8
CPU Revenue	NA	NA	74	145	142	166	190	205	212	215	NA	9
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	NA	NA	8	13	6	6	5	5	4	4	NA	-8
Software Revenue	NA	NA	33	48	42	50	59	64	67	69	NA	10
Bundled	NA	NA	24	33	20	22	24	25	25	24	NA	4
Unbundled	NA	NA	8	15	22	28	34	39	42	45	NA	15
Service Revenue	NA	NA	34	48	44	52	61	66	69	71	NA	10
Total Factory Revenue	NA	NA	149	253	235	274	315	339	352	358	NA	9
Increase over Prior Year (%)	NA	NA	NA	70	-7	17	15	8	4	2		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.
Source: Dataquest (April 1994)

Table 12
CAD/CAM/CAE/GIS History and Forecast

Application: Mechanical
Region: North America
Platform: Personal Computer

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	46,581	44,905	41,976	51,658	59,361	64,500	68,300	71,100	72,900	73,700	6	4
Unit Shipments or Seats	46,581	44,905	41,976	51,658	59,361	64,500	68,300	71,100	72,900	73,700	6	4
CPU Installed Base	142,438	170,154	186,402	202,347	211,514	217,600	228,500	242,600	254,900	263,000	10	4
Installed Seats	142,438	170,154	186,402	202,347	211,514	217,600	228,500	242,600	254,900	263,000	10	4
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	10.9	19.7	13.0	14.0	9.0	8.7	8.3	8.0	7.9	7.8	-5	-3
Hardware-Only ASP	4.6	3.9	3.5	3.3	3.0	2.9	2.9	2.8	2.8	2.8	-10	-2
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	216	176	148	173	179	191	199	204	207	205	-5	3
CPU Revenue	209	164	138	165	172	184	192	196	199	197	-5	3
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	7	12	10	8	7	8	8	8	8	8	0	2
Software Revenue	101	105	104	131	150	168	184	197	209	218	10	8
Bundled	3	3	2	3	4	5	5	5	6	6	7	5
Unbundled	98	102	102	128	145	163	178	192	203	212	10	8
Service Revenue	14	13	5	6	8	10	12	13	15	16	-12	15
Total Factory Revenue	331	294	258	309	337	369	395	415	430	439	0	5
Increase over Prior Year (%)	25	-11	-12	20	9	10	7	5	4	2		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.
Source: Dataquest (April 1994)

Table 13
CAD/CAM/CAE/GIS History and Forecast

Application: Mechanical
Region: Europe
Platform: All Platforms

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	58,848	63,322	74,144	86,669	90,972	95,800	102,400	109,900	115,300	120,000	12	6
Unit Shipments or Seats	67,006	71,626	80,353	92,444	97,794	102,400	108,800	115,900	120,800	125,400	10	5
CPU Installed Base	165,509	214,600	264,502	313,544	348,778	375,800	402,800	433,600	462,400	484,000	20	7
Installed Seats	202,911	260,668	314,825	365,710	401,593	427,500	452,700	481,300	507,000	526,300	19	6
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	75.2	59.7	63.8	54.3	45.1	41.8	39.1	36.8	35.1	34.0	-12	-5
Hardware-Only ASP	10.0	10.7	11.7	10.1	9.6	9.6	9.5	9.5	9.7	9.8	-1	0
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	1,384	1,374	1,623	1,564	1,439	1,428	1,430	1,443	1,465	1,499	1	1
CPU Revenue	1,066	1,089	1,316	1,291	1,195	1,198	1,214	1,241	1,273	1,313	3	2
Terminal Revenue	138	106	117	94	86	81	76	72	69	67	-11	-5
Peripheral Revenue (Turnkey)	180	179	190	179	158	149	140	130	124	119	-3	-6
Software Revenue	614	725	899	879	872	913	969	1,029	1,084	1,139	9	5
Bundled	380	438	545	453	436	434	435	427	420	414	4	-1
Unbundled	234	287	354	426	436	478	534	602	664	725	17	11
Service Revenue	421	514	592	629	620	623	637	651	674	702	10	3
Total Factory Revenue	2,419	2,613	3,114	3,072	2,932	2,964	3,036	3,123	3,223	3,340	5	3
Increase over Prior Year (%)	13	8	19	-1	-5	1	2	3	3	4		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.
Source: Dataquest (April 1994)

Table 14
CAD/CAM/CAE/GIS History and Forecast

Application: Mechanical
Region: Europe
Platform: Technical Workstation

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	21,374	26,169	32,704	39,063	40,414	43,200	47,100	51,400	56,100	61,200	17	9
Unit Shipments or Seats	21,374	26,169	32,704	39,063	40,415	43,200	47,100	51,400	56,100	61,200	17	9
CPU Installed Base	46,739	70,349	98,237	129,147	156,051	180,600	202,900	225,100	245,900	262,900	35	11
Installed Seats	46,447	70,349	98,237	129,147	156,051	180,600	202,900	225,100	245,900	262,900	35	11
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	53.5	46.6	47.9	44.8	38.2	36.1	33.9	32.2	31.1	30.2	-8	-5
Hardware-Only ASP	19.5	21.9	20.5	19.7	19.1	18.3	17.6	16.9	16.2	15.6	-1	-4
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	673	747	857	963	861	857	866	890	926	969	6	2
CPU Revenue	563	637	736	832	745	751	770	802	843	889	7	4
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	110	111	121	131	115	105	96	88	83	80	1	-7
Software Revenue	350	461	592	617	601	629	670	715	763	813	14	6
Bundled	234	298	383	349	321	312	309	300	292	286	8	-2
Unbundled	116	164	208	268	280	317	362	416	471	527	25	13
Service Revenue	261	334	370	469	459	462	474	490	514	540	15	3
Total Factory Revenue	1,284	1,543	1,819	2,049	1,920	1,947	2,011	2,095	2,203	2,323	11	4
Increase over Prior Year (%)	49	20	18	13	-6	1	3	4	5	5		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.
Source: Dataquest (April 1994)

Table 15
CAD/CAM/CAE/GIS History and Forecast

Application: Mechanical
Region: Europe
Platform: Host-Dependent

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	1,717	2,835	1,725	890	950	1,000	1,000	1,000	1,000	1,100	-14	3
Unit Shipments or Seats	9,875	11,140	7,933	6,665	7,771	7,600	7,300	6,900	6,600	6,500	-6	-4
CPU Installed Base	9,174	11,045	12,012	11,780	11,305	10,800	10,300	9,600	9,300	8,900	5	-5
Installed Seats	47,209	57,113	62,335	63,945	64,120	62,500	60,100	57,300	53,900	51,200	8	-4
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	459.2	264.6	451.2	500.3	405.2	370.9	340.9	312.2	285.2	261.5	-3	-8
Hardware-Only ASP	163.4	116.4	223.2	366.3	387.8	370.6	353.6	336.4	319.9	304.2	24	-5
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	483	444	507	345	321	304	289	269	252	245	-10	-5
CPU Revenue	306	299	353	230	216	205	195	181	168	164	-8	-5
Terminal Revenue	138	106	117	94	86	81	76	72	69	67	-11	-5
Peripheral Revenue (Turnkey)	39	40	38	21	19	18	17	16	15	14	-17	-5
Software Revenue	157	160	128	86	78	74	70	64	59	57	-16	-6
Bundled	128	128	98	65	60	58	55	51	46	44	-17	-6
Unbundled	29	32	30	21	18	16	14	14	13	13	-11	-7
Service Revenue	143	164	167	118	108	103	99	93	87	85	-7	-5
Total Factory Revenue	783	767	802	549	507	482	458	426	398	386	-10	-5
Increase over Prior Year (%)	-20	-2	4	-32	-8	-5	-5	-7	-7	-3		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.
Source: Dataquest (April 1994)

Table 16
CAD/CAM/CAE/GIS History and Forecast

Application: Mechanical
Region: Europe
Platform: Server

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	NA	NA	1,599	1,370	2,233	2,600	2,900	3,300	3,600	3,900	NA	12
Unit Shipments or Seats	NA	NA	1,599	1,370	2,233	2,600	2,900	3,300	3,600	3,900	NA	12
CPU Installed Base	NA	NA	1,599	2,969	5,120	7,500	9,700	12,000	13,800	15,300	NA	24
Installed Seats	NA	NA	1,599	2,969	5,120	7,500	9,700	12,000	13,800	15,300	NA	24
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	NA	NA	121.3	75.0	56.8	53.4	50.4	48.1	46.7	45.7	NA	-4
Hardware-Only ASP	NA	NA	40.6	44.3	33.8	33.1	32.4	31.7	31.1	30.5	NA	-2
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	NA	NA	89	65	81	86	88	91	96	99	NA	4
CPU Revenue	NA	NA	77	57	71	75	78	81	86	90	NA	5
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	NA	NA	12	8	10	11	10	10	10	9	NA	-2
Software Revenue	NA	NA	48	26	38	45	51	57	63	67	NA	12
Bundled	NA	NA	42	22	34	41	46	51	55	57	NA	11
Unbundled	NA	NA	6	3	4	4	5	7	8	10	NA	24
Service Revenue	NA	NA	35	26	34	38	41	44	47	49	NA	7
Total Factory Revenue	NA	NA	173	117	153	169	181	192	206	215	NA	7
Increase over Prior Year (%)	NA	NA	NA	-32	31	10	7	6	7	4		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.
Source: Dataquest (April 1994)

Table 17
CAD/CAM/CAE/GIS History and Forecast

Application: Mechanical
Region: Europe
Platform: Personal Computer

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	35,757	34,317	38,116	45,347	47,374	49,000	51,500	54,300	54,600	53,800	7	3
Unit Shipments or Seats	35,757	34,317	38,116	45,347	47,374	49,000	51,500	54,300	54,600	53,800	7	3
CPU Installed Base	109,596	133,206	152,653	169,648	176,301	176,900	179,900	186,900	193,400	196,900	13	2
Installed Seats	109,255	133,206	152,653	169,648	176,301	176,900	179,900	186,900	193,400	196,900	13	2
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	28.6	25.0	24.8	20.3	13.6	12.4	11.9	11.6	11.4	11.3	-17	-4
Hardware-Only ASP	5.2	4.2	3.7	3.6	3.2	3.2	3.1	3.1	3.0	3.0	-11	-1
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	227	183	170	191	177	182	187	193	191	187	-6	1
CPU Revenue	197	154	151	172	163	167	171	177	175	171	-5	1
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	30	29	19	19	14	15	16	16	16	16	-18	3
Software Revenue	107	104	131	150	155	164	177	192	199	202	10	5
Bundled	18	12	21	16	21	23	25	26	27	27	4	5
Unbundled	89	91	110	133	135	141	153	166	172	175	11	5
Service Revenue	17	17	20	17	19	20	23	25	27	28	2	8
Total Factory Revenue	352	303	320	358	351	367	387	410	417	416	-0	3
Increase over Prior Year (%)	19	-14	5	12	-2	4	5	6	2	-0		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.
Source: Dataquest (April 1994)

Table 18
CAD/CAM/CAE/GIS History and Forecast

Application: Mechanical
Region: Asia
Platform: All Platforms

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	37,328	50,091	69,394	81,250	81,379	83,400	85,900	89,000	92,400	96,600	22	3
Unit Shipments or Seats	43,540	56,367	75,501	86,448	87,257	88,900	90,900	93,400	96,400	100,400	19	3
CPU Installed Base	91,008	132,878	189,319	249,668	294,324	323,300	341,000	355,900	371,000	384,700	34	6
Installed Seats	111,993	160,768	222,537	286,326	333,973	364,700	382,100	395,400	407,600	418,400	31	5
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	57.3	50.5	42.4	41.7	42.0	39.8	37.6	35.7	34.4	33.5	-7	-4
Hardware-Only ASP	14.8	13.4	9.8	8.5	8.2	8.4	8.5	8.6	8.7	8.9	-14	2
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	1,069	1,316	1,335	1,437	1,400	1,387	1,365	1,353	1,360	1,383	7	-0
CPU Revenue	790	1,012	1,059	1,162	1,133	1,128	1,115	1,110	1,123	1,148	9	0
Terminal Revenue	109	92	82	61	47	43	40	35	33	31	-19	-8
Peripheral Revenue (Turnkey)	170	212	195	214	219	216	210	207	205	204	7	-1
Software Revenue	462	554	612	681	744	776	808	843	881	925	13	4
Bundled	343	394	391	436	476	489	501	512	515	516	9	2
Unbundled	118	160	220	245	268	287	307	331	365	409	23	9
Service Revenue	227	298	290	329	355	366	375	383	397	414	12	3
Total Factory Revenue	1,757	2,168	2,236	2,446	2,499	2,529	2,548	2,578	2,638	2,722	9	2
Increase over Prior Year (%)	2	23	3	9	2	1	1	1	2	3		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.

Source: Dataquest (April 1994)

Table 19
CAD/CAM/CAE/GIS History and Forecast

Application: Mechanical
Region: Asia
Platform: Technical Workstation

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	11,662	16,961	17,683	21,145	23,885	26,000	28,300	30,800	33,300	36,200	20	9
Unit Shipments or Seats	11,662	16,961	17,683	21,145	23,885	26,000	28,300	30,800	33,300	36,200	20	9
CPU Installed Base	21,431	36,955	52,741	70,286	87,444	103,700	118,300	132,100	145,300	156,200	42	12
Installed Seats	20,724	36,955	52,741	70,286	87,444	103,700	118,300	132,100	145,300	156,200	43	12
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	52.6	42.7	46.9	53.5	55.1	52.1	49.0	46.5	44.9	43.6	1	-5
Hardware-Only ASP	21.5	30.8	27.8	28.7	23.8	22.8	21.9	21.0	20.1	19.3	3	-4
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	378	512	552	739	790	796	797	808	828	853	20	2
CPU Revenue	279	380	425	582	628	637	641	653	674	699	22	2
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	99	132	127	157	162	159	156	155	154	154	13	-1
Software Revenue	217	254	292	367	440	472	504	538	572	609	19	7
Bundled	173	184	209	263	304	316	329	342	347	348	15	3
Unbundled	44	69	82	104	137	156	175	196	225	261	33	14
Service Revenue	81	119	130	185	227	239	249	260	274	289	29	5
Total Factory Revenue	676	886	973	1,291	1,457	1,506	1,550	1,606	1,674	1,752	21	4
Increase over Prior Year (%)	38	31	10	33	13	3	3	4	4	5		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.
Source: Dataquest (April 1994)

Table 20
CAD/CAM/CAE/GIS History and Forecast

Application: Mechanical
Region: Asia
Platform: Host-Dependent

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	3,297	3,684	2,527	2,378	2,576	2,700	2,700	2,700	2,800	3,000	-6	3
Unit Shipments or Seats	9,509	9,959	8,635	7,575	8,453	8,100	7,700	7,200	6,900	6,700	-3	-5
CPU Installed Base	6,947	10,322	12,436	14,205	15,805	17,500	18,200	18,700	19,400	20,000	23	5
Installed Seats	28,763	38,212	45,655	50,863	55,454	58,800	59,300	58,200	56,000	53,700	18	-1
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	211.2	232.8	198.9	176.6	133.8	123.5	113.4	103.9	95.1	87.5	-11	-8
Hardware-Only ASP	130.8	114.7	290.2	257.7	286.9	266.4	252.5	240.0	228.3	216.6	22	-5
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	513	573	451	353	286	273	257	235	222	216	-14	-5
CPU Revenue	357	432	334	264	210	201	190	175	166	162	-12	-5
Terminal Revenue	109	92	82	61	47	43	40	35	33	31	-19	-8
Peripheral Revenue (Turnkey)	47	50	35	28	30	28	27	25	24	23	-11	-5
Software Revenue	136	174	115	100	94	89	83	75	70	68	-9	-6
Bundled	104	143	86	84	81	77	73	67	63	61	-6	-5
Unbundled	32	30	29	16	13	11	10	9	7	7	-20	-13
Service Revenue	124	155	119	98	84	81	77	71	68	67	-9	-4
Total Factory Revenue	774	903	686	550	464	443	417	381	361	350	-12	-5
Increase over Prior Year (%)	-14	17	-24	-20	-16	-5	-6	-9	-5	-3		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.
Source: Dataquest (April 1994)

Table 21
CAD/CAM/CAE/GIS History and Forecast

Application: Mechanical
Region: Asia
Platform: Server

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	NA	NA	1,356	1,037	1,090	1,200	1,300	1,400	1,600	1,700	NA	9
Unit Shipments or Seats	NA	NA	1,356	1,037	1,090	1,200	1,300	1,400	1,600	1,700	NA	9
CPU Installed Base	NA	NA	1,356	2,393	3,421	4,400	5,300	6,200	6,800	7,400	NA	17
Installed Seats	NA	NA	1,356	2,393	3,421	4,400	5,300	6,200	6,800	7,400	NA	17
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	NA	NA	63.4	90.0	72.7	68.8	65.1	62.1	60.3	59.0	NA	-4
Hardware-Only ASP	NA	NA	45.5	40.9	44.6	43.8	42.9	42.0	41.2	40.4	NA	-2
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	NA	NA	55	50	54	55	57	61	64	67	NA	4
CPU Revenue	NA	NA	48	46	51	52	54	57	60	63	NA	4
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	NA	NA	7	4	3	3	3	3	4	4	NA	5
Software Revenue	NA	NA	27	15	14	16	18	21	24	27	NA	13
Bundled	NA	NA	23	10	9	11	13	16	18	19	NA	16
Unbundled	NA	NA	4	5	5	5	5	6	6	7	NA	7
Service Revenue	NA	NA	19	16	16	17	18	20	21	23	NA	7
Total Factory Revenue	NA	NA	101	82	84	87	93	101	109	116	NA	7
Increase over Prior Year (%)	NA	NA	NA	-19	3	4	7	9	7	6		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.
Source: Dataquest (April 1994)

Table 22
CAD/CAM/CAE/GIS History and Forecast

Application: Mechanical
Region: Asia
Platform: Personal Computer

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	22,369	29,447	47,827	56,691	53,829	53,600	53,600	54,000	54,700	55,800	25	1
Unit Shipments or Seats	22,369	29,447	47,827	56,691	53,829	53,600	53,600	54,000	54,700	55,800	25	1
CPU Installed Base	62,631	85,601	122,785	162,784	187,655	197,800	199,300	198,900	199,400	201,100	32	1
Installed Seats	62,506	85,601	122,785	162,784	187,655	197,800	199,300	198,900	199,400	201,100	32	1
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	19.7	19.2	14.3	12.6	13.4	13.0	12.4	12.0	11.7	11.6	-9	-3
Hardware-Only ASP	5.8	4.7	4.1	4.0	3.6	3.6	3.5	3.5	3.4	3.4	-11	-1
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	178	230	276	295	270	264	253	249	246	247	11	-2
CPU Revenue	154	201	251	270	245	238	229	225	223	224	12	-2
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	25	30	25	25	25	25	24	24	23	23	0	-2
Software Revenue	109	126	178	199	196	199	203	208	214	222	16	3
Bundled	66	66	73	80	82	85	86	88	88	88	6	1
Unbundled	42	60	105	119	113	114	117	121	126	134	28	3
Service Revenue	21	24	22	30	29	30	31	32	34	36	8	4
Total Factory Revenue	308	380	476	523	494	493	487	489	494	504	13	0
Increase over Prior Year (%)	-6	24	25	10	-5	-0	-1	0	1	2		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.

Source: Dataquest (April 1994)

Table 23
CAD/CAM/CAE/GIS History and Forecast

Application: Mechanical
Region: Rest of World
Platform: All Platforms

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	2,591	2,878	4,206	5,702	6,545	7,200	8,000	8,900	9,900	10,600	26	10
Unit Shipments or Seats	2,872	3,140	4,483	6,196	7,067	7,800	8,600	9,400	10,400	11,100	25	9
CPU Installed Base	6,579	8,799	12,007	16,203	20,197	23,800	27,300	31,100	35,100	38,700	32	14
Installed Seats	8,492	10,705	13,885	18,272	22,480	26,200	30,000	34,000	38,100	41,800	28	13
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	60.5	44.9	38.2	57.6	46.0	43.1	39.9	36.9	34.8	33.3	-7	-6
Hardware-Only ASP	8.7	6.6	7.8	9.6	9.0	9.3	9.4	9.4	9.2	9.0	1	0
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	46	38	53	92	96	102	109	115	120	124	20	5
CPU Revenue	35	29	44	75	79	84	90	96	101	105	23	6
Terminal Revenue	5	4	4	8	7	7	8	8	8	8	8	1
Peripheral Revenue (Turnkey)	6	5	6	9	10	11	11	11	12	12	14	2
Software Revenue	18	18	29	50	53	59	67	74	81	86	31	10
Bundled	10	9	14	24	25	27	30	33	35	37	25	8
Unbundled	8	9	16	26	28	32	36	41	46	50	37	12
Service Revenue	13	12	17	34	36	39	43	47	50	52	29	7
Total Factory Revenue	77	67	99	175	186	201	219	235	251	262	24	7
Increase over Prior Year (%)	6	-13	47	77	6	8	9	7	7	5		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.

Source: Dataquest (April 1994)

Table 24
CAD/CAM/CAE/GIS History and Forecast

Application: Mechanical
Region: Rest of World
Platform: Technical Workstation

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	634	687	1,100	1,864	2,183	2,500	2,900	3,200	3,600	3,900	36	12
Unit Shipments or Seats	634	687	1,100	1,864	2,183	2,500	2,900	3,200	3,600	3,900	36	12
CPU Installed Base	1,781	2,345	3,229	4,779	6,478	8,300	10,300	12,400	14,400	16,000	38	20
Installed Seats	1,781	2,345	3,229	4,779	6,478	8,300	10,300	12,400	14,400	16,000	38	20
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	46.4	33.6	41.4	42.4	34.5	32.6	30.7	29.1	28.1	27.3	-7	-5
Hardware-Only ASP	19.4	22.2	18.8	17.9	17.3	16.7	16.0	15.3	14.7	14.1	-3	-4
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	19	16	26	42	43	46	50	53	56	58	22	6
CPU Revenue	15	13	22	37	38	41	44	47	50	52	25	7
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	4	3	4	5	5	5	5	6	6	6	8	1
Software Revenue	9	8	17	29	29	33	37	41	45	48	36	10
Bundled	6	6	10	14	13	13	15	16	17	17	19	6
Unbundled	2	3	8	15	16	20	23	25	28	30	63	13
Service Revenue	8	7	11	21	23	25	27	29	32	34	31	8
Total Factory Revenue	36	31	54	91	95	104	114	123	132	139	28	8
Increase over Prior Year (%)	38	-13	74	69	4	9	10	8	7	5		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.
Source: Dataquest (April 1994)

Table 25
CAD/CAM/CAE/GIS History and Forecast

Application: Mechanical
Region: Rest of World
Platform: Host-Dependent

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	62	53	46	90	95	100	100	100	100	100	11	1
Unit Shipments or Seats	344	316	323	584	618	600	700	700	700	600	16	-1
CPU Installed Base	322	333	335	378	425	500	500	600	700	800	7	13
Installed Seats	2,235	2,239	2,213	2,447	2,708	3,000	3,200	3,500	3,700	3,900	5	8
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	601.0	399.7	288.1	398.5	336.1	306.0	280.9	257.5	235.8	216.9	-14	-8
Hardware-Only ASP	155.4	176.0	331.3	228.8	243.1	231.0	219.4	208.5	198.0	188.1	12	-5
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	17	13	12	25	25	25	26	26	25	24	9	-1
CPU Revenue	10	8	7	16	16	17	17	17	16	15	12	-1
Terminal Revenue	5	4	4	8	7	7	8	8	8	8	8	1
Peripheral Revenue (Turnkey)	2	1	1	1	1	1	1	1	1	1	-12	-4
Software Revenue	5	5	3	6	6	6	6	6	5	5	1	-3
Bundled	4	4	2	4	4	4	4	4	3	3	2	-5
Unbundled	2	1	1	2	2	2	2	2	2	2	-1	2
Service Revenue	5	4	4	8	8	8	8	8	8	7	13	-1
Total Factory Revenue	28	22	19	39	38	39	40	40	38	36	8	-1
Increase over Prior Year (%)	-31	-19	-15	103	-2	2	2	-0	-3	-6		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.
Source: Dataquest (April 1994)

Table 26
CAD/CAM/CAE/GIS History and Forecast

Application: Mechanical
Region: Rest of World
Platform: Server

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	NA	NA	121	284	379	500	600	700	800	900	NA	19
Unit Shipments or Seats	NA	NA	121	284	379	500	600	700	800	900	NA	19
CPU Installed Base	NA	NA	121	405	766	1,200	1,600	2,100	2,500	2,900	NA	30
Installed Seats	NA	NA	121	405	766	1,200	1,600	2,100	2,500	2,900	NA	30
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	NA	NA	53.0	69.9	66.8	62.8	59.3	56.6	54.9	53.8	NA	-4
Hardware-Only ASP	NA	NA	38.8	43.9	32.0	31.4	30.8	30.1	29.5	28.9	NA	-2
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	NA	NA	5	12	14	16	17	19	21	22	NA	9
CPU Revenue	NA	NA	4	10	12	13	15	17	18	20	NA	10
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	NA	NA	0	2	2	2	2	2	2	3	NA	3
Software Revenue	NA	NA	1	6	7	9	11	12	14	16	NA	16
Bundled	NA	NA	1	5	7	8	10	11	12	13	NA	14
Unbundled	NA	NA	0	1	1	1	1	2	2	3	NA	30
Service Revenue	NA	NA	2	4	5	5	6	7	8	9	NA	13
Total Factory Revenue	NA	NA	8	22	26	30	35	39	43	47	NA	12
Increase over Prior Year (%)	NA	NA	NA	180	20	15	14	12	11	9		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.

Source: Dataquest (April 1994)

Table 27
CAD/CAM/CAE/GIS History and Forecast

Application: Mechanical
Region: Rest of World
Platform: Personal Computer

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	CAGR (%) 1989-1993	CAGR (%) 1993-1998
HARDWARE SHIPMENT DATA												
CPU Shipments	1,894	2,137	2,939	3,464	3,887	4,100	4,500	4,900	5,400	5,800	20	8
Unit Shipments or Seats	1,894	2,137	2,939	3,464	3,887	4,100	4,500	4,900	5,400	5,800	20	8
CPU Installed Base	4,477	6,122	8,323	10,641	12,528	13,800	14,800	16,000	17,500	19,000	29	9
Installed Seats	4,477	6,122	8,323	10,641	12,528	13,800	14,800	16,000	17,500	19,000	29	9
CALCULATED AVERAGE SELLING PRICE DATA (Thousands of U.S. Dollars)												
Turnkey ASP	9.7	6.2	6.1	19.3	14.6	14.2	13.5	13.1	12.8	12.7	11	-3
Hardware-Only ASP	4.8	3.9	3.5	3.5	3.2	3.2	3.1	3.1	3.0	3.0	-10	-2
REVENUE DATA (Millions of U.S. Dollars)												
Hardware Revenue	9	9	10	13	14	15	16	17	19	20	11	7
CPU Revenue	9	8	10	12	13	13	14	15	16	17	9	7
Terminal Revenue	0	0	0	0	0	0	0	0	0	0	NA	NA
Peripheral Revenue (Turnkey)	0	0	1	1	2	2	2	2	2	2	47	8
Software Revenue	4	5	7	9	11	12	13	15	17	18	27	12
Bundled	0	0	1	1	2	2	2	3	3	3	49	13
Unbundled	4	5	6	8	9	10	11	12	14	15	24	11
Service Revenue	1	1	1	1	1	1	1	2	2	2	14	16
Total Factory Revenue	14	14	18	23	26	28	30	34	38	40	16	9
Increase over Prior Year (%)	94	-2	32	27	11	8	8	11	11	7		

Note: In 1991, server was added as a platform. This reclassification reduced 1991 growth rates for the other platforms.
Source: Dataquest (April 1994)

For More Information...

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

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Dataquest®
a company of
The Dun & Bradstreet Corporation

Dataquest®

a company of
The Dun & Bradstreet Corporation

Corporate Headquarters
Dataquest Incorporated
1290 Ridder Park Drive
San Jose, California 95131-2398
United States
Phone: 01-408-437-8000
Facsimile: 01-408-437-0292

Dataquest Incorporated
550 Cochituate Road
Framingham, Massachusetts 01701-9324
United States
Phone: 01-508-370-5555
Facsimile: 01-508-370-6262

Invitational Computer Conferences (ICC)
3990 Westerly Place, Suite 100
Newport Beach, California 92660
United States
Phone: 01-714-476-9117
Facsimile: 01-714-476-9969

Dataquest Japan Limited
Shinkawa Sanko Building
1-3-17, Shinkawa, Chuo-ku
Tokyo 104
Japan
Phone: 81-3-5566-0411
Facsimile: 81-3-5566-0425

Dataquest Korea
Trade Tower, Suite 3806
159 Samsung-dong
Kangnam-gu, Seoul 135-729
Korea
Phone: 82-2-551-1331
Facsimile: 82-2-551-1330

European Headquarters
Dataquest Europe Limited
Holmers Farm Way
High Wycombe, Bucks
HP12 4UL
England
Phone: 44-494-422722
Facsimile: 44-494-422742

Dataquest GmbH
Kronstadter Strasse 9
81677 Munich
Germany
Phone: 49-89-930-9090
Facsimile: 49-89-930-3277

Dataquest Europe SA
Tour Franklin
Cedex 11
92042 Paris-La-Défense
France
Phone: 33-1-41-25-18-00
Facsimile: 33-1-41-25-18-18

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Software

CAD/CAM/CAE and GIS Mechanical Market Share—1993

Market Statistics

1994

Program: Mechanical Applications Worldwide
Product Code: CMEC-WW-MS-9401
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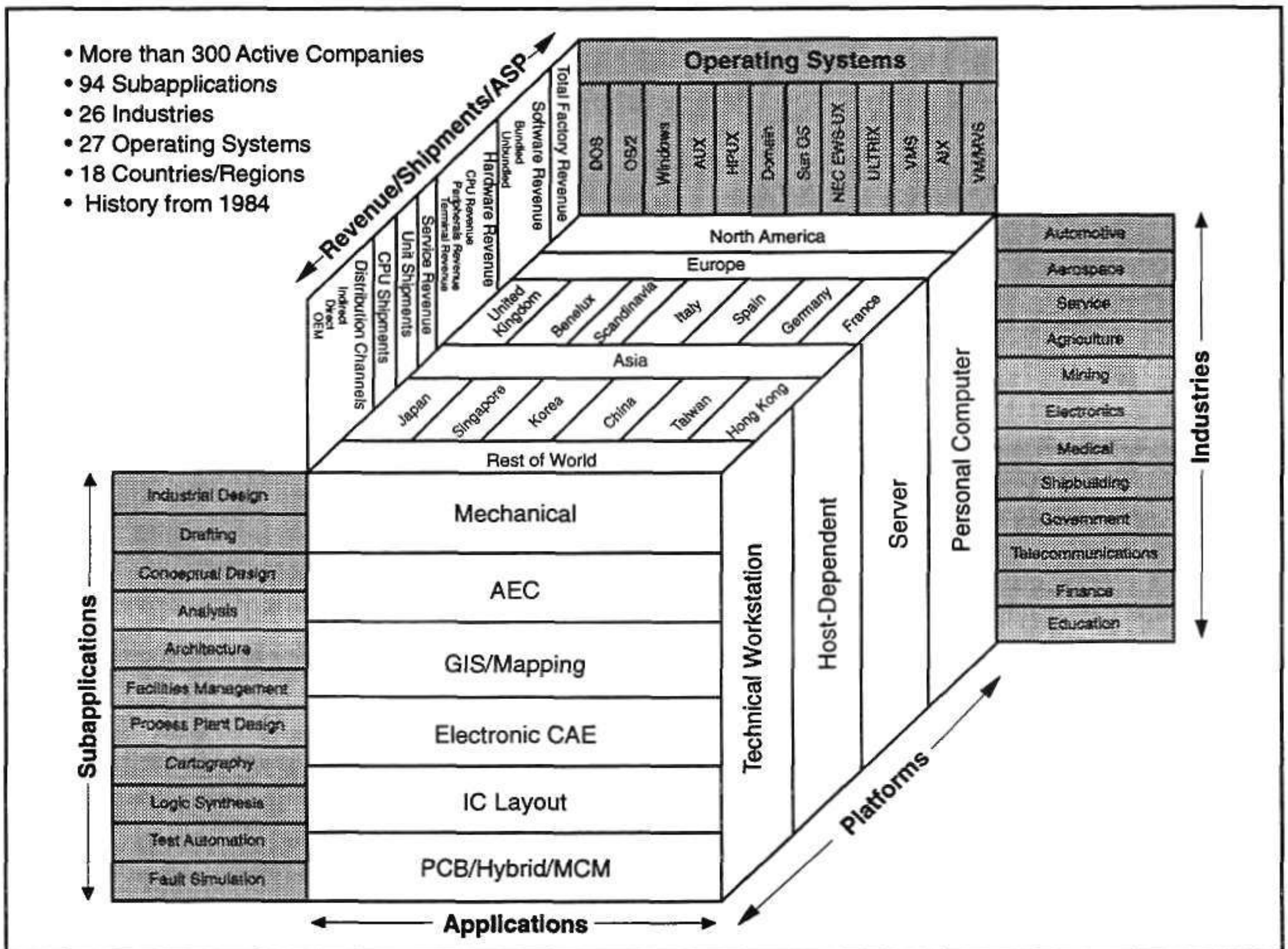
CAD/CAM/CAE and GIS Mechanical Market Share—1993

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.

Figure 1
CAD/CAM/CAE/GIS Market Database



Source: Dataquest (February 1994)

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Table 1
CAD/CAM/CAE/GIS 1992-1993 Market Summary

	Software Revenue 1992 ($M)	Software Revenue 1993 ($M)	Growth Rate (%)	Total Revenue 1992 ($M)	Total Revenue 1993 ($M)	Growth Rate (%)	Hardware Unit Shipments 1992	Hardware Unit Shipments 1993	Growth Rate (%)
Application									
Mechanical	2,235.1	2,391.6	7.0	8,079.0	8,126.7	0.6	312,647	341,620	9.3
AEC	754.4	828.5	9.8	2,385.7	2,399.1	0.6	167,517	187,728	12.1
GIS/Mapping	587.1	653.8	11.4	2,018.3	2,124.8	5.3	87,918	104,504	18.9
Electronic CAE	740.7	787.7	6.3	2,135.7	2,295.7	7.5	96,797	102,196	5.6
IC Layout	228.6	234.6	2.6	640.6	686.5	7.2	14,580	17,368	19.1
PCB/Hybrid/MCM	290.9	290.2	-0.3	915.9	933.2	1.9	35,858	36,999	3.2
Total	4,836.7	5,186.3	7.2	16,175.2	16,565.8	2.4	715,317	790,415	10.5
Region									
North America	1,629.3	1,804.5	10.8	5,262.4	5,538.4	5.2	295,649	337,773	14.2
Europe	1,709.9	1,755.9	2.7	5,959.5	5,851.8	-1.8	238,241	261,348	9.7
Asia	1,375.1	1,500.0	9.1	4,575.7	4,799.7	4.9	160,991	168,811	4.9
Rest of World	122.5	125.9	2.8	377.7	375.9	-0.5	20,436	22,483	10.0
Total	4,836.7	5,186.3	7.2	16,175.2	16,565.8	2.4	715,317	790,415	10.5
In Local Currency									
Europe (ECU)	1,314.3	1,504.0	14.4	4,580.6	5,012.5	9.4			
Asia (Yen)	173,879	166,799	-4.1	578,591	533,729	-7.8			
Platform									
Technical Workstation	3,100.5	3,358.5	8.3	9,838.5	10,472.6	6.4	195,523	221,887	13.5
Host-Dependent	353.8	320.5	-9.4	2,324.6	1,925.0	-17.2	29,886	32,548	8.9
Server	190.6	210.8	10.6	1,040.4	1,070.6	2.9	15,030	17,482	16.3
Personal Computer	1,191.8	1,296.6	8.8	2,971.8	3,097.7	4.2	474,879	518,498	9.2
Total	4,836.7	5,186.3	7.2	16,175.2	16,565.8	2.4	715,317	790,415	10.5

Source: Dataquest (February 1994)

A companion article analyzing major shifts in the 1993 market was published in our *Dataquest Alert,* dated January 31, 1994.

Table 1 summarizes the performance in various segments of the CAD/CAM/CAE/GIS markets in 1993 versus 1992. With the devaluation of the dollar against the yen (¥126.45/$ in 1992 versus ¥111.20/$ in 1993) and the appreciation of the dollar against the ECU (ECU 0.770/$ in 1992 versus ECU 0.858/$ in 1993) actual growth is not as it appears when denominated in U.S. dollars. With 75 percent of the Asian market in Japan, denominating in yen gives a rough indication of real growth in the Asian market, which was a negative 7.8 percent.

About This Document

This document contains Dataquest's detailed market share information on the CAD/CAM/CAE/GIS industry. Following is a description 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 database with GIS revenue and all companies in database with AEC revenue
- Electronic design automation applications—All companies in database with EDA (electronic CAE, IC layout, PCB/hybrid/MCM) revenue
- Europe Overview—All Europe-based companies and all other companies with more than $1 million in European revenue
- Asia—All Asia-based companies and all other companies with more than $1 million in Asian revenue
- PC CAD—All companies in database with personal computer revenue

We no longer publish top-level market statistics for the entire CAD/CAM/CAE/GIS industry or companies whose revenue in any segment is less than $1 million. This data is available by calling Kathy Klotz at (408) 437-8243. More detailed data on these markets may be requested through our client inquiry service.

We recognize that final bookeeping is not yet complete for all companies. This document represents our best effort to get early, accurate information to our subscribers. We will follow up with primary and secondary research from February 1 through April 30 to verify and crosstab and refine, producing our market share update by May 31.

Dataquest's policy is to continually update its market information, for current and past years, with any new data received in order to arrive at the most accurate market representation possible.

Segmentation Definitions

This section lists the definitions specific to this document. The following paragraphs define the segments.

Applications

Mechanical

The mechanical segment refers to computer-aided tools used by engineers, designers, analysts, technicians, and draftspeople working predominantly in the discrete manufacturing industries, but includes government and education. Users of mechanical CAD/CAM/CAE tools work in all departments across the typical organization, with a majority found in product design, advanced engineering, and manufacturing engineering. Common design applications include conceptual design, industrial design, structural or thermal analysis, detail design, and electromechanical design (the mechanical part of design with electrical or electronic components and mechanisms). Common manufacturing applications include tool and fixture design, numerical control part programming, off-line robotics programming, and interface to quality control systems. Management tools for database control and distribution are included in this segment, as well as user-defined application programming.

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 is composed of 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 process of designing 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), design verification tools (DRC/ERC/logic-to-layout), compilers, and module development tools.

- PCB/Hybrid/MCM—This segment covers products used to create the placement and routing of the traces and components laid out on a printed circuit board. Also included in this category are thermal analysis tools.

Regions

The following paragraphs define the regions.

North America

North America includes United States, Mexico, and Canada.

Europe

Europe includes the United Kingdom, Scandinavia, Benelux, France, Germany, Italy, Spain, and Rest of Europe.

Asia

Asia includes Japan, Singapore, Taiwan, Korea, China, and Hong Kong.

Rest of World

Rest of World includes all other countries including Australia, New Zealand, Oceania, Africa, Central America, South America, and the Middle East.

Platforms

The following paragraphs define the platforms.

Technical Workstation

A technical workstation is a single-user computer distinguished from a personal computer by its features and by the user's potential range of expansion on the platform. Features include a virtual, multitasking operating system (UNIX, VMS, or Domain); the computer is designed by the manufacturer to run high-performance graphics applications in a multiuser/multitasking environment.

Host-Dependent

Host-dependent is a shared logic system in which the external workstations' functions are dependent on a host computer.

Server

A server is a computer that transparently provides its resources for use by other computer systems. It is a system on a network that provides specific functionality to other computer systems: the clients. Functions include file storage, database access, and compute capability. Dataquest tracks the following major categories of servers used for CAD/CAM/CAE and GIS applications:

- Compute Servers—These systems provide capabilities for solving numerical problems (for example, simulations, statistical calculations, and simultaneous partial differential equations). System features usually include high-speed computational capabilities (for example, vector and parallel processing) and large memories.
- Print Servers—These systems provide access to printers, specialized printing applications software, and print-spooling resources to a network.

- File Servers—These systems provide mass storage capability to clients on a network. Services can range from temporary storage of working files to long-term backup and archive systems.
- Database Servers—These systems manage databases as a shared resource to a network. These servers handle such functions as physical data storage, data security, and high-level queries and can access stored information at the record level.

Personal Computer

A personal computer is a single-user computer distinguished from a technical workstation by its features and by the user's potential range of expansion on the platform. Features found in technical workstations (such as a virtual operating system, networking, high-performance graphics, multiuser/multitasking capability) are optional rather than integrated by the manufacturer.

Metrics

The following paragraphs define measurements.

- Total factory revenue is defined as 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 software revenue, hardware revenue, and service revenue.
- Unit shipment is defined as the number of seats delivered (number of possible simultaneous users of product delivered) excluding OEM shipments.
- Hardware revenue is revenue derived from sales of CPUs (including operating systems), terminals (for host-dependent systems), and peripherals.
- Software revenue is revenue derived from the sale of bundled (part of a turnkey system) and unbundled application software.
- Service revenue is defined as all revenue derived from the service and support of CAD/CAM/CAE/GIS systems. Service revenue can be calculated in the tables by subtracting hardware and software revenue from total revenue.
    - Maintenance fees for hardware and software
    - Management and operations services—help desk, education and training, disaster recovery, vaulting, and configuration management.
    - Service bureau—project work, including construction of database, data conversion, product design, analysis, or manufacturing.
    - Application development—design and development of customized software applications or the modification, enhancement of customization of existing software applications, adding new functionality.

- Consulting revenue—assessment of CAD/CAM/CAE/GIS business and information technology needs and the formulation of a plan based on needs identification.
- Implementation and integration services—planning, implementation, migration, and integration of software products (software network support and integration, account integration management, data center design, and construction).

Market Share Methodology

Dataquest uses both primary and secondary sources to produce our market share data. In the fourth quarter of each year and second quarter of the subsequent year, we survey all participants in each industry. Each vendor is offered the opportunity to self-report the information required. Although there is a primary contact for each company, large companies are surveyed across product lines and across geographic regions. Thus, there is a corresponding increase in the number of contacts at large companies. (Dataquest maintains a large contact database on all sources of information). Examples of the job titles of people contacted for information are the following:

- President and CEO
- Vice president and general manager
- Vice president of marketing
- Vice president, strategic product planning
- Director of strategic planning
- Director of marketing
- Director of market development
- Manager, CAD/CAM/CAE/GIS Marketing Programs
- Market research analyst

The Audit Process

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

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

- Articles in both the general and trade press
- Annual reports, SEC documents, credit reports
- Company publications and press releases
- Reports from financial analysts
- User studies
- Reseller and supplier reports and reports from a vendor's competitors

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

Dataquest analysts have many years of experience in how to apply the above tools 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—particularly useful when comparing regions or applications.

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 are available January 31. All tables will be published and distributed to clients by March 31.
- Forecasting from the market share tables provides a five-year forecast period, available after March 31. The books will be shipped by May 31.
- Final updated market share tables, based on additional data collection and analysis, will be completed by May 31. 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 these final market data. Books will be shipped by July 31.
- We provide complete final forecast tables by July 31. These tables take into consideration changes in the market share during the previous six months. Books will be shipped by September 31.

Database Changes

Tables 2 through 5 show changes made to the database since last year's market share update. PC clone manufacturers are no longer tracked individually. We continue to show PC sales by IBM, Hewlett-Packard, and Digital, which also sell other platforms. The 1993 sale of GeoVision Systems to SHL Systemhouse, Computervision-GIS to Unisys, and Logic Modeling Corporation to Synopsys will be recognized in market reporting beginning in 1994.

Table 2
Companies Renamed

Company Name	Renamed to:
Alper Systems	Sysdeco Ltd.
Areon	Kreon
CADAM	Altium
Catalpa	Catalpa groupe Missler
Geotrace Technologies	Cadlynx
Logic Control	Logic Systems Designers
RIB/RZB	RIB Bausoftware
Sener Sistemas Marinos	Sener Inginiera y Sistemas
STI Strassle	Strassle Informationssysteme

Source: Dataquest (February 1994)

Table 3
Companies (or CAD Portions Thereof) Sold/Merged

Company Name	Acquired by, Merged with, Technology Sold to:
Aries Technology	MacNeal Schwendler
ASG	Softdesk
CAD Language Systems	Compass Design Automation
CAD/CAM Group	Data I/O
Comdisco	Cadence
DAT Standard info ssystemes	ISD Software
EEsof	Hewlett-Packard
Expertest	Sunrise Test
Fides Industrielle Automation	Strassle
HP Cade	Hewlett-Packard
Inca	Zycad
Infocel	Understanding Systems
PiE Design	Quickturn Design Systems
Quad Design Technology	Viewlogic
Wisdom Systems	ICAD

Source: Dataquest (February 1994)

Table 4
Companies Deleted

Company Removed from Database:
European
Club Informatico SA
DATAID Technologies
DECISA
Micrograph
Olivetti*
North American
Bechtel
Compaq*
Dell Computer*
Engineering Systems Corporation
GeoQuest
Mega CADD
Object Design
Objectivity
Ontos
The CAD Group
Ultimap

*We no longer follow individual PC clone makers.
Source: Dataquest (February 1994)

Table 5
Companies Added

Company Added to Database:
European
APIC Systemes
ISD Software
North American
Aptix
Earth Resource Mapping
Graftek
Graphic Data Systems (GDS)
Systems Science, Inc.
Tactics Int'l Ltd.
VLSI Libraries
Asian
Adam Net
Kozo
Okura
Tachnodia
TECHSPERT
Toshiba Engineering
Yokogawa Digital Computer

Source: Dataquest (February 1994)

Table 6
1993 CAD/CAM/CAE/GIS Market Share

Application:	Mechanical
Platform:	All Platforms
Region:	Worldwide
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
IBM	1,561.7	989.1	305.0	55,876	19.2%	22.9%	12.8%	16.4%
Hewlett-Packard	641.4	444.7	74.9	24,539	7.9%	10.3%	3.1%	7.2%
Computervision	525.0	128.3	160.7	7,031	6.5%	3.0%	6.7%	2.1%
Digital	402.9	318.4	.1	12,744	5.0%	7.4%	.0%	3.7%
Sun Microsystems	304.1	242.5	.0	14,502	3.7%	5.6%	.0%	4.2%
Silicon Graphics	276.9	252.1	.0	10,859	3.4%	5.8%	.0%	3.2%
EDS Unigraphics	247.4	72.4	116.2	3,724	3.0%	1.7%	4.9%	1.1%
NEC	245.8	165.4	58.4	11,515	3.0%	3.8%	2.4%	3.4%
Fujitsu	219.9	128.9	67.4	8,751	2.7%	3.0%	2.8%	2.6%
Nihon Unisys	217.5	128.8	44.4	1,191	2.7%	3.0%	1.9%	.3%
Intergraph	188.2	59.1	67.0	4,529	2.3%	1.4%	2.8%	1.3%
Parametric Technology	184.1	.0	150.8	0	2.3%	.0%	6.3%	.0%
SDRC	177.0	.0	154.0	0	2.2%	.0%	6.4%	.0%
Autodesk	175.6	.0	175.6	0	2.2%	.0%	7.3%	.0%
Hitachi	143.6	67.5	61.8	6,076	1.8%	1.6%	2.6%	1.8%
Control Data Systems	142.7	65.0	29.5	6,187	1.8%	1.5%	1.2%	1.8%
Toshiba—NO OEM	113.3	56.7	45.3	3,663	1.4%	1.3%	1.9%	1.1%
Hitachi Zosen Info Systems	89.8	76.1	4.4	865	1.1%	1.8%	.2%	.3%
Matra Datavision	89.2	24.7	47.7	841	1.1%	.6%	2.0%	.2%
MacNeal-Schwendler	84.6	.0	84.6	0	1.0%	.0%	3.5%	.0%
Applicon	70.0	23.1	27.4	792	.9%	.5%	1.1%	.2%
Siemens Nixdorf Info systeme	64.7	33.2	11.7	1,774	.8%	.8%	.5%	.5%

(Continued)

Table 6 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application:	Mechanical
Platform:	All Platforms
Region:	Worldwide
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Apple Computer	59.5	59.6	.0	14,158	.7%	1.4%	.0%	4.1%
Mitsubishi Electric	50.3	39.3	6.3	795	.6%	.9%	.3%	.2%
Kubota Computer	45.0	34.2	7.2	515	.6%	.8%	.3%	.2%
Hakuto	43.1	25.4	17.6	1,006	.5%	.6%	.7%	.3%
Sharp System Products—NO OEM	43.0	20.7	22.3	398	.5%	.5%	.9%	.1%
Mutoh Industries—NO OEM	42.5	15.2	23.3	1,015	.5%	.4%	1.0%	.3%
PDA Engineering	41.9	.0	39.4	0	.5%	.0%	1.6%	.0%
Cisigraph	33.5	9.1	16.2	385	.4%	.2%	.7%	.1%
Tachnodia	33.2	26.0	.5	526	.4%	.6%	.0%	.2%
Investronica SA	31.5	19.7	8.3	1,077	.4%	.5%	.3%	.3%
Cimatron	30.9	13.6	14.0	1,040	.4%	.3%	.6%	.3%
Graftek	30.7	12.6	11.6	779	.4%	.3%	.5%	.2%
Swanson Analysis	30.0	.0	27.0	0	.4%	.0%	1.1%	.0%
ASCAD/ASCAM	28.2	16.7	8.7	436	.3%	.4%	.4%	.1%
Delcam International	28.1	9.8	12.6	371	.3%	.2%	.5%	.1%
Gerber Systems	26.8	12.6	11.5	397	.3%	.3%	.5%	.1%
Alias Research	26.5	.0	24.4	0	.3%	.0%	1.0%	.0%
Straessle Informationssysteme	25.7	3.5	16.3	369	.3%	.1%	.7%	.1%
Tokyo Electron—NO OEM	25.6	8.7	11.3	124	.3%	.2%	.5%	.0%
Auto-Trol	23.5	8.0	9.3	288	.3%	.2%	.4%	.1%
Andor	23.1	5.1	17.1	421	.3%	.1%	.7%	.1%
Toyo Information Systems—NO OEM	23.0	13.7	6.9	258	.3%	.3%	.3%	.1%

(Continued)

Table 6 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: All Platforms
Region: Worldwide
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Mitsui Engineering	22.1	15.3	4.5	178	.3%	.4%	.2%	.1%
Marcus Computer Systeme	22.1	11.3	7.6	400	.3%	.3%	.3%	.1%
Kozo Keikaku Engineering	21.6	1.3	5.8	40	.3%	.0%	.2%	.0%
ADRA Systems	21.0	.5	16.0	37	.3%	.0%	.7%	.0%
ISD Software	20.6	4.3	13.0	682	.3%	.1%	.5%	.2%
Isicad CAD/CAM Systeme	19.4	5.2	10.1	223	.2%	.1%	.4%	.1%
Cimlinc	18.9	.0	12.7	579	.2%	.0%	.5%	.2%
Wiechers Datentechnik	18.2	3.9	10.7	327	.2%	.1%	.4%	.1%
ICAD	17.6	.0	14.3	0	.2%	.0%	.6%	.0%
Radan Computational	17.4	5.9	8.7	349	.2%	.1%	.4%	.1%
CAD Lab	16.8	.0	13.9	0	.2%	.0%	.6%	.0%
Sony	16.6	16.6	.0	823	.2%	.4%	.0%	.2%
Digital Kienzle	16.4	8.2	4.6	248	.2%	.2%	.2%	.1%
Han Dataport	16.2	4.9	9.0	367	.2%	.1%	.4%	.1%
ItalCad	16.2	5.3	6.2	185	.2%	.1%	.3%	.1%
Graphtec Engineering	15.3	7.5	7.0	404	.2%	.2%	.3%	.1%
MCS	15.1	.6	12.8	83	.2%	.0%	.5%	.0%
Rasna Corporation	14.2	.0	12.8	0	.2%	.0%	.5%	.0%
MARC	14.1	.0	13.4	0	.2%	.0%	.6%	.0%
Tebis	13.7	3.6	2.1	92	.2%	.1%	.1%	.0%
Mechanical Dynamics	13.3	.0	10.8	0	.2%	.0%	.4%	.0%
Adam Net	11.5	6.6	3.6	14	.1%	.2%	.2%	.0%

(Continued)

Table 6 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: All Platforms
Region: Worldwide
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Omron	11.5	5.7	4.6	255	.1%	.1%	.2%	.1%
Exapt	10.9	5.2	3.8	210	.1%	.1%	.2%	.1%
CAMAX Systems Inc.	10.6	1.5	6.7	138	.1%	.0%	.3%	.0%
Point Control	10.6	.0	8.5	0	.1%	.0%	.4%	.0%
CADKEY	10.2	.0	10.2	0	.1%	.0%	.4%	.0%
ICL	10.0	5.8	3.4	287	.1%	.1%	.1%	.1%
Framasoft	10.0	.3	4.3	19	.1%	.0%	.2%	.0%
SPATIAL Technology	8.9	.9	8.0	0	.1%	.0%	.3%	.0%
PAFEC	8.6	2.6	4.9	107	.1%	.1%	.2%	.0%
Design Automation	8.6	1.8	6.5	295	.1%	.0%	.3%	.1%
CADIX	8.3	3.6	4.1	46	.1%	.1%	.2%	.0%
Engineering Mechanics	8.1	.6	7.0	42	.1%	.0%	.3%	.0%
Wacom	8.1	1.6	5.7	261	.1%	.0%	.2%	.1%
CAD Distribution	7.9	.0	7.1	101	.1%	.0%	.3%	.0%
Sumitomo Denko Workstation	7.9	7.9	.0	855	.1%	.2%	.0%	.3%
CNC Software	7.8	.0	7.8	0	.1%	.0%	.3%	.0%
Research Machines	7.8	7.8	.0	2,890	.1%	.2%	.0%	.8%
Algor Interactive Systems	6.5	.0	5.7	0	.1%	.0%	.2%	.0%
Ziegler Informatics	6.1	.0	6.1	0	.1%	.0%	.3%	.0%
Serbi	5.1	.6	4.5	200	.1%	.0%	.2%	.1%
CADSI	4.9	.6	3.8	30	.1%	.0%	.2%	.0%
Pathtrace	4.8	1.0	3.2	81	.1%	.0%	.1%	.0%

(Continued)

Table 6 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: All Platforms
Region: Worldwide
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Technische Computer Systeme	4.8	.7	3.6	79	.1%	.0%	.2%	.0%
Moda CAD	4.7	1.0	3.3	46	.1%	.0%	.1%	.0%
Ricoh—NO OEM	4.5	.0	3.8	0	.1%	.0%	.2%	.0%
Whessoe Computing Systems	4.4	.0	4.4	0	.1%	.0%	.2%	.0%
Anilam Electronics	3.9	.7	2.8	46	.0%	.0%	.1%	.0%
Micrografx	3.6	.0	3.6	0	.0%	.0%	.2%	.0%
American Small Business Comp.	3.6	.0	3.6	0	.0%	.0%	.1%	.0%
Vero International Software	3.4	.0	3.1	0	.0%	.0%	.1%	.0%
FEA	3.3	.7	.9	198	.0%	.0%	.0%	.1%
RoboCAD Solutions	3.3	.0	2.6	0	.0%	.0%	.1%	.0%
Foresight Resources	3.1	.0	2.9	0	.0%	.0%	.1%	.0%
debis Systemhaus	3.1	.7	2.0	22	.0%	.0%	.1%	.0%
Superdraft	2.9	1.3	1.3	208	.0%	.0%	.1%	.1%
Century Research Center	2.9	1.5	1.1	14	.0%	.0%	.0%	.0%
Kloeckner-Moeller	2.8	.6	1.9	0	.0%	.0%	.1%	.0%
CATALPA groupe Missler	2.8	1.2	1.2	84	.0%	.0%	.1%	.0%
Caroline Informatique	2.7	.5	1.4	27	.0%	.0%	.1%	.0%
Solbourne	2.5	2.5	.0	207	.0%	.1%	.0%	.1%
FEGS	2.2	.0	1.2	0	.0%	.0%	.0%	.0%
ISKA	2.1	.9	.9	39	.0%	.0%	.0%	.0%
Computational Mechanics	2.1	.0	2.1	0	.0%	.0%	.1%	.0%
CAD Centre	2.0	.0	1.7	0	.0%	.0%	.1%	.0%

(Continued)

Table 6 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: All Platforms
Region: Worldwide
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Uchida Yoko	2.0	1.2	.7	53	.0%	.0%	.0%	.0%
CAMTEK	1.8	.4	1.2	159	.0%	.0%	.1%	.0%
Softronics	1.6	.3	1.3	123	.0%	.0%	.1%	.0%
Softdesk	1.6	.0	1.6	0	.0%	.0%	.1%	.0%
Evolution Computing	1.5	.0	1.5	0	.0%	.0%	.1%	.0%
Ashlar	1.4	.0	.0	0	.0%	.0%	.0%	.0%
Valisys	1.3	.0	.0	0	.0%	.0%	.0%	.0%
Claris	1.2	.0	1.2	0	.0%	.0%	.0%	.0%
GRAPHSOFT	1.2	.0	1.2	0	.0%	.0%	.0%	.0%
CAD-Capture	1.2	.3	.3	13	.0%	.0%	.0%	.0%
EME	1.1	.3	.5	31	.0%	.0%	.0%	.0%
Kreon	1.0	.5	.2	19	.0%	.0%	.0%	.0%
Zuken	1.0	.3	.5	6	.0%	.0%	.0%	.0%
Other Companies	566.2	534.0	18.4	129,586	7.0%	12.3%	.8%	37.9%
All Companies	8,126.7	4,327.2	2,391.6	341,620	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	5,987.5	3,223.9	1,653.1	286,932	73.7%	74.5%	69.1%	84.0%
All Asian-Based Companies	1,524.7	893.3	454.1	40,795	18.8%	20.6%	19.0%	11.9%
All European-Based Companies	614.6	210.1	284.4	13,893	7.6%	4.9%	11.9%	4.1%
All Hardware Companies	2,327.6	2,067.1	9.9	249,786	28.6%	47.8%	.4%	73.1%
All Turnkey & SW Companies	5,799.1	2,260.2	2,381.7	91,834	71.4%	52.2%	99.6%	26.9%

Source: Dataquest (February 1994)

Table 7
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: Technical Workstation
Region: Worldwide
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
IBM	607.1	419.9	97.0	18,875	12.4%	17.6%	6.3%	18.8%
Hewlett-Packard	606.6	413.8	74.9	15,179	12.4%	17.4%	4.9%	15.1%
Computervision	513.4	127.2	150.9	6,824	10.5%	5.3%	9.8%	6.8%
Silicon Graphics	251.0	230.1	.0	10,378	5.1%	9.7%	.0%	10.3%
Sun Microsystems	248.3	196.2	.0	12,743	5.1%	8.2%	.0%	12.7%
EDS Unigraphics	206.2	59.8	97.5	3,187	4.2%	2.5%	6.3%	3.2%
Parametric Technology	184.1	.0	150.8	0	3.8%	.0%	9.8%	.0%
SDRC	175.2	.0	152.5	0	3.6%	.0%	9.9%	.0%
Intergraph	154.0	49.5	48.3	2,344	3.1%	2.1%	3.1%	2.3%
NEC	122.9	76.3	35.6	3,463	2.5%	3.2%	2.3%	3.4%
Digital	121.0	94.3	.1	4,187	2.5%	4.0%	.0%	4.2%
Fujitsu	117.2	63.3	38.5	2,673	2.4%	2.7%	2.5%	2.7%
Hitachi	109.5	51.5	47.1	2,167	2.2%	2.2%	3.1%	2.2%
Matra Datavision	89.2	24.7	47.7	841	1.8%	1.0%	3.1%	.8%
Nihon Unisys	87.0	47.9	23.5	493	1.8%	2.0%	1.5%	.5%
Hitachi Zosen Info Systems	85.8	72.5	4.4	865	1.8%	3.0%	.3%	.9%
Applicon	70.0	23.1	27.4	792	1.4%	1.0%	1.8%	.8%
Toshiba—NO OEM	68.0	34.0	27.2	755	1.4%	1.4%	1.8%	.8%
Siemens Nixdorf Info systeme	61.5	30.1	11.7	1,208	1.3%	1.3%	.8%	1.2%
Control Data Systems	56.8	31.4	15.0	1,489	1.2%	1.3%	1.0%	1.5%
Sharp System Products—NO OEM	43.0	20.7	22.3	398	.9%	.9%	1.5%	.4%

(Continued)

Table 7 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: Technical Workstation
Region: Worldwide
Units: Millions of U.S. Dollars/Actual Units

Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Market Share: Total Factory Revenue	Market Share: Hardware Revenue	Market Share: Software Revenue	Market Share: Hardware Units Shipped
Mitsubishi Electric	38.7	32.9	2.7	363	.8%	1.4%	.2%	.4%
PDA Engineering	37.7	.0	35.5	0	.8%	.0%	2.3%	.0%
Kubota Computer	36.0	27.3	5.8	343	.7%	1.1%	.4%	.3%
Cisigraph	30.2	8.2	14.6	368	.6%	.3%	.9%	.4%
ASCAD/ASCAM	27.3	16.1	8.5	413	.6%	.7%	.6%	.4%
Gerber Systems	26.8	12.6	11.5	397	.5%	.5%	.7%	.4%
Alias Research	26.5	.0	24.4	0	.5%	.0%	1.6%	.0%
Straessle Informationssysteme	25.7	3.5	16.3	369	.5%	.1%	1.1%	.4%
Tokyo Electron—NO OEM	25.6	8.7	11.3	124	.5%	.4%	.7%	.1%
Delcam International	24.8	8.6	11.2	284	.5%	.4%	.7%	.3%
Graftek	24.6	9.7	9.5	505	.5%	.4%	.6%	.5%
Tachnodia	24.3	19.4	.2	273	.5%	.8%	.0%	.3%
Auto-Trol	23.5	8.0	9.3	288	.5%	.3%	.6%	.3%
Marcus Computer Systeme	22.1	11.3	7.6	400	.5%	.5%	.5%	.4%
Mitsui Engineering	20.4	14.1	4.2	141	.4%	.6%	.3%	.1%
Isicad CAD/CAM Systeme	19.4	5.2	10.1	223	.4%	.2%	.7%	.2%
Toyo Information Systems—NO OEM	19.3	11.8	5.8	237	.4%	.5%	.4%	.2%
ISD Software	18.5	4.3	11.0	682	.4%	.2%	.7%	.7%
Swanson Analysis	18.3	.0	16.4	0	.4%	.0%	1.1%	.0%
Cimatron	18.3	8.1	8.3	389	.4%	.3%	.5%	.4%
Cimlinc	18.0	.0	12.0	579	.4%	.0%	.8%	.6%

(Continued)

Table 7 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: Technical Workstation
Region: Worldwide
Units: Millions of U.S. Dollars/Actual Units

Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Market Share: Total Factory Revenue	Market Share: Hardware Revenue	Market Share: Software Revenue	Market Share: Hardware Units Shipped
ICAD	17.6	.0	14.3	0	.4%	.0%	.9%	.0%
Radan Computational	17.2	5.9	8.6	332	.4%	.2%	.6%	.3%
Sony	16.6	16.6	.0	823	.3%	.7%	.0%	.8%
Digital Kienzle	16.4	8.2	4.6	248	.3%	.3%	.3%	.2%
ItalCad	16.2	5.3	6.2	185	.3%	.2%	.4%	.2%
Mutoh Industries—NO OEM	16.2	5.8	8.8	239	.3%	.2%	.6%	.2%
Graphtec Engineering	15.3	7.5	7.0	404	.3%	.3%	.5%	.4%
ADRA Systems	15.1	.5	11.3	37	.3%	.0%	.7%	.0%
Han Dataport	14.4	4.2	8.0	326	.3%	.2%	.5%	.3%
MacNeal-Schwendler	14.1	.0	14.1	0	.3%	.0%	.9%	.0%
CAD Lab	14.0	.0	11.3	0	.3%	.0%	.7%	.0%
Autodesk	12.7	.0	12.7	0	.3%	.0%	.8%	.0%
Omron	11.5	5.7	4.6	255	.2%	.2%	.3%	.3%
Rasna Corporation	11.2	.0	10.1	0	.2%	.0%	.7%	.0%
CAMAX Systems Inc.	10.6	1.5	6.7	138	.2%	.1%	.4%	.1%
MARC	10.6	.0	10.1	0	.2%	.0%	.7%	.0%
ICL	10.0	5.8	3.4	287	.2%	.2%	.2%	.3%
Mechanical Dynamics	9.6	.0	7.8	0	.2%	.0%	.5%	.0%
Kozo Keikaku Engineering	9.1	.9	2.7	10	.2%	.0%	.2%	.0%
Framasoft	9.0	.3	3.9	19	.2%	.0%	.3%	.0%
CADIX	8.3	3.6	4.1	46	.2%	.1%	.3%	.0%

(Continued)

Table 7 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: Technical Workstation
Region: Worldwide
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
SPATIAL Technology	8.0	.0	8.0	0	.2%	.0%	.5%	.0%
MCS	7.9	.3	6.7	30	.2%	.0%	.4%	.0%
PAFEC	7.5	2.6	3.8	107	.2%	.1%	.2%	.1%
Sumitomo Denko Workstation	7.4	7.4	.0	813	.2%	.3%	.0%	.8%
Adam Net	5.8	.9	3.6	11	.1%	.0%	.2%	.0%
Engineering Mechanics	4.9	.6	3.8	42	.1%	.0%	.2%	.0%
Ricoh—NO OEM	4.5	.0	3.8	0	.1%	.0%	.2%	.0%
CADSI	4.0	.5	3.1	16	.1%	.0%	.2%	.0%
Exapt	3.3	1.6	1.2	112	.1%	.1%	.1%	.1%
Technische Computer Systeme	3.3	.5	2.5	37	.1%	.0%	.2%	.0%
Hakuto	2.6	1.6	1.0	31	.1%	.1%	.1%	.0%
debis Systemhaus	2.3	.5	1.5	11	.0%	.0%	.1%	.0%
ISKA	2.1	.9	.9	39	.0%	.0%	.1%	.0%
FEGS	2.0	.0	1.1	0	.0%	.0%	.1%	.0%
CAD Centre	2.0	.0	1.7	0	.0%	.0%	.1%	.0%
CADKEY	1.8	.0	1.8	0	.0%	.0%	.1%	.0%
Wiechers Datentechnik	1.8	.7	.8	44	.0%	.0%	.1%	.0%
Uchida Yoko	1.8	1.1	.6	44	.0%	.0%	.0%	.0%
Century Research Center	1.7	.9	.6	12	.0%	.0%	.0%	.0%
Caroline Informatique	1.7	.3	.9	9	.0%	.0%	.1%	.0%
CATALPA groupe Missler	1.7	.7	.8	19	.0%	.0%	.0%	.0%

(Continued)

Table 7 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application:	Mechanical
Platform:	Technical Workstation
Region:	Worldwide
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Wacom	1.3	.3	1.0	22	.0%	.0%	.1%	.0%
FEA	1.3	.3	.3	20	.0%	.0%	.0%	.0%
Valisys	1.2	.0	.0	0	.0%	.0%	.0%	.0%
Computational Mechanics	1.1	.0	1.1	0	.0%	.0%	.1%	.0%
Point Control	1.1	.0	.8	0	.0%	.0%	.1%	.0%
Zuken	1.0	.3	.5	6	.0%	.0%	.0%	.0%
Other Companies	28.7	11.8	15.1	526	.6%	.5%	1.0%	.5%
All Companies	4,893.1	2,381.1	1,535.2	100,534	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	3,521.6	1,684.8	1,055.9	78,330	72.0%	70.8%	68.8%	77.9%
All Asian-Based Companies	924.9	543.7	279.1	15,442	18.9%	22.8%	18.2%	15.4%
All European-Based Companies	446.5	152.6	200.3	6,763	9.1%	6.4%	13.0%	6.7%
All Hardware Companies	1,181.3	1,018.3	5.9	51,041	24.1%	42.8%	.4%	50.8%
All Turnkey & SW Companies	3,711.7	1,362.9	1,529.3	49,494	75.9%	57.2%	99.6%	49.2%

Source: Dataquest (February 1994)

Table 8
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: Host-Dependent
Region: Worldwide
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
IBM	598.8	374.1	90.5	7,940	41.5%	40.2%	37.0%	30.1%
Digital	142.7	111.3	.0	0	9.9%	12.0%	.0%	.0%
Nihon Unisys	130.5	80.9	20.9	698	9.0%	8.7%	8.5%	2.6%
Control Data Systems	81.1	31.9	13.3	4,684	5.6%	3.4%	5.4%	17.8%
NEC	61.4	45.5	10.5	127	4.3%	4.9%	4.3%	.5%
Fujitsu	59.0	27.1	23.6	889	4.1%	2.9%	9.6%	3.4%
MacNeal-Schwendler	49.3	.0	49.3	0	3.4%	.0%	20.2%	.0%
Hitachi	11.3	5.3	4.9	2,744	.8%	.6%	2.0%	10.4%
Tachnodia	9.0	6.6	.3	253	.6%	.7%	.1%	1.0%
Toshiba—NO OEM	7.9	4.0	3.2	106	.5%	.4%	1.3%	.4%
Exapt	7.6	3.6	2.7	98	.5%	.4%	1.1%	.4%
Mitsubishi Electric	6.5	3.1	1.8	18	.5%	.3%	.7%	.1%
Graftek	5.6	2.8	2.0	262	.4%	.3%	.8%	1.0%
Swanson Analysis	5.1	.0	4.6	0	.4%	.0%	1.9%	.0%
PDA Engineering	4.2	.0	3.9	0	.3%	.0%	1.6%	.0%
Hitachi Zosen Info Systems	4.0	3.6	.0	0	.3%	.4%	.0%	.0%
Toyo Information Systems—NO OEM	3.7	2.0	1.2	21	.3%	.2%	.5%	.1%
MARC	3.5	.0	3.4	0	.2%	.0%	1.4%	.0%
Mechanical Dynamics	2.8	.0	2.3	0	.2%	.0%	.9%	.0%
Intergraph	2.1	.0	1.9	0	.1%	.0%	.8%	.0%
SDRC	1.8	.0	1.6	0	.1%	.0%	.6%	.0%

(Continued)

Table 8 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application:	Mechanical
Platform:	Host-Dependent
Region:	Worldwide
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Kozo Keikaku Engineering	1.7	.0	.3	0	.1%	.0%	.1%	.0%
Century Research Center	1.2	.6	.5	2	.1%	.1%	.2%	.0%
Framasoft	1.0	.0	.5	0	.1%	.0%	.2%	.0%
Other Companies	242.7	228.3	1.8	8,537	16.8%	24.5%	.7%	32.4%
All Companies	1,444.5	930.6	244.6	26,379	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	1,137.7	748.3	172.8	21,421	78.8%	80.4%	70.7%	81.2%
All Asian-Based Companies	296.2	178.6	67.0	4,858	20.5%	19.2%	27.4%	18.4%
All European-Based Companies	10.6	3.7	4.8	99	.7%	.4%	1.9%	.4%
All Hardware Companies	396.8	344.4	3.2	9,641	27.5%	37.0%	1.3%	36.5%
All Turnkey & SW Companies	1,047.7	586.2	241.4	16,738	72.5%	63.0%	98.7%	63.5%

Source: Dataquest (February 1994)

Table 9
1993 CAD/CAM/CAE/GIS Market Share

Application:	Mechanical
Platform:	Server
Region:	Worldwide
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
IBM	189.9	104.4	46.2	2,805	38.2%	34.8%	47.3%	34.7%
Digital	113.7	88.6	.0	1,842	22.9%	29.6%	.0%	22.8%
Sun Microsystems	55.8	46.3	.0	1,759	11.2%	15.4%	.0%	21.8%
EDS Unigraphics	41.2	12.6	18.8	537	8.3%	4.2%	19.2%	6.6%
Silicon Graphics	25.9	22.0	.0	481	5.2%	7.4%	.0%	5.9%
MacNeal-Schwendler	19.9	.0	19.9	0	4.0%	.0%	20.3%	.0%
Intergraph	16.3	4.1	6.5	209	3.3%	1.4%	6.6%	2.6%
Kubota Computer	6.7	5.1	1.1	55	1.4%	1.7%	1.1%	.7%
Adam Net	5.8	5.8	.0	2	1.2%	1.9%	.0%	.0%
Control Data Systems	4.7	1.8	1.2	15	1.0%	.6%	1.2%	.2%
Hewlett-Packard	4.6	3.8	.0	101	.9%	1.3%	.0%	1.3%
Cisigraph	3.3	.9	1.6	17	.7%	.3%	1.7%	.2%
Computervision	2.8	1.1	1.0	38	.6%	.4%	1.0%	.5%
Solbourne	2.2	2.2	.0	152	.4%	.7%	.0%	1.9%
Kozo Keikaku Engineering	1.1	.0	.2	0	.2%	.0%	.2%	.0%
Han Dataport	1.1	.5	.4	16	.2%	.2%	.5%	.2%
Other Companies	1.9	.6	.7	56	.4%	.2%	.8%	.7%
All Companies	496.7	299.7	97.7	8,086	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	478.3	287.0	94.3	7,953	96.3%	95.8%	96.6%	98.4%
All Asian-Based Companies	14.0	11.4	1.3	100	2.8%	3.8%	1.3%	1.2%
All European-Based Companies	4.4	1.4	2.1	33	.9%	.5%	2.1%	.4%
All Hardware Companies	210.8	169.9	.8	4,554	42.4%	56.7%	.8%	56.3%
All Turnkey & SW Companies	285.9	129.8	96.9	3,532	57.6%	43.3%	99.2%	43.7%

Source: Dataquest (February 1994)

Table 10
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: Personal Computer
Region: Worldwide
Units: Millions of U.S. Dollars/Actual Units

Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Market Share: Total Factory Revenue	Market Share: Hardware Revenue	Market Share: Software Revenue	Market Share: Hardware Units Shipped
IBM	165.9	90.8	71.3	26,256	12.8%	12.7%	13.9%	12.7%
Autodesk	162.9	.0	162.9	0	12.6%	.0%	31.7%	.0%
NEC	61.4	43.7	12.3	7,925	4.8%	6.1%	2.4%	3.8%
Apple Computer	59.5	59.6	.0	14,158	4.6%	8.3%	.0%	6.9%
Fujitsu	43.7	38.4	5.3	5,189	3.4%	5.4%	1.0%	2.5%
Hakuto	40.5	23.9	16.6	975	3.1%	3.3%	3.2%	.5%
Toshiba—NO OEM	37.4	18.7	15.0	2,802	2.9%	2.6%	2.9%	1.4%
Investronica SA	31.5	19.7	8.3	1,077	2.4%	2.7%	1.6%	.5%
Hewlett-Packard	30.1	27.2	.0	9,258	2.3%	3.8%	.0%	4.5%
Mutoh Industries—NO OEM	26.3	9.4	14.4	776	2.0%	1.3%	2.8%	.4%
Digital	25.5	24.2	.0	6,715	2.0%	3.4%	.0%	3.3%
Andor	23.1	5.1	17.1	421	1.8%	.7%	3.3%	.2%
Hitachi	22.8	10.7	9.8	1,165	1.8%	1.5%	1.9%	.6%
Wiechers Datentechnik	16.4	3.3	9.8	282	1.3%	.5%	1.9%	.1%
Intergraph	15.8	5.5	10.4	1,976	1.2%	.8%	2.0%	1.0%
Tebis	13.7	3.6	2.1	92	1.1%	.5%	.4%	.0%
Cimatron	12.6	5.5	5.7	651	1.0%	.8%	1.1%	.3%
Kozo Keikaku Engineering	9.7	.4	2.5	31	.8%	.1%	.5%	.0%
Point Control	9.5	.0	7.6	0	.7%	.0%	1.5%	.0%
Computervision	8.8	.0	8.8	170	.7%	.0%	1.7%	.1%
Design Automation	8.6	1.8	6.5	295	.7%	.2%	1.3%	.1%

(Continued)

Table 10 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application:	Mechanical
Platform:	Personal Computer
Region:	Worldwide
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
CADKEY	8.4	.0	8.4	0	.6%	.0%	1.6%	.0%
CAD Distribution	7.9	.0	7.1	101	.6%	.0%	1.4%	.0%
CNC Software	7.8	.0	7.8	0	.6%	.0%	1.5%	.0%
Research Machines	7.8	7.8	.0	2,890	.6%	1.1%	.0%	1.4%
MCS	7.3	.3	6.2	53	.6%	.0%	1.2%	.0%
Wacom	6.8	1.4	4.7	239	.5%	.2%	.9%	.1%
Swanson Analysis	6.6	.0	6.0	0	.5%	.0%	1.2%	.0%
Ziegler Informatics	6.1	.0	6.1	0	.5%	.0%	1.2%	.0%
ADRA Systems	5.9	.0	4.7	0	.5%	.0%	.9%	.0%
Algor Interactive Systems	5.5	.0	4.8	0	.4%	.0%	.9%	.0%
Serbi	5.1	.6	4.5	200	.4%	.1%	.9%	.1%
Mitsubishi Electric	5.0	3.3	1.7	414	.4%	.5%	.3%	.2%
Pathtrace	4.8	1.0	3.2	81	.4%	.1%	.6%	.0%
Moda CAD	4.7	1.0	3.3	46	.4%	.1%	.6%	.0%
Anilam Electronics	3.9	.7	2.8	46	.3%	.1%	.5%	.0%
Micrografx	3.6	.0	3.6	0	.3%	.0%	.7%	.0%
American Small Business Comp.	3.6	.0	3.6	0	.3%	.0%	.7%	.0%
Vero International Software	3.4	.0	3.1	0	.3%	.0%	.6%	.0%
Whessoe Computing Systems	3.3	.0	3.3	0	.3%	.0%	.6%	.0%
Delcam International	3.3	1.3	1.5	87	.3%	.2%	.3%	.0%
RoboCAD Solutions	3.3	.0	2.6	0	.3%	.0%	.5%	.0%

(Continued)

Table 10 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: Personal Computer
Region: Worldwide
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Engineering Mechanics	3.2	.0	3.2	0	.3%	.0%	.6%	.0%
Siemens Nixdorf Info systeme	3.2	3.1	.0	565	.2%	.4%	.0%	.3%
Foresight Resources	3.1	.0	2.9	0	.2%	.0%	.6%	.0%
Rasna Corporation	3.0	.0	2.7	0	.2%	.0%	.5%	.0%
Superdraft	2.9	1.3	1.3	208	.2%	.2%	.3%	.1%
CAD Lab	2.9	.0	2.6	0	.2%	.0%	.5%	.0%
Kloeckner-Moeller	2.8	.6	1.9	0	.2%	.1%	.4%	.0%
Kubota Computer	2.3	1.7	.4	117	.2%	.2%	.1%	.1%
ISD Software	2.1	.0	2.1	0	.2%	.0%	.4%	.0%
FEA	1.8	.4	.4	178	.1%	.1%	.1%	.1%
CAMTEK	1.7	.4	1.2	157	.1%	.1%	.2%	.1%
Mitsui Engineering	1.7	1.2	.3	37	.1%	.2%	.1%	.0%
Softronics	1.6	.3	1.3	123	.1%	.0%	.2%	.1%
Evolution Computing	1.5	.0	1.5	0	.1%	.0%	.3%	.0%
Technische Computer Systeme	1.5	.3	1.1	42	.1%	.0%	.2%	.0%
Ashlar	1.4	.0	.0	0	.1%	.0%	.0%	.0%
MacNeal-Schwendler	1.3	.0	1.3	0	.1%	.0%	.3%	.0%
Softdesk	1.2	.0	1.2	0	.1%	.0%	.2%	.0%
Claris	1.2	.0	1.2	0	.1%	.0%	.2%	.0%
GRAPHSOFT	1.2	.0	1.2	0	.1%	.0%	.2%	.0%
PAFEC	1.1	.0	1.1	0	.1%	.0%	.2%	.0%

(Continued)

Table 10 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: Personal Computer
Region: Worldwide
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
CATALPA groupe Missler	1.1	.5	.5	65	.1%	.1%	.1%	.0%
Kreon	1.0	.5	.2	19	.1%	.1%	.0%	.0%
Caroline Informatique	1.0	.2	.5	19	.1%	.0%	.1%	.0%
Other Companies	306.8	296.9	8.7	120,720	23.7%	41.5%	1.7%	58.4%
All Companies	1,292.5	715.8	514.1	206,621	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	849.9	503.8	330.1	179,227	65.8%	70.4%	64.2%	86.7%
All Asian-Based Companies	289.5	159.7	106.7	20,395	22.4%	22.3%	20.7%	9.9%
All European-Based Companies	153.0	52.4	77.3	6,998	11.8%	7.3%	15.0%	3.4%
All Hardware Companies	538.7	534.5	.0	184,551	41.7%	74.7%	.0%	89.3%
All Turnkey & SW Companies	753.8	181.4	514.1	22,070	58.3%	25.3%	100.0%	10.7%

Source: Dataquest (February 1994)

Table 11
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: All Platforms
Region: North America
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
IBM	403.4	287.5	58.2	20,991	18.1%	25.3%	8.1%	17.5%
Hewlett-Packard	169.5	122.2	16.5	9,211	7.6%	10.8%	2.3%	7.7%
Silicon Graphics	156.3	140.0	.0	5,727	7.0%	12.3%	.0%	4.8%
EDS Unigraphics	156.1	45.5	73.2	2,375	7.0%	4.0%	10.1%	2.0%
Sun Microsystems	150.8	120.2	.0	8,025	6.8%	10.6%	.0%	6.7%
Digital	140.4	110.9	.1	5,245	6.3%	9.8%	.0%	4.4%
Parametric Technology	116.0	.0	95.0	0	5.2%	.0%	13.2%	.0%
Computervision	111.5	25.2	36.8	1,450	5.0%	2.2%	5.1%	1.2%
Autodesk	84.1	.0	84.1	0	3.8%	.0%	11.7%	.0%
Intergraph	79.7	24.7	28.9	1,996	3.6%	2.2%	4.0%	1.7%
SDRC	64.3	.0	56.0	0	2.9%	.0%	7.8%	.0%
Control Data Systems	56.9	26.0	11.7	2,464	2.5%	2.3%	1.6%	2.0%
MacNeal-Schwendler	54.4	.0	54.4	0	2.4%	.0%	7.5%	.0%
Applicon	28.7	9.5	11.2	339	1.3%	.8%	1.6%	.3%
Apple Computer	27.9	27.9	.0	7,337	1.2%	2.5%	.0%	6.1%
PDA Engineering	25.1	.0	23.6	0	1.1%	.0%	3.3%	.0%
Graftek	23.8	9.8	9.0	609	1.1%	.9%	1.2%	.5%
Alias Research	17.2	.0	15.9	0	.8%	.0%	2.2%	.0%
Swanson Analysis	17.1	.0	15.4	0	.8%	.0%	2.1%	.0%
Gerber Systems	16.1	7.6	6.9	238	.7%	.7%	1.0%	.2%
Auto-Trol	15.9	5.4	6.3	193	.7%	.5%	.9%	.2%

(Continued)

Table 11 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: All Platforms
Region: North America
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Cimlinc	11.3	.0	7.6	342	.5%	.0%	1.1%	.3%
Rasna Corporation	11.2	.0	10.1	0	.5%	.0%	1.4%	.0%
ICAD	10.9	.0	8.9	0	.5%	.0%	1.2%	.0%
ADRA Systems	10.5	.2	8.0	19	.5%	.0%	1.1%	.0%
MCS	9.5	.4	8.1	52	.4%	.0%	1.1%	.0%
CADKEY	8.2	.0	8.2	0	.4%	.0%	1.1%	.0%
Point Control	7.4	.0	5.9	0	.3%	.0%	.8%	.0%
CAMAX Systems Inc.	7.2	1.0	4.5	94	.3%	.1%	.6%	.1%
Kubota Computer	6.8	5.1	1.1	77	.3%	.5%	.1%	.1%
Mechanical Dynamics	6.1	.0	5.0	0	.3%	.0%	.7%	.0%
Engineering Mechanics	6.1	.4	5.3	31	.3%	.0%	.7%	.0%
Algor Interactive Systems	5.5	.0	4.8	0	.2%	.0%	.7%	.0%
CNC Software	4.7	.0	4.7	0	.2%	.0%	.7%	.0%
Delcam International	4.5	1.6	2.0	59	.2%	.1%	.3%	.0%
Cimatron	4.4	1.9	2.0	150	.2%	.2%	.3%	.1%
SPATIAL Technology	4.0	.4	3.6	0	.2%	.0%	.5%	.0%
Cisigraph	3.3	.9	1.6	38	.1%	.1%	.2%	.0%
American Small Business Comp.	3.2	.0	3.2	0	.1%	.0%	.4%	.0%
Moda CAD	3.1	.6	2.2	30	.1%	.1%	.3%	.0%
CADSI	3.1	.4	2.4	18	.1%	.0%	.3%	.0%
MARC	2.8	.0	2.7	0	.1%	.0%	.4%	.0%

(Continued)

Table 11 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: All Platforms
Region: North America
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Foresight Resources	2.6	.0	2.4	0	.1%	.0%	.3%	.0%
Matra Datavision	2.6	.8	1.5	26	.1%	.1%	.2%	.0%
Investronica SA	2.2	1.4	.6	75	.1%	.1%	.1%	.1%
Micrografx	2.1	.0	2.1	0	.1%	.0%	.3%	.0%
Solbourne	1.9	1.9	.0	154	.1%	.2%	.0%	.1%
Softdesk	1.4	.0	1.4	0	.1%	.0%	.2%	.0%
Ashlar	1.2	.0	.0	0	.1%	.0%	.0%	.0%
GRAPHSOFT	1.2	.0	1.2	0	.1%	.0%	.2%	.0%
Evolution Computing	1.1	.0	1.1	0	.1%	.0%	.2%	.0%
Valisys	1.1	.0	.0	0	.0%	.0%	.0%	.0%
Pathtrace	1.0	.2	.7	14	.0%	.0%	.1%	.0%
Other Companies	166.1	157.3	5.5	52,850	7.4%	13.8%	.8%	44.0%
All Companies	2,233.6	1,136.7	721.3	120,231	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	2,206.5	1,124.7	710.2	119,779	98.8%	98.9%	98.5%	99.6%
All Asian-Based Companies	6.8	5.1	1.1	77	.3%	.5%	.1%	.1%
All European-Based Companies	20.3	6.9	10.1	375	.9%	.6%	1.4%	.3%
All Hardware Companies	894.2	785.8	3.8	104,252	40.0%	69.1%	.5%	86.7%
All Turnkey & SW Companies	1,339.4	350.9	717.5	15,979	60.0%	30.9%	99.5%	13.3%

Source: Dataquest (February 1994)

Table 12
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: Technical Workstation
Region: North America
Units: Millions of U.S. Dollars/Actual Units

Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Market Share: Total Factory Revenue	Market Share: Hardware Revenue	Market Share: Software Revenue	Market Share: Hardware Units Shipped
IBM	195.7	153.8	20.7	8,104	14.0%	23.3%	4.5%	23.7%
Hewlett-Packard	154.2	108.6	16.5	4,754	11.0%	16.5%	3.5%	13.9%
Silicon Graphics	142.3	128.0	.0	5,448	10.2%	19.4%	.0%	16.0%
EDS Unigraphics	131.9	38.1	62.2	2,047	9.4%	5.8%	13.4%	6.0%
Sun Microsystems	125.4	99.1	.0	7,126	9.0%	15.0%	.0%	20.9%
Parametric Technology	116.0	.0	95.0	0	8.3%	.0%	20.4%	.0%
Computervision	107.3	24.8	33.4	1,363	7.7%	3.8%	7.2%	4.0%
SDRC	63.7	.0	55.4	0	4.6%	.0%	11.9%	.0%
Intergraph	63.4	20.4	19.9	1,044	4.5%	3.1%	4.3%	3.1%
Digital	42.1	32.8	.1	1,694	3.0%	5.0%	.0%	5.0%
Applicon	28.7	9.5	11.2	339	2.1%	1.4%	2.4%	1.0%
Control Data Systems	22.7	12.5	6.0	592	1.6%	1.9%	1.3%	1.7%
PDA Engineering	22.6	.0	21.3	0	1.6%	.0%	4.6%	.0%
Graftek	19.1	7.5	7.3	395	1.4%	1.1%	1.6%	1.2%
Alias Research	17.2	.0	15.9	0	1.2%	.0%	3.4%	.0%
Gerber Systems	16.1	7.6	6.9	238	1.1%	1.1%	1.5%	.7%
Auto-Trol	15.9	5.4	6.3	193	1.1%	.8%	1.4%	.6%
ICAD	10.9	.0	8.9	0	.8%	.0%	1.9%	.0%
Swanson Analysis	10.8	.0	9.7	0	.8%	.0%	2.1%	.0%
Cimlinc	10.8	.0	7.2	342	.8%	.0%	1.6%	1.0%
Rasna Corporation	9.0	.0	8.1	0	.6%	.0%	1.7%	.0%
ADRA Systems	7.6	.2	5.7	19	.5%	.0%	1.2%	.1%
CAMAX Systems Inc.	7.2	1.0	4.5	94	.5%	.2%	1.0%	.3%

(Continued)

Table 12 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application:	Mechanical
Platform:	Technical Workstation
Region:	North America
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
MacNeal-Schwendler	7.1	.0	7.1	0	.5%	.0%	1.5%	.0%
Autodesk	5.9	.0	5.9	0	.4%	.0%	1.3%	.0%
Kubota Computer	5.4	4.1	.9	51	.4%	.6%	.2%	.2%
MCS	5.0	.2	4.2	19	.4%	.0%	.9%	.1%
Mechanical Dynamics	4.4	.0	3.6	0	.3%	.0%	.8%	.0%
Delcam International	4.0	1.4	1.8	45	.3%	.2%	.4%	.1%
Engineering Mechanics	3.7	.4	2.8	31	.3%	.1%	.6%	.1%
SPATIAL Technology	3.6	.0	3.6	0	.3%	.0%	.8%	.0%
Cisigraph	3.0	.8	1.4	36	.2%	.1%	.3%	.1%
Cimatron	2.9	1.3	1.3	65	.2%	.2%	.3%	.2%
Matra Datavision	2.6	.8	1.5	26	.2%	.1%	.3%	.1%
CADSI	2.5	.3	2.0	10	.2%	.0%	.4%	.0%
MARC	2.1	.0	2.0	0	.2%	.0%	.4%	.0%
CADKEY	1.5	.0	1.5	0	.1%	.0%	.3%	.0%
Valisys	1.0	.0	.0	0	.1%	.0%	.0%	.0%
Other Companies	4.5	.6	3.4	66	.3%	.1%	.7%	.2%
All Companies	1,399.4	659.1	464.8	34,142	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	1,380.0	650.7	456.7	33,913	98.6%	98.7%	98.3%	99.3%
All Asian-Based Companies	5.4	4.1	.9	51	.4%	.6%	.2%	.2%
All European-Based Companies	14.0	4.3	7.3	178	1.0%	.6%	1.6%	.5%
All Hardware Companies	511.6	438.3	2.3	23,870	36.6%	66.5%	.5%	69.9%
All Turnkey & SW Companies	887.8	220.8	462.6	10,272	63.4%	33.5%	99.5%	30.1%

Source: Dataquest (February 1994)

Table 13
1993 CAD/CAM/CAE/GIS Market Share

Application:	Mechanical
Platform:	Host-Dependent
Region:	North America
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
IBM	125.7	78.0	18.9	1,705	40.9%	42.3%	29.2%	29.6%
Digital	49.7	38.7	.0	0	16.1%	21.0%	.0%	.0%
Control Data Systems	32.4	12.8	5.3	1,866	10.5%	6.9%	8.2%	32.4%
MacNeal-Schwendler	29.9	.0	29.9	0	9.7%	.0%	46.3%	.0%
Graftek	4.4	2.2	1.6	205	1.4%	1.2%	2.4%	3.6%
Swanson Analysis	2.7	.0	2.5	0	.9%	.0%	3.8%	.0%
PDA Engineering	2.5	.0	2.4	0	.8%	.0%	3.7%	.0%
Intergraph	1.6	.0	1.4	0	.5%	.0%	2.2%	.0%
Mechanical Dynamics	1.3	.0	1.0	0	.4%	.0%	1.6%	.0%
Other Companies	57.3	52.7	1.6	1,989	18.6%	28.6%	2.4%	34.5%
All Companies	307.5	184.4	64.5	5,765	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	307.3	184.4	64.3	5,765	99.9%	100.0%	99.7%	100.0%
All Asian-Based Companies	.0	.0	.0	0	.0%	.0%	.0%	.0%
All European-Based Companies	.2	.0	.2	0	.1%	.0%	.3%	.0%
All Hardware Companies	110.5	93.4	1.2	2,410	35.9%	50.6%	1.9%	41.8%
All Turnkey & SW Companies	197.0	91.0	63.3	3,355	64.1%	49.4%	98.1%	58.2%

Source: Dataquest (February 1994)

Table 14
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: Server
Region: North America
Units: Millions of U.S. Dollars/Actual Units

Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Market Share: Total Factory Revenue	Market Share: Hardware Revenue	Market Share: Software Revenue	Market Share: Hardware Units Shipped
IBM	41.7	24.4	10.1	760	23.3%	23.6%	23.9%	23.1%
Digital	39.6	30.9	.0	693	22.2%	29.9%	.0%	21.1%
Sun Microsystems	25.4	21.1	.0	898	14.2%	20.4%	.0%	27.3%
EDS Unigraphics	24.2	7.4	11.0	327	13.6%	7.1%	26.1%	10.0%
MacNeal-Schwendler	16.3	.0	16.3	0	9.1%	.0%	38.6%	.0%
Silicon Graphics	14.1	12.0	.0	279	7.9%	11.6%	.0%	8.5%
Intergraph	8.0	2.0	3.2	115	4.5%	1.9%	7.6%	3.5%
Hewlett-Packard	2.5	2.1	.0	60	1.4%	2.0%	.0%	1.8%
Control Data Systems	1.9	.7	.5	6	1.1%	.7%	1.1%	.2%
Solbourne	1.6	1.6	.0	113	.9%	1.5%	.0%	3.4%
Computervision	1.1	.4	.3	15	.6%	.4%	.8%	.5%
Kubota Computer	1.0	.8	.2	8	.6%	.7%	.4%	.3%
Other Companies	1.3	.2	.6	12	.7%	.2%	1.5%	.4%
All Companies	178.6	103.5	42.2	3,288	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	177.2	102.6	41.9	3,278	99.2%	99.2%	99.2%	99.7%
All Asian-Based Companies	1.0	.8	.2	8	.6%	.7%	.4%	.3%
All European-Based Companies	.3	.1	.2	2	.2%	.1%	.4%	.1%
All Hardware Companies	86.9	70.7	.3	2,134	48.7%	68.3%	.7%	64.9%
All Turnkey & SW Companies	91.6	32.8	41.9	1,154	51.3%	31.7%	99.3%	35.1%

Source: Dataquest (February 1994)

Table 15
1993 CAD/CAM/CAE/GIS Market Share

Application:	Mechanical
Platform:	Personal Computer
Region:	North America
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Autodesk	78.2	.0	78.2	0	22.5%	.0%	52.2%	.0%
IBM	40.4	31.3	8.6	10,422	11.6%	16.5%	5.7%	13.5%
Apple Computer	27.9	27.9	.0	7,337	8.0%	14.7%	.0%	9.5%
Hewlett-Packard	12.8	11.6	.0	4,397	3.7%	6.1%	.0%	5.7%
Digital	9.0	8.5	.0	2,859	2.6%	4.5%	.0%	3.7%
CADKEY	6.7	.0	6.7	0	1.9%	.0%	4.5%	.0%
Intergraph	6.7	2.3	4.4	836	1.9%	1.2%	2.9%	1.1%
Point Control	6.7	.0	5.3	0	1.9%	.0%	3.6%	.0%
CNC Software	4.7	.0	4.7	0	1.4%	.0%	3.2%	.0%
Algor Interactive Systems	4.7	.0	4.1	0	1.3%	.0%	2.7%	.0%
MCS	4.6	.2	3.9	33	1.3%	.1%	2.6%	.0%
Swanson Analysis	3.6	.0	3.2	0	1.0%	.0%	2.2%	.0%
American Small Business Comp.	3.2	.0	3.2	0	.9%	.0%	2.1%	.0%
Computervision	3.1	.0	3.1	72	.9%	.0%	2.1%	.1%
Moda CAD	3.1	.6	2.2	30	.9%	.3%	1.4%	.0%
ADRA Systems	2.9	.0	2.4	0	.8%	.0%	1.6%	.0%
Foresight Resources	2.6	.0	2.4	0	.8%	.0%	1.6%	.0%
Engineering Mechanics	2.4	.0	2.4	0	.7%	.0%	1.6%	.0%
Rasna Corporation	2.2	.0	2.0	0	.6%	.0%	1.3%	.0%
Investronica SA	2.2	1.4	.6	75	.6%	.7%	.4%	.1%
Micrografx	2.1	.0	2.1	0	.6%	.0%	1.4%	.0%

(Continued)

Table 15 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: Personal Computer
Region: North America
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Cimatron	1.6	.7	.7	84	.4%	.3%	.5%	.1%
Ashlar	1.2	.0	.0	0	.3%	.0%	.0%	.0%
GRAPHSOFT	1.2	.0	1.2	0	.3%	.0%	.8%	.0%
Evolution Computing	1.1	.0	1.1	0	.3%	.0%	.8%	.0%
Softdesk	1.1	.0	1.1	0	.3%	.0%	.7%	.0%
MacNeal-Schwendler	1.1	.0	1.1	0	.3%	.0%	.7%	.0%
Pathtrace	1.0	.2	.7	14	.3%	.1%	.5%	.0%
Other Companies	110.0	105.2	4.4	50,875	31.6%	55.4%	3.0%	66.0%
All Companies	348.1	189.8	149.8	77,035	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	342.0	187.1	147.3	76,822	98.3%	98.5%	98.3%	99.7%
All Asian-Based Companies	.3	.3	.1	18	.1%	.1%	.0%	.0%
All European-Based Companies	5.7	2.5	2.5	196	1.6%	1.3%	1.6%	.3%
All Hardware Companies	185.2	183.5	.0	75,838	53.2%	96.6%	.0%	98.4%
All Turnkey & SW Companies	162.9	6.4	149.8	1,197	46.8%	3.4%	100.0%	1.6%

Source: Dataquest (February 1994)

Table 16
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: All Platforms
Region: Europe
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
IBM	829.6	530.7	144.9	22,809	26.0%	32.1%	16.5%	19.0%
Hewlett-Packard	342.8	236.1	41.2	11,384	10.7%	14.3%	4.7%	9.5%
Computervision	314.7	67.4	105.9	4,897	9.9%	4.1%	12.1%	4.1%
Digital	198.3	156.8	.0	5,772	6.2%	9.5%	.0%	4.8%
Sun Microsystems	114.0	90.9	.0	4,818	3.6%	5.5%	.0%	4.0%
Intergraph	85.1	27.1	29.6	1,974	2.7%	1.6%	3.4%	1.6%
Matra Datavision	84.5	23.3	45.1	795	2.6%	1.4%	5.1%	.7%
Silicon Graphics	79.0	70.5	.0	3,811	2.5%	4.3%	.0%	3.2%
Control Data Systems	72.0	32.7	15.1	3,135	2.3%	2.0%	1.7%	2.6%
EDS Unigraphics	63.8	19.0	30.2	942	2.0%	1.1%	3.4%	.8%
Siemens Nixdorf Info systeme	63.3	32.4	11.5	1,734	2.0%	2.0%	1.3%	1.4%
Autodesk	61.7	.0	61.7	0	1.9%	.0%	7.0%	.0%
SDRC	53.1	.0	46.2	0	1.7%	.0%	5.3%	.0%
Parametric Technology	49.7	.0	40.7	0	1.6%	.0%	4.6%	.0%
Applicon	38.5	12.7	15.0	424	1.2%	.8%	1.7%	.4%
ASCAD/ASCAM	28.2	16.7	8.7	436	.9%	1.0%	1.0%	.4%
Investronica SA	23.6	14.8	6.2	808	.7%	.9%	.7%	.7%
Cisigraph	23.6	6.4	11.3	272	.7%	.4%	1.3%	.2%
Straessle Informationssysteme	23.1	3.2	14.6	341	.7%	.2%	1.7%	.3%
Marcus Computer Systeme	22.1	11.3	7.6	400	.7%	.7%	.9%	.3%
Delcam International	21.1	7.4	9.5	280	.7%	.4%	1.1%	.2%
ISD Software	20.6	4.3	13.0	682	.6%	.3%	1.5%	.6%

(Continued)

Table 16 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: All Platforms
Region: Europe
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Cimatron	20.3	9.0	9.2	686	.6%	.5%	1.1%	.6%
Isicad CAD/CAM Systeme	18.6	5.0	9.7	216	.6%	.3%	1.1%	.2%
MacNeal-Schwendler	18.4	.0	18.4	0	.6%	.0%	2.1%	.0%
Wiechers Datentechnik	18.1	3.9	10.5	324	.6%	.2%	1.2%	.3%
CAD Lab	16.8	.0	13.9	0	.5%	.0%	1.6%	.0%
Digital Kienzle	16.4	8.2	4.6	248	.5%	.5%	.5%	.2%
Han Dataport	16.2	4.9	9.0	367	.5%	.3%	1.0%	.3%
ItalCad	16.2	5.3	6.2	185	.5%	.3%	.7%	.2%
Radan Computational	16.1	5.5	8.1	324	.5%	.3%	.9%	.3%
Tebis	13.3	3.5	2.0	89	.4%	.2%	.2%	.1%
Apple Computer	12.6	12.6	.0	2,646	.4%	.8%	.0%	2.2%
PDA Engineering	12.6	.0	11.8	0	.4%	.0%	1.3%	.0%
Exapt	10.9	5.2	3.8	210	.3%	.3%	.4%	.2%
ICL	10.0	5.8	3.4	287	.3%	.4%	.4%	.2%
Framasoft	9.3	.3	3.6	19	.3%	.0%	.4%	.0%
PAFEC	8.6	2.6	4.9	107	.3%	.2%	.6%	.1%
Swanson Analysis	8.0	.0	7.2	0	.3%	.0%	.8%	.0%
CAD Distribution	7.9	.0	7.1	101	.2%	.0%	.8%	.1%
Research Machines	7.8	7.8	.0	2,890	.2%	.5%	.0%	2.4%
Cimlinc	6.6	.0	4.4	169	.2%	.0%	.5%	.1%
Auto-Trol	6.5	2.3	2.6	81	.2%	.1%	.3%	.1%
Ziegler Informatics	6.0	.0	6.0	0	.2%	.0%	.7%	.0%

(Continued)

Table 16 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: All Platforms
Region: Europe
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Gerber Systems	5.4	2.5	2.3	79	.2%	.2%	.3%	.1%
ADRA Systems	5.3	.1	4.0	9	.2%	.0%	.5%	.0%
Serbi	5.1	.6	4.5	200	.2%	.0%	.5%	.2%
Technische Computer Systeme	4.1	.6	3.1	68	.1%	.0%	.4%	.1%
Alias Research	4.0	.0	3.7	0	.1%	.0%	.4%	.0%
MARC	3.5	.0	3.4	0	.1%	.0%	.4%	.0%
RoboCAD Solutions	3.3	.0	2.6	0	.1%	.0%	.3%	.0%
FEA	3.3	.7	.9	196	.1%	.0%	.1%	.2%
Whessoe Computing Systems	3.2	.0	3.2	0	.1%	.0%	.4%	.0%
MCS	3.2	.1	2.7	17	.1%	.0%	.3%	.0%
debis Systemhaus	3.1	.7	2.0	22	.1%	.0%	.2%	.0%
Pathtrace	3.0	.7	2.0	56	.1%	.0%	.2%	.0%
CATALPA groupe Missler	2.8	1.2	1.2	84	.1%	.1%	.1%	.1%
Kloeckner-Moeller	2.8	.6	1.9	0	.1%	.0%	.2%	.0%
Caroline Informatique	2.7	.5	1.4	27	.1%	.0%	.2%	.0%
SPATIAL Technology	2.7	.3	2.4	0	.1%	.0%	.3%	.0%
Mechanical Dynamics	2.5	.0	2.0	0	.1%	.0%	.2%	.0%
Anilam Electronics	2.5	.5	1.8	0	.1%	.0%	.2%	.0%
Vero International Software	2.4	.0	2.2	0	.1%	.0%	.2%	.0%
Superdraft	2.3	1.0	1.0	164	.1%	.1%	.1%	.1%
ICAD	2.3	.0	1.9	0	.1%	.0%	.2%	.0%
ISKA	2.1	.9	.9	39	.1%	.1%	.1%	.0%

(Continued)

Table 16 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: All Platforms
Region: Europe
Units: Millions of U.S. Dollars/Actual Units

Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Market Share: Total Factory Revenue	Market Share: Hardware Revenue	Market Share: Software Revenue	Market Share: Hardware Units Shipped
Rasna Corporation	2.1	.0	1.9	0	.1%	.0%	.2%	.0%
FEGS	2.0	.0	1.1	0	.1%	.0%	.1%	.0%
CAMTEK	1.8	.4	1.2	159	.1%	.0%	.1%	.1%
Softronics	1.6	.3	1.3	123	.1%	.0%	.1%	.1%
Micrografx	1.5	.0	1.5	0	.0%	.0%	.2%	.0%
Graftek	1.5	.7	.6	31	.0%	.0%	.1%	.0%
Point Control	1.5	.0	1.2	0	.0%	.0%	.1%	.0%
Engineering Mechanics	1.2	.1	1.1	6	.0%	.0%	.1%	.0%
CAD-Capture	1.2	.3	.3	13	.0%	.0%	.0%	.0%
Moda CAD	1.1	.2	.8	10	.0%	.0%	.1%	.0%
EME	1.1	.3	.5	31	.0%	.0%	.1%	.0%
CAMAX Systems Inc.	1.1	.2	.7	14	.0%	.0%	.1%	.0%
CADSI	1.0	.1	.8	7	.0%	.0%	.1%	.0%
CADKEY	1.0	.0	1.0	0	.0%	.0%	.1%	.0%
Other Companies	210.4	197.1	7.5	43,993	6.6%	11.9%	.9%	36.7%
All Companies	3,190.9	1,655.8	876.7	120,010	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	2,632.5	1,464.5	620.7	107,219	82.5%	88.4%	70.8%	89.3%
All Asian-Based Companies	.0	.0	.0	0	.0%	.0%	.0%	.0%
All European-Based Companies	558.4	191.3	256.1	12,791	17.5%	11.6%	29.2%	10.7%
All Hardware Companies	937.4	818.8	5.3	85,822	29.4%	49.5%	.6%	71.5%
All Turnkey & SW Companies	2,253.5	837.0	871.4	34,188	70.6%	50.5%	99.4%	28.5%

Source: Dataquest (February 1994)

Table 17
1993 CAD/CAM/CAE/GIS Market Share

Application:	Mechanical
Platform:	Technical Workstation
Region:	Europe
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
IBM	336.3	225.8	57.0	9,300	17.0%	24.7%	9.5%	22.5%
Hewlett-Packard	328.1	222.9	41.2	7,624	16.5%	24.4%	6.9%	18.5%
Computervision	308.1	66.8	100.3	4,779	15.5%	7.3%	16.7%	11.6%
Sun Microsystems	92.8	73.3	.0	4,219	4.7%	8.0%	.0%	10.2%
Matra Datavision	84.5	23.3	45.1	795	4.3%	2.5%	7.5%	1.9%
Intergraph	72.0	23.2	22.6	1,016	3.6%	2.5%	3.8%	2.5%
Silicon Graphics	67.2	60.5	.0	3,610	3.4%	6.6%	.0%	8.7%
Siemens Nixdorf Info systeme	60.1	29.4	11.5	1,181	3.0%	3.2%	1.9%	2.9%
Digital	59.4	46.3	.0	1,891	3.0%	5.1%	.0%	4.6%
SDRC	52.6	.0	45.7	0	2.7%	.0%	7.6%	.0%
EDS Unigraphics	51.1	15.0	24.3	781	2.6%	1.6%	4.1%	1.9%
Parametric Technology	49.7	.0	40.7	0	2.5%	.0%	6.8%	.0%
Applicon	38.5	12.7	15.0	424	1.9%	1.4%	2.5%	1.0%
Control Data Systems	28.8	15.8	7.7	756	1.5%	1.7%	1.3%	1.8%
ASCAD/ASCAM	27.3	16.1	8.5	413	1.4%	1.8%	1.4%	1.0%
Straessle Informationssysteme	23.1	3.2	14.6	341	1.2%	.3%	2.4%	.8%
Marcus Computer Systeme	22.1	11.3	7.6	400	1.1%	1.2%	1.3%	1.0%
Cisigraph	21.2	5.7	10.2	260	1.1%	.6%	1.7%	.6%
Isicad CAD/CAM Systeme	18.6	5.0	9.7	216	.9%	.5%	1.6%	.5%
Delcam International	18.6	6.5	8.4	214	.9%	.7%	1.4%	.5%
ISD Software	18.5	4.3	11.0	682	.9%	.5%	1.8%	1.6%

(Continued)

Table 17 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: Technical Workstation
Region: Europe
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Digital Kienzle	16.4	8.2	4.6	248	.8%	.9%	.8%	.6%
ItalCad	16.2	5.3	6.2	185	.8%	.6%	1.0%	.4%
Radan Computational	16.0	5.5	8.0	309	.8%	.6%	1.3%	.7%
Han Dataport	14.4	4.2	8.0	326	.7%	.5%	1.3%	.8%
CAD Lab	14.0	.0	11.3	0	.7%	.0%	1.9%	.0%
PDA Engineering	11.3	.0	10.6	0	.6%	.0%	1.8%	.0%
Cimatron	11.2	4.9	5.1	228	.6%	.5%	.8%	.6%
ICL	10.0	5.8	3.4	287	.5%	.6%	.6%	.7%
Framasoft	8.4	.3	3.2	19	.4%	.0%	.5%	.0%
PAFEC	7.5	2.6	3.8	107	.4%	.3%	.6%	.3%
Auto-Trol	6.5	2.3	2.6	81	.3%	.2%	.4%	.2%
Cimlinc	6.3	.0	4.2	169	.3%	.0%	.7%	.4%
MacNeal-Schwendler	5.5	.0	5.5	0	.3%	.0%	.9%	.0%
Gerber Systems	5.4	2.5	2.3	79	.3%	.3%	.4%	.2%
Swanson Analysis	4.9	.0	4.4	0	.2%	.0%	.7%	.0%
Autodesk	4.3	.0	4.3	0	.2%	.0%	.7%	.0%
Alias Research	4.0	.0	3.7	0	.2%	.0%	.6%	.0%
ADRA Systems	3.8	.1	2.8	9	.2%	.0%	.5%	.0%
Exapt	3.3	1.6	1.2	112	.2%	.2%	.2%	.3%
Technische Computer Systeme	2.9	.4	2.1	32	.1%	.0%	.4%	.1%
MARC	2.6	.0	2.5	0	.1%	.0%	.4%	.0%
SPATIAL Technology	2.4	.0	2.4	0	.1%	.0%	.4%	.0%

(Continued)

Table 17 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: Technical Workstation
Region: Europe
Units: Millions of U.S. Dollars/Actual Units

Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Market Share: Total Factory Revenue	Market Share: Hardware Revenue	Market Share: Software Revenue	Market Share: Hardware Units Shipped
debis Systemhaus	2.3	.5	1.5	11	.1%	.1%	.2%	.0%
ICAD	2.3	.0	1.9	0	.1%	.0%	.3%	.0%
ISKA	2.1	.9	.9	39	.1%	.1%	.1%	.1%
FEGS	1.8	.0	1.0	0	.1%	.0%	.2%	.0%
Mechanical Dynamics	1.8	.0	1.5	0	.1%	.0%	.2%	.0%
Wiechers Datentechnik	1.8	.6	.8	44	.1%	.1%	.1%	.1%
Caroline Informatique	1.7	.3	.9	9	.1%	.0%	.1%	.0%
Rasna Corporation	1.7	.0	1.5	0	.1%	.0%	.3%	.0%
CATALPA groupe Missler	1.7	.7	.8	19	.1%	.1%	.1%	.0%
MCS	1.7	.0	1.4	6	.1%	.0%	.2%	.0%
FEA	1.3	.3	.3	19	.1%	.0%	.1%	.0%
Graftek	1.2	.5	.5	20	.1%	.1%	.1%	.0%
CAMAX Systems Inc.	1.1	.2	.7	14	.1%	.0%	.1%	.0%
Other Companies	5.2	.5	3.8	35	.3%	.1%	.6%	.1%
All Companies	1,983.1	915.1	600.5	41,311	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	1,572.0	773.0	418.6	35,017	79.3%	84.5%	69.7%	84.8%
All Asian-Based Companies	.0	.0	.0	0	.0%	.0%	.0%	.0%
All European-Based Companies	411.1	142.1	181.9	6,294	20.7%	15.5%	30.3%	15.2%
All Hardware Companies	490.0	417.4	3.2	19,920	24.7%	45.6%	.5%	48.2%
All Turnkey & SW Companies	1,493.1	497.7	597.3	21,390	75.3%	54.4%	99.5%	51.8%

Source: Dataquest (February 1994)

Table 18
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: Host-Dependent
Region: Europe
Units: Millions of U.S. Dollars/Actual Units

Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Market Share: Total Factory Revenue	Market Share: Hardware Revenue	Market Share: Software Revenue	Market Share: Hardware Units Shipped
IBM	347.3	218.1	52.8	4,690	59.6%	56.6%	65.6%	44.1%
Digital	70.2	54.8	.0	0	12.0%	14.2%	.0%	.0%
Control Data Systems	40.8	16.0	6.7	2,370	7.0%	4.2%	8.4%	22.3%
MacNeal-Schwendler	12.9	.0	12.9	0	2.2%	.0%	16.0%	.0%
Exapt	7.6	3.6	2.7	98	1.3%	.9%	3.3%	.9%
PDA Engineering	1.2	.0	1.2	0	.2%	.0%	1.5%	.0%
Other Companies	102.9	92.6	4.2	3,480	17.7%	24.1%	5.2%	32.7%
All Companies	583.0	385.2	80.4	10,638	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	573.0	381.4	76.3	10,539	98.3%	99.0%	94.8%	99.1%
All Asian-Based Companies	.0	.0	.0	0	.0%	.0%	.0%	.0%
All European-Based Companies	10.0	3.7	4.2	99	1.7%	1.0%	5.2%	.9%
All Hardware Companies	174.9	149.8	1.7	4,071	30.0%	38.9%	2.1%	38.3%
All Turnkey & SW Companies	408.0	235.4	78.7	6,567	70.0%	61.1%	97.9%	61.7%

Source: Dataquest (February 1994)

Table 19
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: Server
Region: Europe
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
IBM	109.7	59.5	26.5	1,533	48.3%	42.4%	70.2%	43.3%
Digital	56.0	43.7	.0	874	24.7%	31.1%	.0%	24.7%
Sun Microsystems	21.2	17.6	.0	598	9.3%	12.5%	.0%	16.9%
EDS Unigraphics	12.8	4.0	5.9	161	5.6%	2.8%	15.5%	4.5%
Silicon Graphics	11.9	10.1	.0	202	5.2%	7.2%	.0%	5.7%
Intergraph	6.0	1.5	2.4	65	2.6%	1.1%	6.3%	1.8%
Control Data Systems	2.4	.9	.6	8	1.1%	.6%	1.7%	.2%
Cisigraph	2.4	.7	1.2	12	1.0%	.5%	3.1%	.3%
Computervision	1.6	.6	.6	20	.7%	.4%	1.6%	.6%
Hewlett-Packard	1.3	1.0	.0	25	.6%	.7%	.0%	.7%
Han Dataport	1.1	.5	.4	16	.5%	.3%	1.2%	.4%
Other Companies	.8	.4	.2	28	.3%	.3%	.6%	.8%
All Companies	226.9	140.4	37.8	3,541	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	223.4	139.3	36.2	3,514	98.5%	99.2%	95.8%	99.2%
All Asian-Based Companies	.0	.0	.0	0	.0%	.0%	.0%	.0%
All European-Based Companies	3.4	1.1	1.6	28	1.5%	.8%	4.2%	.8%
All Hardware Companies	95.0	76.2	.4	1,808	41.9%	54.3%	1.1%	51.0%
All Turnkey & SW Companies	131.8	64.2	37.4	1,734	58.1%	45.7%	98.9%	49.0%

Source: Dataquest (February 1994)

Table 20
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: Personal Computer
Region: Europe
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Autodesk	57.4	.0	57.4	0	14.4%	.0%	36.3%	.0%
IBM	36.3	27.3	8.6	7,285	9.1%	12.7%	5.4%	11.3%
Investronica SA	23.6	14.8	6.2	808	5.9%	6.9%	3.9%	1.3%
Wiechers Datentechnik	16.2	3.2	9.7	280	4.1%	1.5%	6.2%	.4%
Hewlett-Packard	13.5	12.2	.0	3,736	3.4%	5.6%	.0%	5.8%
Tebis	13.3	3.5	2.0	89	3.3%	1.6%	1.3%	.1%
Digital	12.7	12.0	.0	3,008	3.2%	5.6%	.0%	4.7%
Apple Computer	12.6	12.6	.0	2,646	3.2%	5.9%	.0%	4.1%
Cimatron	9.1	4.0	4.2	458	2.3%	1.9%	2.6%	.7%
CAD Distribution	7.9	.0	7.1	101	2.0%	.0%	4.5%	.2%
Research Machines	7.8	7.8	.0	2,890	2.0%	3.6%	.0%	4.5%
Intergraph	7.2	2.5	4.7	894	1.8%	1.2%	3.0%	1.4%
Ziegler Informatics	6.0	.0	6.0	0	1.5%	.0%	3.8%	.0%
Serbi	5.1	.6	4.5	200	1.3%	.3%	2.8%	.3%
Computervision	5.0	.0	5.0	98	1.3%	.0%	3.2%	.2%
RoboCAD Solutions	3.3	.0	2.6	0	.8%	.0%	1.6%	.0%
Siemens Nixdorf Info systeme	3.2	3.0	.0	553	.8%	1.4%	.0%	.9%
Pathtrace	3.0	.7	2.0	56	.8%	.3%	1.3%	.1%
CAD Lab	2.9	.0	2.6	0	.7%	.0%	1.6%	.0%

(Continued)

Table 20 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: Personal Computer
Region: Europe
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Kloeckner-Moeller	2.8	.6	1.9	0	.7%	.3%	1.2%	.0%
Anilam Electronics	2.5	.5	1.8	0	.6%	.2%	1.1%	.0%
Delcam International	2.5	.9	1.1	66	.6%	.4%	.7%	.1%
Whessoe Computing Systems	2.5	.0	2.5	0	.6%	.0%	1.6%	.0%
Vero International Software	2.4	.0	2.2	0	.6%	.0%	1.4%	.0%
Superdraft	2.3	1.0	1.0	164	.6%	.5%	.7%	.3%
Swanson Analysis	2.2	.0	1.9	0	.5%	.0%	1.2%	.0%
ISD Software	2.1	.0	2.1	0	.5%	.0%	1.3%	.0%
FEA	1.8	.4	.4	176	.4%	.2%	.3%	.3%
CAMTEK	1.7	.4	1.2	157	.4%	.2%	.7%	.2%
Softronics	1.6	.3	1.3	123	.4%	.2%	.8%	.2%
Micrografx	1.5	.0	1.5	0	.4%	.0%	1.0%	.0%
MCS	1.5	.0	1.3	11	.4%	.0%	.8%	.0%
ADRA Systems	1.5	.0	1.2	0	.4%	.0%	.7%	.0%
Point Control	1.3	.0	1.1	0	.3%	.0%	.7%	.0%
Technische Computer Systeme	1.3	.2	1.0	37	.3%	.1%	.6%	.1%
PAFEC	1.1	.0	1.1	0	.3%	.0%	.7%	.0%
CATALPA groupe Missler	1.1	.5	.5	65	.3%	.2%	.3%	.1%
Moda CAD	1.1	.2	.8	10	.3%	.1%	.5%	.0%

(Continued)

Table 20 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: Personal Computer
Region: Europe
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	**Total Factory Revenue**	**Hardware Revenue**	**Software Revenue**	**Hardware Units Shipped**	**Total Factory Revenue**	**Hardware Revenue**	**Software Revenue**	**Hardware Units Shipped**
Caroline Informatique	1.0	.2	.5	19	.3%	.1%	.3%	.0%
Other Companies	116.3	105.7	9.2	40,593	29.2%	49.1%	5.8%	62.9%
All Companies	398.0	215.2	158.0	64,520	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	264.1	170.7	89.6	58,149	66.4%	79.3%	56.7%	90.1%
All Asian-Based Companies	.0	.0	.0	0	.0%	.0%	.0%	.0%
All European-Based Companies	133.9	44.5	68.4	6,371	33.6%	20.7%	43.3%	9.9%
All Hardware Companies	177.4	175.5	.0	60,023	44.6%	81.6%	.0%	93.0%
All Turnkey & SW Companies	220.5	39.7	158.0	4,497	55.4%	18.4%	100.0%	7.0%

Source: Dataquest (February 1994)

Table 21
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: All Platforms
Region: Asia
Units: Millions of U.S. Dollars/Actual Units

Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Market Share: Total Factory Revenue	Market Share: Hardware Revenue	Market Share: Software Revenue	Market Share: Hardware Units Shipped
IBM	275.0	137.6	92.1	10,636	10.8%	9.5%	12.4%	11.4%
NEC	245.8	165.4	58.4	11,515	9.7%	11.4%	7.8%	12.3%
Fujitsu	219.9	128.9	67.4	8,751	8.7%	8.9%	9.0%	9.4%
Nihon Unisys	217.5	128.8	44.4	1,191	8.6%	8.9%	6.0%	1.3%
Hitachi	143.6	67.5	61.8	6,076	5.7%	4.6%	8.3%	6.5%
Hewlett-Packard	118.6	79.5	15.7	3,375	4.7%	5.5%	2.1%	3.6%
Toshiba—NO OEM	113.3	56.7	45.3	3,663	4.5%	3.9%	6.1%	3.9%
Hitachi Zosen Info Systems	89.8	76.1	4.4	865	3.5%	5.2%	.6%	.9%
Computervision	83.1	30.2	15.0	373	3.3%	2.1%	2.0%	.4%
Digital	56.2	44.4	.0	1,493	2.2%	3.1%	.0%	1.6%
Mitsubishi Electric	50.3	39.3	6.3	795	2.0%	2.7%	.8%	.9%
SDRC	47.2	.0	41.0	0	1.9%	.0%	5.5%	.0%
Hakuto	43.1	25.4	17.6	1,006	1.7%	1.7%	2.4%	1.1%
Sharp System Products—NO OEM	43.0	20.7	22.3	398	1.7%	1.4%	3.0%	.4%
Mutoh Industries—NO OEM	42.5	15.2	23.3	1,015	1.7%	1.0%	3.1%	1.1%
Silicon Graphics	41.6	41.6	.0	1,320	1.6%	2.9%	.0%	1.4%
Kubota Computer	38.2	29.1	6.1	438	1.5%	2.0%	.8%	.5%
Sun Microsystems	36.2	28.9	.0	1,497	1.4%	2.0%	.0%	1.6%
Tachnodia	33.2	26.0	.5	526	1.3%	1.8%	.1%	.6%
Autodesk	26.3	.0	26.3	0	1.0%	.0%	3.5%	.0%
Tokyo Electron—NO OEM	25.6	8.7	11.3	124	1.0%	.6%	1.5%	.1%

(Continued)

Table 21 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: All Platforms
Region: Asia
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Andor	23.1	5.1	17.1	421	.9%	.3%	2.3%	.5%
Toyo Information Systems—NO OEM	23.0	13.7	6.9	258	.9%	.9%	.9%	.3%
EDS Unigraphics	22.5	6.6	10.5	332	.9%	.5%	1.4%	.4%
Mitsui Engineering	22.1	15.3	4.5	178	.9%	1.1%	.6%	.2%
Kozo Keikaku Engineering	21.6	1.3	5.8	40	.8%	.1%	.8%	.0%
Parametric Technology	18.4	.0	15.1	0	.7%	.0%	2.0%	.0%
Sony	16.6	16.6	.0	823	.7%	1.1%	.0%	.9%
Apple Computer	16.0	16.0	.0	3,377	.6%	1.1%	.0%	3.6%
Graphtec Engineering	15.3	7.5	7.0	404	.6%	.5%	.9%	.4%
Intergraph	12.1	3.7	4.4	276	.5%	.3%	.6%	.3%
Adam Net	11.5	6.6	3.6	14	.5%	.5%	.5%	.0%
Omron	11.5	5.7	4.6	255	.5%	.4%	.6%	.3%
MacNeal-Schwendler	10.2	.0	10.2	0	.4%	.0%	1.4%	.0%
Control Data Systems	10.1	4.6	2.0	431	.4%	.3%	.3%	.5%
Design Automation	8.6	1.8	6.5	295	.3%	.1%	.9%	.3%
CADIX	8.3	3.6	4.1	46	.3%	.2%	.5%	.0%
Wacom	8.1	1.6	5.7	261	.3%	.1%	.8%	.3%
Sumitomo Denko Workstation	7.9	7.9	.0	855	.3%	.5%	.0%	.9%
MARC	7.8	.0	7.4	0	.3%	.0%	1.0%	.0%
Cisigraph	6.3	1.7	3.0	73	.2%	.1%	.4%	.1%
Gerber Systems	5.4	2.5	2.3	79	.2%	.2%	.3%	.1%

(Continued)

Table 21 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: All Platforms
Region: Asia
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Alias Research	5.3	.0	4.9	0	.2%	.0%	.7%	.0%
Graftek	5.0	2.1	1.9	129	.2%	.1%	.3%	.1%
Mechanical Dynamics	4.7	.0	3.8	0	.2%	.0%	.5%	.0%
Ricoh—NO OEM	4.5	.0	3.8	0	.2%	.0%	.5%	.0%
ICAD	4.4	.0	3.6	0	.2%	.0%	.5%	.0%
Swanson Analysis	4.3	.0	3.8	0	.2%	.0%	.5%	.0%
ADRA Systems	4.2	.1	3.2	7	.2%	.0%	.4%	.0%
Cimatron	3.4	1.5	1.5	113	.1%	.1%	.2%	.1%
PDA Engineering	3.4	.0	3.2	0	.1%	.0%	.4%	.0%
Investronica SA	3.2	2.0	.9	108	.1%	.1%	.1%	.1%
Century Research Center	2.9	1.5	1.1	14	.1%	.1%	.1%	.0%
Applicon	2.8	1.0	1.2	29	.1%	.1%	.2%	.0%
Straessle Informationssysteme	2.6	.4	1.6	16	.1%	.0%	.2%	.0%
MCS	2.4	.1	2.1	13	.1%	.0%	.3%	.0%
CAMAX Systems Inc.	2.3	.3	1.5	30	.1%	.0%	.2%	.0%
SPATIAL Technology	2.2	.2	2.0	0	.1%	.0%	.3%	.0%
Uchida Yoko	2.0	1.2	.7	53	.1%	.1%	.1%	.1%
Matra Datavision	1.6	.4	.9	15	.1%	.0%	.1%	.0%
Anilam Electronics	1.4	.3	1.0	46	.1%	.0%	.1%	.0%
Radan Computational	1.2	.4	.6	24	.0%	.0%	.1%	.0%
Auto-Trol	1.1	.4	.4	14	.0%	.0%	.1%	.0%

(Continued)

Table 21 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: All Platforms
Region: Asia
Units: Millions of U.S. Dollars/Actual Units

Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Market Share: Total Factory Revenue	Market Share: Hardware Revenue	Market Share: Software Revenue	Market Share: Hardware Units Shipped
Point Control	1.1	.0	.8	0	.0%	.0%	.1%	.0%
CADKEY	1.0	.0	1.0	0	.0%	.0%	.1%	.0%
Zuken	1.0	.3	.5	6	.0%	.0%	.1%	.0%
Other Companies	197.2	171.3	19.2	29,361	7.8%	11.8%	2.6%	31.4%
All Companies	2,541.1	1,455.0	744.8	93,452	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	1,000.4	559.9	279.9	52,310	39.4%	38.5%	37.6%	56.0%
All Asian-Based Companies	1,518.0	888.2	453.0	40,718	59.7%	61.0%	60.8%	43.6%
All European-Based Companies	22.7	6.9	11.9	424	.9%	.5%	1.6%	.5%
All Hardware Companies	459.5	429.6	.6	53,721	18.1%	29.5%	.1%	57.5%
All Turnkey & SW Companies	2,081.6	1,025.4	744.3	39,731	81.9%	70.5%	99.9%	42.5%

Source: Dataquest (February 1994)

Table 22
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: Technical Workstation
Region: Asia
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
NEC	122.9	76.3	35.6	3,463	8.6%	9.9%	8.1%	14.8%
Fujitsu	117.2	63.3	38.5	2,673	8.2%	8.2%	8.7%	11.4%
Hewlett-Packard	114.9	76.3	15.7	2,559	8.1%	9.9%	3.6%	10.9%
Hitachi	109.5	51.5	47.1	2,167	7.7%	6.7%	10.7%	9.3%
Nihon Unisys	87.0	47.9	23.5	493	6.1%	6.2%	5.3%	2.1%
Hitachi Zosen Info Systems	85.8	72.5	4.4	865	6.0%	9.4%	1.0%	3.7%
Computervision	82.6	30.2	14.5	373	5.8%	3.9%	3.3%	1.6%
Toshiba—NO OEM	68.0	34.0	27.2	755	4.8%	4.4%	6.2%	3.2%
IBM	55.6	27.8	15.6	974	3.9%	3.6%	3.5%	4.2%
SDRC	46.7	.0	40.6	0	3.3%	.0%	9.2%	.0%
Sharp System Products—NO OEM	43.0	20.7	22.3	398	3.0%	2.7%	5.1%	1.7%
Silicon Graphics	41.6	41.6	.0	1,320	2.9%	5.4%	.0%	5.6%
Mitsubishi Electric	38.7	32.9	2.7	363	2.7%	4.3%	.6%	1.5%
Kubota Computer	30.6	23.2	4.9	292	2.1%	3.0%	1.1%	1.2%
Sun Microsystems	27.6	21.8	.0	1,255	1.9%	2.8%	.0%	5.4%
Tokyo Electron—NO OEM	25.6	8.7	11.3	124	1.8%	1.1%	2.6%	.5%
Tachnodia	24.3	19.4	.2	273	1.7%	2.5%	.1%	1.2%
Mitsui Engineering	20.4	14.1	4.2	141	1.4%	1.8%	1.0%	.6%
Toyo Information Systems—NO OEM	19.3	11.8	5.8	237	1.4%	1.5%	1.3%	1.0%
EDS Unigraphics	19.0	5.5	9.0	293	1.3%	.7%	2.0%	1.3%
Parametric Technology	18.4	.0	15.1	0	1.3%	.0%	3.4%	.0%
Digital	16.9	13.2	.0	497	1.2%	1.7%	.0%	2.1%
Sony	16.6	16.6	.0	823	1.2%	2.2%	.0%	3.5%

(Continued)

Table 22 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: Technical Workstation
Region: Asia
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Mutoh Industries—NO OEM	16.2	5.8	8.8	239	1.1%	.7%	2.0%	1.0%
Graphtec Engineering	15.3	7.5	7.0	404	1.1%	1.0%	1.6%	1.7%
Omron	11.5	5.7	4.6	255	.8%	.7%	1.0%	1.1%
Intergraph	9.6	3.1	3.0	136	.7%	.4%	.7%	.6%
Kozo Keikaku Engineering	9.1	.9	2.7	10	.6%	.1%	.6%	.0%
CADIX	8.3	3.6	4.1	46	.6%	.5%	.9%	.2%
Sumitomo Denko Workstation	7.4	7.4	.0	813	.5%	1.0%	.0%	3.5%
MARC	5.8	.0	5.5	0	.4%	.0%	1.3%	.0%
Adam Net	5.8	.9	3.6	11	.4%	.1%	.8%	.0%
Cisigraph	5.7	1.5	2.8	70	.4%	.2%	.6%	.3%
Gerber Systems	5.4	2.5	2.3	79	.4%	.3%	.5%	.3%
Alias Research	5.3	.0	4.9	0	.4%	.0%	1.1%	.0%
Ricoh—NO OEM	4.5	.0	3.8	0	.3%	.0%	.9%	.0%
ICAD	4.4	.0	3.6	0	.3%	.0%	.8%	.0%
Graftek	4.0	1.6	1.6	83	.3%	.2%	.4%	.4%
Control Data Systems	4.0	2.2	1.0	103	.3%	.3%	.2%	.4%
Mechanical Dynamics	3.4	.0	2.7	0	.2%	.0%	.6%	.0%
ADRA Systems	3.0	.1	2.3	7	.2%	.0%	.5%	.0%
PDA Engineering	3.0	.0	2.8	0	.2%	.0%	.6%	.0%
Applicon	2.8	1.0	1.2	29	.2%	.1%	.3%	.1%
Straessle Informationssysteme	2.6	.4	1.6	16	.2%	.0%	.4%	.1%
Hakuto	2.6	1.6	1.0	31	.2%	.2%	.2%	.1%
CAMAX Systems Inc.	2.3	.3	1.5	30	.2%	.0%	.3%	.1%

(Continued)

Table 22 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: Technical Workstation
Region: Asia
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Cimatron	2.3	1.0	1.0	52	.2%	.1%	.2%	.2%
Swanson Analysis	2.3	.0	2.0	0	.2%	.0%	.5%	.0%
Autodesk	2.2	.0	2.2	0	.2%	.0%	.5%	.0%
SPATIAL Technology	2.0	.0	2.0	0	.1%	.0%	.5%	.0%
Uchida Yoko	1.8	1.1	.6	44	.1%	.1%	.1%	.2%
Century Research Center	1.7	.9	.6	12	.1%	.1%	.1%	.1%
Matra Datavision	1.6	.4	.9	15	.1%	.1%	.2%	.1%
MacNeal-Schwendler	1.3	.0	1.3	0	.1%	.0%	.3%	.0%
Wacom	1.3	.3	1.0	22	.1%	.0%	.2%	.1%
MCS	1.3	.1	1.1	5	.1%	.0%	.2%	.0%
Radan Computational	1.2	.4	.6	23	.1%	.1%	.1%	.1%
Auto-Trol	1.1	.4	.4	14	.1%	.0%	.1%	.1%
Zuken	1.0	.3	.5	6	.1%	.0%	.1%	.0%
Other Companies	29.0	11.3	15.7	521	2.0%	1.5%	3.6%	2.2%
All Companies	1,424.2	771.4	440.6	23,413	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	490.1	228.0	154.3	7,845	34.4%	29.6%	35.0%	33.5%
All Asian-Based Companies	919.5	539.6	278.3	15,391	64.6%	69.9%	63.2%	65.7%
All European-Based Companies	14.6	3.8	8.1	177	1.0%	.5%	1.8%	.8%
All Hardware Companies	166.1	151.0	.3	6,654	11.7%	19.6%	.1%	28.4%
All Turnkey & SW Companies	1,258.1	620.4	440.3	16,759	88.3%	80.4%	99.9%	71.6%

Source: Dataquest (February 1994)

Table 23
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: Host-Dependent
Region: Asia
Units: Millions of U.S. Dollars/Actual Units

Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Market Share: Total Factory Revenue	Market Share: Hardware Revenue	Market Share: Software Revenue	Market Share: Hardware Units Shipped
Nihon Unisys	130.5	80.9	20.9	698	25.1%	23.8%	22.2%	7.4%
IBM	101.8	63.1	15.3	1,219	19.6%	18.6%	16.2%	13.0%
NEC	61.4	45.5	10.5	127	11.8%	13.4%	11.1%	1.4%
Fujitsu	59.0	27.1	23.6	889	11.3%	8.0%	25.1%	9.5%
Digital	20.0	15.6	.0	0	3.8%	4.6%	.0%	.0%
Hitachi	11.3	5.3	4.9	2,744	2.2%	1.6%	5.2%	29.2%
Tachnodia	9.0	6.6	.3	253	1.7%	1.9%	.3%	2.7%
Toshiba—NO OEM	7.9	4.0	3.2	106	1.5%	1.2%	3.4%	1.1%
Mitsubishi Electric	6.5	3.1	1.8	18	1.3%	.9%	1.9%	.2%
Control Data Systems	5.8	2.3	.9	327	1.1%	.7%	1.0%	3.5%
MacNeal-Schwendler	5.6	.0	5.6	0	1.1%	.0%	5.9%	.0%
Hitachi Zosen Info Systems	4.0	3.6	.0	0	.8%	1.1%	.0%	.0%
Toyo Information Systems—NO OEM	3.7	2.0	1.2	21	.7%	.6%	1.3%	.2%
MARC	1.9	.0	1.8	0	.4%	.0%	2.0%	.0%
Kozo Keikaku Engineering	1.7	.0	.3	0	.3%	.0%	.4%	.0%
Swanson Analysis	1.3	.0	1.2	0	.2%	.0%	1.2%	.0%

(Continued)

Table 23 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application:	Mechanical
Platform:	Host-Dependent
Region:	Asia
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Century Research Center	1.2	.6	.5	2	.2%	.2%	.5%	.0%
Other Companies	87.4	80.3	2.3	3,000	16.8%	23.6%	2.5%	31.9%
All Companies	520.0	339.9	94.1	9,405	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	223.5	161.3	26.8	4,547	43.0%	47.4%	28.5%	48.3%
All Asian-Based Companies	296.2	178.6	67.0	4,858	57.0%	52.6%	71.2%	51.7%
All European-Based Companies	.3	.0	.3	0	.1%	.0%	.3%	.0%
All Hardware Companies	104.9	95.7	.2	3,020	20.2%	28.2%	.2%	32.1%
All Turnkey & SW Companies	415.1	244.2	94.0	6,386	79.8%	71.8%	99.8%	67.9%

Source: Dataquest (February 1994)

Table 24
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: Server
Region: Asia
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
IBM	31.1	16.5	7.8	410	39.8%	33.7%	54.0%	38.6%
Digital	15.7	12.2	.0	235	20.1%	25.0%	.0%	22.1%
Sun Microsystems	8.6	7.1	.0	242	10.9%	14.5%	.0%	22.7%
Adam Net	5.8	5.8	.0	2	7.4%	11.8%	.0%	.2%
Kubota Computer	5.7	4.4	.9	47	7.3%	8.9%	6.4%	4.4%
EDS Unigraphics	3.5	1.1	1.6	39	4.5%	2.2%	10.9%	3.7%
MacNeal-Schwendler	3.1	.0	3.1	0	3.9%	.0%	21.2%	.0%
Intergraph	1.2	.3	.5	13	1.5%	.6%	3.3%	1.2%
Kozo Keikaku Engineering	1.1	.0	.2	0	1.4%	.0%	1.5%	.0%
Other Companies	2.5	1.6	.4	75	3.1%	3.2%	2.8%	7.1%
All Companies	78.1	48.8	14.4	1,063	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	64.5	38.1	13.0	969	82.5%	78.0%	90.1%	91.1%
All Asian-Based Companies	13.0	10.6	1.1	92	16.7%	21.7%	7.9%	8.6%
All European-Based Companies	.6	.2	.3	3	.8%	.3%	1.9%	.3%
All Hardware Companies	25.7	20.6	.0	546	32.9%	42.2%	.3%	51.3%
All Turnkey & SW Companies	52.4	28.2	14.4	518	67.1%	57.8%	99.7%	48.7%

Source: Dataquest (February 1994)

Table 25
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: Personal Computer
Region: Asia
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
IBM	86.5	30.2	53.5	8,033	16.7%	10.2%	27.3%	13.5%
NEC	61.4	43.7	12.3	7,925	11.8%	14.8%	6.3%	13.3%
Fujitsu	43.7	38.4	5.3	5,189	8.4%	13.0%	2.7%	8.7%
Hakuto	40.5	23.9	16.6	975	7.8%	8.1%	8.5%	1.6%
Toshiba—NO OEM	37.4	18.7	15.0	2,802	7.2%	6.3%	7.6%	4.7%
Mutoh Industries—NO OEM	26.3	9.4	14.4	776	5.1%	3.2%	7.4%	1.3%
Autodesk	24.1	.0	24.1	0	4.6%	.0%	12.3%	.0%
Andor	23.1	5.1	17.1	421	4.5%	1.7%	8.8%	.7%
Hitachi	22.8	10.7	9.8	1,165	4.4%	3.6%	5.0%	2.0%
Apple Computer	16.0	16.0	.0	3,377	3.1%	5.4%	.0%	5.7%
Kozo Keikaku Engineering	9.7	.4	2.5	31	1.9%	.1%	1.3%	.1%
Design Automation	8.6	1.8	6.5	295	1.7%	.6%	3.3%	.5%
Wacom	6.8	1.4	4.7	239	1.3%	.5%	2.4%	.4%
Mitsubishi Electric	5.0	3.3	1.7	414	1.0%	1.1%	.9%	.7%
Digital	3.6	3.4	.0	761	.7%	1.2%	.0%	1.3%
Investronica SA	3.2	2.0	.9	108	.6%	.7%	.4%	.2%
Hewlett-Packard	2.9	2.6	.0	801	.6%	.9%	.0%	1.3%
Kubota Computer	1.9	1.5	.3	99	.4%	.5%	.2%	.2%
Mitsui Engineering	1.7	1.2	.3	37	.3%	.4%	.2%	.1%
Anilam Electronics	1.4	.3	1.0	46	.3%	.1%	.5%	.1%
ADRA Systems	1.2	.0	.9	0	.2%	.0%	.5%	.0%

(Continued)

Table 25 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application:	Mechanical
Platform:	Personal Computer
Region:	Asia
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
MCS	1.2	.0	1.0	8	.2%	.0%	.5%	.0%
Cimatron	1.1	.5	.5	61	.2%	.2%	.3%	.1%
Intergraph	1.0	.3	.7	127	.2%	.1%	.3%	.2%
Other Companies	87.8	80.3	6.7	25,882	16.9%	27.2%	3.4%	43.4%
All Companies	518.8	294.9	195.7	59,571	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	222.4	132.6	85.7	38,949	42.9%	44.9%	43.8%	65.4%
All Asian-Based Companies	289.2	159.4	106.6	20,377	55.7%	54.0%	54.5%	34.2%
All European-Based Companies	7.2	3.0	3.3	244	1.4%	1.0%	1.7%	.4%
All Hardware Companies	162.8	162.4	.0	43,502	31.4%	55.0%	.0%	73.0%
All Turnkey & SW Companies	356.0	132.6	195.7	16,069	68.6%	45.0%	100.0%	27.0%

Source: Dataquest (February 1994)

Table 26
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: All Platforms
Region: Rest of World
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
IBM	53.7	33.4	9.8	1,439	33.3%	41.8%	20.1%	18.2%
Computervision	15.8	5.5	3.0	311	9.8%	6.9%	6.2%	3.9%
SDRC	12.4	.0	10.8	0	7.7%	.0%	22.2%	.0%
Intergraph	11.3	3.5	4.1	283	7.0%	4.4%	8.4%	3.6%
Hewlett-Packard	10.5	6.9	1.5	568	6.5%	8.7%	3.1%	7.2%
Digital	8.0	6.3	.0	234	5.0%	7.9%	.0%	2.9%
EDS Unigraphics	5.0	1.4	2.3	75	3.1%	1.8%	4.8%	.9%
Control Data Systems	3.7	1.7	.7	158	2.3%	2.1%	1.5%	2.0%
Autodesk	3.5	.0	3.5	0	2.2%	.0%	7.2%	.0%
Sun Microsystems	3.1	2.5	.0	163	1.9%	3.1%	.0%	2.1%
Apple Computer	3.0	3.0	.0	799	1.9%	3.8%	.0%	10.1%
Cimatron	2.8	1.2	1.3	91	1.8%	1.5%	2.6%	1.1%
Investronica SA	2.5	1.6	.7	86	1.6%	2.0%	1.4%	1.1%
Delcam International	2.5	.9	1.1	32	1.5%	1.1%	2.3%	.4%
MacNeal-Schwendler	1.7	.0	1.7	0	1.0%	.0%	3.5%	.0%
Siemens Nixdorf Info systeme	1.5	.8	.2	40	.9%	1.0%	.4%	.5%
CNC Software	1.4	.0	1.4	0	.9%	.0%	2.8%	.0%
ADRA Systems	1.1	.0	.8	2	.7%	.0%	1.6%	.0%

(Continued)

Table 26 (Continued)
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: All Platforms
Region: Rest of World
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Vero International Software	1.0	.0	.9	0	.6%	.0%	1.9%	.0%
Other Companies	16.9	11.0	4.9	3,646	10.4%	13.8%	10.1%	46.0%
All Companies	161.3	79.7	48.6	7,926	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	148.0	74.8	42.4	7,624	91.8%	93.8%	87.1%	96.2%
All Asian-Based Companies	.0	.0	.0	0	.0%	.0%	.0%	.0%
All European-Based Companies	13.3	5.0	6.3	303	8.2%	6.2%	12.9%	3.8%
All Hardware Companies	36.6	32.9	.2	5,991	22.7%	41.2%	.3%	75.6%
All Turnkey & SW Companies	124.7	46.9	48.5	1,936	77.3%	58.8%	99.7%	24.4%

Source: Dataquest (February 1994)

Table 27
1993 CAD/CAM/CAE/GIS Market Share

Application:	Mechanical
Platform:	Technical Workstation
Region:	Rest of World
Units:	Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
IBM	19.6	12.5	3.7	497	22.7%	35.2%	12.5%	29.8%
Computervision	15.3	5.4	2.7	309	17.7%	15.3%	9.2%	18.5%
SDRC	12.3	.0	10.7	0	14.2%	.0%	36.5%	.0%
Hewlett-Packard	9.5	6.0	1.5	242	11.0%	16.9%	5.1%	14.5%
Intergraph	9.0	2.9	2.8	148	10.4%	8.1%	9.7%	8.9%
EDS Unigraphics	4.2	1.2	2.0	65	4.8%	3.4%	6.7%	3.9%
Digital	2.6	2.0	.0	106	3.0%	5.7%	.0%	6.3%
Sun Microsystems	2.5	2.0	.0	143	2.9%	5.6%	.0%	8.5%
Delcam International	2.2	.8	1.0	25	2.5%	2.1%	3.4%	1.5%
Cimatron	1.9	.8	.9	43	2.2%	2.3%	2.9%	2.6%
Control Data Systems	1.5	.8	.4	37	1.7%	2.3%	1.2%	2.2%
Siemens Nixdorf Info systeme	1.4	.7	.2	27	1.6%	2.1%	.7%	1.6%
Other Companies	4.5	.4	3.5	28	5.2%	1.0%	12.0%	1.7%
All Companies	86.4	35.6	29.2	1,669	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	79.5	33.1	26.2	1,554	92.0%	92.8%	89.7%	93.1%
All Asian-Based Companies	.0	.0	.0	0	.0%	.0%	.0%	.0%
All European-Based Companies	6.9	2.6	3.0	114	8.0%	7.2%	10.3%	6.9%
All Hardware Companies	13.7	11.6	.1	597	15.8%	32.7%	.3%	35.8%
All Turnkey & SW Companies	72.7	24.0	29.1	1,072	84.2%	67.3%	99.7%	64.2%

Source: Dataquest (February 1994)

Table 28
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: Host-Dependent
Region: Rest of World
Units: Millions of U.S. Dollars/Actual Units

					Market Share			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
IBM	24.0	14.9	3.6	325	70.3%	70.0%	65.2%	57.0%
Digital	2.9	2.2	.0	0	8.4%	10.5%	.0%	.0%
Control Data Systems	2.2	.9	.3	120	6.3%	4.0%	6.2%	21.0%
Other Companies	5.1	3.3	1.6	125	15.0%	15.5%	28.7%	22.0%
All Companies	**34.1**	**21.2**	**5.5**	**570**	**100.0%**	**100.0%**	**100.0%**	**100.0%**
All N.A.-Based Companies	33.9	21.2	5.4	570	99.6%	100.0%	97.5%	100.0%
All Asian-Based Companies	.0	.0	.0	0	.0%	.0%	.0%	.0%
All European-Based Companies	.1	.0	.1	0	.4%	.0%	2.5%	.0%
All Hardware Companies	6.5	5.6	.1	140	19.1%	26.2%	.9%	24.5%
All Turnkey & SW Companies	27.6	15.7	5.5	430	80.9%	73.8%	99.1%	75.5%

Source: Dataquest (February 1994)

Table 29
1993 CAD/CAM/CAE/GIS Market Share

Application: Mechanical
Platform: Server
Region: Rest of World
Units: Millions of U.S. Dollars/Actual Units

Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Market Share: Total Factory Revenue	Market Share: Hardware Revenue	Market Share: Software Revenue	Market Share: Hardware Units Shipped
IBM	7.5	4.0	1.8	101	56.9%	57.7%	56.5%	52.3%
Digital	2.3	1.8	.0	40	17.3%	25.5%	.0%	20.6%
Intergraph	1.1	.3	.5	16	8.6%	4.0%	13.9%	8.5%
Other Companies	2.3	.9	1.0	36	17.2%	12.8%	29.6%	18.6%
All Companies	13.2	7.0	3.2	193	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	13.1	7.0	3.2	193	99.8%	99.9%	99.4%	99.9%
All Asian-Based Companies	.0	.0	.0	0	.0%	.0%	.0%	.0%
All European-Based Companies	.0	.0	.0	0	.2%	.1%	.6%	.1%
All Hardware Companies	3.1	2.5	.0	66	23.9%	35.5%	.3%	34.3%
All Turnkey & SW Companies	10.0	4.5	3.2	127	76.1%	64.5%	99.7%	65.7%

Source: Dataquest (February 1994)

Table 30
1993 CAD/CAM/CAE/GIS Market Share

Application:	Mechanical
Platform:	Personal Computer
Region:	Rest of World
Units:	Millions of U.S. Dollars/Actual Units

Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Market Share: Total Factory Revenue	Market Share: Hardware Revenue	Market Share: Software Revenue	Market Share: Hardware Units Shipped
Autodesk	3.3	.0	3.3	0	11.8%	.0%	30.6%	.0%
Apple Computer	3.0	3.0	.0	799	10.9%	19.0%	.0%	14.5%
IBM	2.7	1.9	.7	517	9.7%	12.2%	6.7%	9.4%
Investronica SA	2.5	1.6	.7	86	9.1%	9.9%	6.2%	1.6%
CNC Software	1.4	.0	1.4	0	5.0%	.0%	12.9%	.0%
Vero International Software	1.0	.0	.9	0	3.6%	.0%	8.6%	.0%
Other Companies	13.8	9.4	3.7	4,093	49.8%	58.8%	35.1%	74.5%
All Companies	27.7	15.9	10.7	5,495	100.0%	100.0%	100.0%	100.0%
All N.A.-Based Companies	21.4	13.5	7.5	5,307	77.5%	84.9%	70.7%	96.6%
All Asian-Based Companies	.0	.0	.0	0	.0%	.0%	.0%	.0%
All European-Based Companies	6.2	2.4	3.1	188	22.5%	15.1%	29.3%	3.4%
All Hardware Companies	13.3	13.2	.0	5,188	48.0%	82.8%	.0%	94.4%
All Turnkey & SW Companies	14.4	2.7	10.7	307	52.0%	17.2%	100.0%	5.6%

Source: Dataquest (February 1994)

For More Information...

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

Via fax .... (408) 437-0292

Dataquest®

a company of The Dun & Bradstreet Corporation

Dataquest®

a company of
The Dun & Bradstreet Corporation

Corporate Headquarters
Dataquest Incorporated
1290 Ridder Park Drive
San Jose, California 95131-2398
United States
Phone: 01-408-437-8000
Facsimile: 01-408-437-0292

Dataquest Incorporated
550 Cochituate Road
Framingham, Massachusetts 01701-9324
United States
Phone: 01-508-370-5555
Facsimile: 01-508-370-6262

Invitational Computer Conferences (ICC)
3990 Westerly Place, Suite 100
Newport Beach, California 92660
United States
Phone: 01-714-476-9117
Facsimile: 01-714-476-9969

Dataquest Japan Limited
Shinkawa Sanko Building
1-3-17, Shinkawa, Chuo-ku
Tokyo 104
Japan
Phone: 81-3-5566-0411
Facsimile: 81-3-5566-0425

Dataquest Korea
Trade Tower, Suite 3806
159 Samsung-dong
Kangnam-gu, Seoul 135-729
Korea
Phone: 82-2-551-1331
Facsimile: 82-2-551-1330

European Headquarters
Dataquest Europe Limited
Holmers Farm Way
High Wycombe, Bucks
HP12 4UL
England
Phone: 44-494-422722
Facsimile: 44-494-422742

Dataquest GmbH
Kronstadter Strasse 9
81677 Munich
Germany
Phone: 49-89-930-9090
Facsimile: 49-89-930-3277

Dataquest Europe SA
Tour Franklin
Cedex 11
92042 Paris-La-Défense
France
Phone: 33-1-41-25-18-00
Facsimile: 33-1-41-25-18-18

Representative Agencies in
Bangkok, Hong Kong,
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Chapter 1
Report Overview

Objectives

This mechanical CAD/CAM/CAE 1994 Market Trends report presents the results of Dataquest's research and analysis in the 1993 mechanical CAD/CAM/CAE market. It provides a comprehensive analysis of the market and is organized as follows:

- Executive Overview—This is a bulletized summary of the major findings of the report.
- Trends Analysis—The major trends and issues driving the market are defined, discussed, and analyzed. High growth areas are identified. Leading vendors are positioned in software and hardware markets. Each subapplication area is covered, and specific end-user topics with an impact on the growth of the market are discussed.
- High-Growth Areas—Several application areas are identified as high-growth opportunities. Each is described in a brief overview with contributing market dynamics, risks, or expectations identified.
- Leading Vendors—The top 10 leading vendors in worldwide revenue for mechanical CAD/CAM/CAE are identified. Each is reviewed for major recent accomplishments. Major strengths, weaknesses, and risks in future success are discussed, with a brief statistical review.
- Market Performance—A methodology and definitions are presented before the market results of 1993 are analyzed, looking at the market by region, platform, industry, and operating system. A top 10 analysis is given that identifies all of the top 10 vendors by total factory revenue, software, and hardware revenue, and in selected major markets.
- Appendix—A detailed market share table showing revenue and unit shipments.

Methodology

The market and trends analysis is based on more than 50 years of industry experience in the CAD/CAM/CAE group. We use the results of primary research to define, measure, and estimate the significant parameters of the market. Vendor- and end-user-based surveys are conducted to gain further insight into significant market dynamics. First-hand discussions with end users, investors, and vendors are used to verify assumptions and to check analysis results.

Project Analyst: Michael J. Seely

Chapter 2
Executive Summary

The mechanical CAD/CAM/CAE market is the largest application area in CAD/CAM/CAE and represented about 49 percent of the total in 1993. Electronic design automation (EDA); architectural, engineering, and construction (AEC); and geographic information systems (GIS) comprise the total market.

Major Trends and Issues

Major trends and issues in this market are as follows:

- The level of indispensability is rising as the scope of mechanical CAD/CAM/CAE increases.
- More than 43 percent of all revenue in 1993 came from systems with solid modeling as a core capability. But 39 percent of the users said they would be purchasing 2-D-only-based products.
- PCs have lost 3.6 percent in the last five years, dropping to 62 percent share of market in 1993 based on unit seat count. Technical workstations have gained 7.7 percent market share, increasing to 29 percent share in 1993.
- New workstation purchases will move older hardware downward to the less needy. This will soften the opportunity for Windows NT-based new hardware.
- Expect software prices to stabilize or increase slightly for leading products.
- Expect second-tier software products with stale technology to use price as a leading competitive weapon.
- The direct utility of office automation tools now has little impact on the CAD/CAM/CAE process, but the influence is growing.
- Other trends in mass market computing, such as pen-based and mobile products, will have utility in some special CAD applications. Many applications can be envisioned, such as a tool setup, assembly verification, and training.
- Full implementation of automation technology in the engineering environment will evolve well into the next millennium. The replacement market for hardware and software is gaining importance as the potential seat count approaches 50 percent saturation.
- The Advanced Information Technology in Design and Manufacturing (AIT) initiative has a core team of leading European manufacturers. The intention of this group is to develop a shared vision of the future of IT in a manufacturing environment and force the vendor community to support the effort.

- The standards that comprise Continuous Acquisition and Life-Cycle Support (CALS) enable electronic access to information over the entire life cycle of a product, from initial design to manufacturing to maintenance and support. It is a very comprehensive set of standards, encompassing everything from the design of printed circuit boards to tooling for metal parts.
- One of the Standard for the Exchange of Product Data's (STEP) main visions is to have various systems accept and use product data so that suppliers, vendors, and manufacturers will be able to receive and supply information about product parts and the interrelationships of parts and materials. STEP is viewed as a successor to IGES not only because it contains graphical information in a file-transferable format, but also because it incorporates manufacturing information on product features such as size, materials, properties, and part relationships.

High-Growth Areas

High-growth areas are as follows:

- Styling and industrial design
- Mechanical computer-aided engineering (MCAE)
- Knowledge-based engineering
- Product data management
- System design synthesis
- Rapid prototyping
- Virtual reality

Market Analysis

The following lists an overview of the market analysis covered more fully in chapters 5 and 6 of this report:

- Total factory revenue for the worldwide market in 1993 was $7.86 billion. The U.S.-based vendors shipped almost three-fourths of the total, Asian vendors shipped 19.0 percent, and European vendors only 7.5 percent. The vast majority of products developed in Asia were sold in Asia.
- The major regions of the world are nearly balanced for revenue shipments, with Europe being the largest at 36.5 percent, then Asia and North America. This trend is expected to continue for the foreseeable future, with the European market leading consumption and the Asian and North American markets approaching the same size.
- As a group the worldwide top 10 in total revenue gained slight market share to 58 percent in 1993, with $4.57 billion in revenue.

- Most of the top 10 in total factory revenue gained slight market share. The exceptions were Intergraph, which fell to No. 12, IBM, and Computervision, based on revenue.
- The big gainers were Silicon Graphics, which gained 1.6 percent share in revenue, Sun Microsystems with 1.3 percent, HP at 1.2 percent, and Digital Equipment Corporation at 1.0 percent.
- IBM continues to lead the market with its CATIA and CADAM product offerings. It leads the market in most regions for total factory revenue, and for host-based and server revenue for both hardware and software. This represented $1.33 billion in total mechanical CAD/CAM/CAE revenue, with a 3.4 percent drop from 1993.
- Autodesk has the No. 1 position in PC-based software in every major region. This is a newly won position in Asia, where a few of the local Asian products had edged it out of the lead.
- Revenue growth of 86 percent in 1993 brings PTC over the $151 million mark. If PTC can maintain this growth rate for two more years, it will be the largest mechanical CAD/CAM/CAE software vendor in the world.
- Computervision maintained its lead with top revenue share in software revenue on the technical workstation in Europe. Overall, Computervision's total software revenue dropped about 24 percent in 1993.
- EDS made significant progress in improving software revenue in 1993 with more than a 20 percent growth. At the same time, growth in total revenue brought worldwide revenue to the $274.7 million level.
- A published 27.9 percent revenue growth in software in 1993 illustrates the success of SDRC. Recent announcements highlight abnormal accounting practices in recording shipments to dealers as booked orders. The impact on growth cannot be estimated at this time. Because both 1992 and 1993 were affected, net growth may not change significantly, although total sales occurred at a lower level.
- MacNeal-Schwendler experienced better-than-average growth with a 24.6 percent increase reaching $74.1 million in software sales. New product development, recent acquisition activity, and continued sales on host-based systems contribute to this growth.
- HP dropped slightly below the industry average in 1993. The $70.8 million in software sales was a negative 2.9 percent growth rate. The ME10-based products sold well. Sales of Precision Engineering SolidDesigner, the new ACIS-based solid modeler, got off to a slow start.
- The 1993 revenue of $70.5 million came with a 2.8 percent growth reduction for Intergraph. In marked contrast to significant growth in 1992, 1993 was a wait-and-see year for many Intergraph users.
- Almost 100,000 more PC-based seats are sold each year than technical workstations. About 87,000 technical workstations were shipped in 1993 versus 188,000 PCs. This ratio holds fairly constant until 1998, with the PC losing some share of market. From a revenue standpoint, the ratio is dramatically different.

- Documentation and drafting applications continue to be the most widely used and sold (see Figure 6-4).
- MCAE, including all design and analysis applications, represented almost half of the market and had more than a 17 percent growth rate in 1993.
- Analysis applications are dominated by structural analysis. Almost half of the total revenue in this area comes from this one application. This group had an 8 percent growth rate from 1992 to 1993.
- Manufacturing engineering applications are dominated by tool design and fixture design activities. Fixture design in particular has seen a boost in growth with a 20 percent increase over the 1992 level.
- Manufacturing process simulation has been a sleepy application area with little growth activity. An exception to this trend in 1993 came from the numerical control (NC) part programming area, which had a 20 percent growth.
- Automotive and aerospace have been the two largest industrial user groups. In 1993, industrial and commercial machinery edged out aerospace for the No. 2 slot.
- The highest growth industries of significant size were fabricated metal ($152 million and 17.7 percent growth) and industrial and commercial machinery ($281 million and 12.3 percent growth).
- Some of the smaller markets with surprising growth levels include: telecommunications at 94.1 percent, government in national security and defense at 34.9 percent, and education at 27.1 percent.

Chapter 3
Trends Analysis

Introduction

The 25-year-plus history of mechanical CAD/CAM/CAE has witnessed an amazing progression of technologies and applications developed for the benefit of engineers, designers, and technicians. The earliest stage was focused on the drafting process and improvements in productivity. As three-dimensional capabilities became available, the designer found that design studies could be done in addition to production drawings. Analysis tools have evolved in a parallel process, targeted for another set of users. These analytical experts use mathematical algorithms to approximate the result of temperature, stress, and vibration conditions in the design. The manufacturing process has received the benefit of modeling and programming for the production of machined and fabricated parts with numerical control. A generalization of all this activity states that every significant workgroup from styling and industrial design to manufacturing and distribution has received the attention of software developers, attempting to make the individual task easier and more productive.

The adventure in this process comes from a simple dynamic that the developers and the potential users cannot anticipate the cause-and-effect relationships between future needs and development. The process is complicated by the competitive nature of the environment, where vendors are inclined to say "yes" when they should say "I do not understand why you are asking for...." The buyers contribute to the problem by not fully understanding their needs and often underestimate the efforts required for planning, implementation, and training. Also, the retirement rate of hardware and software in this environment is about 8 percent per year. This forces the users to be in a constant process of evaluation and change. A sense of urgency to maintain an operation with current functionality is tempered by the constant price/performance improvements in hardware. A delay of three months in a hardware purchase may double performance with no increase in cost. This reality has forced the software vendors to support all the major hardware platforms to ensure that they can operate on the favored platform of the moment.

Manufacturing companies have proved the value of using mechanical CAD/CAM/CAE technology. Many users across the organization are working on a second- or third-generation system. A recent end-user survey found that the average user had learned to use 3.7 different primary CAD tools. Only 1.9 of these are still being used. Many expect to learn the use of a new product in the next two years. The average expectation was one new product.

Point solutions are available for hundreds of task-oriented activities. These are valuable, but a corporate competitive advantage is difficult to achieve if directed only at this level. Perhaps the most important trend in the next five years is the increasing efforts directed toward workgroup applications in product development and manufacturing. Product data management is being discussed as the foundation of this movement. We expect all future software development to consider the boundaries among individuals, work teams, departments, and enterprises as engineering information is shared and developed. Rapid communication of in-process information will characterize the next-generation tools for productivity improvement in mechanical CAD/CAM/CAE.

Indispensability

Often, the definition of the problem defines the solution. The role of CAD/CAM/CAE is often described in terms of "art to part" design and methodology. A slightly broader viewpoint would consider a "concept to customer" orientation. It is our opinion that the full range of potential benefit from the use of automation technology will not be found until the complete process is considered from analysis of current and future customer needs to concept, through design and manufacturing, shipment, operational use, and finally disposal. This big-picture view identifies all opportunities to optimize product performance, manufacturing process, and engineering performance.

The wide variety of mechanical CAD/CAM/CAE tools have become indispensable to the effective operation of many job tasks. This is due more to time pressure for job completion than to an exclusive capability. Many manual or automated techniques can be used to define, verify, and document a mechanical design process. Time pressure to perform high-quality product design in a reduced time frame is making the use of these tool an indispensable part of the complete operation. Historical use of mechanical CAD/CAM/CAE has been on the production of different kinds of product and manufacturing information. The indispensability of this activity will increase dramatically when integrated with next-generation access and communications technology.

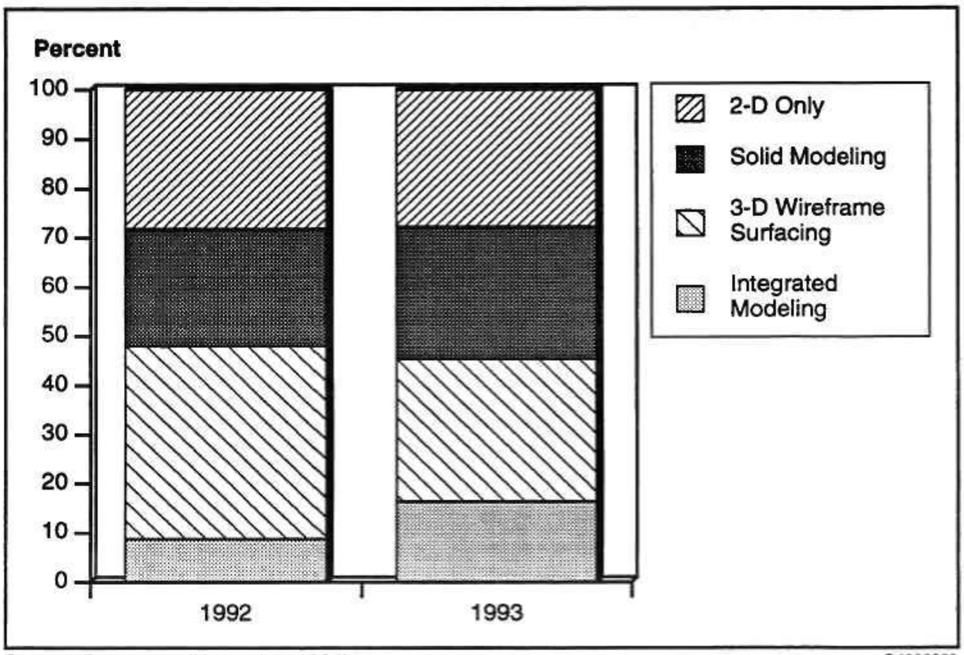
Modeling Technologies

The 1993 end-user survey of mechanical CAD/CAM/CAE users asked what core technology would be used in the products purchased in the next two years. About one-third said they would be purchasing integrated systems that included solid modeling, surfacing, and all 2-D and 3-D wire-frame capability. Another third said they would be getting products based on specific 3-D-based technology. Finally, 39 percent said they would be purchasing 2-D-only-based products. The interest in 3-D and solid modeling is not a surprise. This has been in a steady growth trend for several years. The relatively high interest in 2-D-only solutions is a strong reminder that many drawings are still made in this environment. The continued 2-D interest is encouraged by ongoing development to increase the value of these applications. All of the latest advances in parametric and predictive input tools are available in a 2-D format. In fact, most of the latest thinking in enhanced user interface techniques is developed first in a 2-D mode.

Another useful metric considers vendor shipments based on modeling technology. The most current analysis of this data is shown in Figure 3-1. Even with the technology refreshment described, products based on 2-D-only technology are on a slight decline. Solid modeling-based products are showing slight growth and are expected to peak as interest grows quickly in integrated systems. The growth in both these areas is coming at the expense of 3-D wireframe and surfacing systems. Even if a user has limited need for 3-D applications, the minimal incremental cost and common availability makes the move an easy choice. The platform of choice in a 3-D environment is solid modeling. More than 43 percent of all revenue in 1993 came from systems with solid modeling as a core capability.

The growth in solid modeling is based on the value of more complete data structure. Improvements in performance are rapidly building a strong following. Add-on applications to use the part or assembly information are still less than optimal, but progress is being made in integration between the model and analysis applications, also between the model and documentation, and further into manufacturing applications. Ease of use and satisfactory performance criteria continue to evolve with the growing needs of the users.

Figure 3-1
Software Revenue, by Modeling Technology



Source: Dataquest (November 1994)

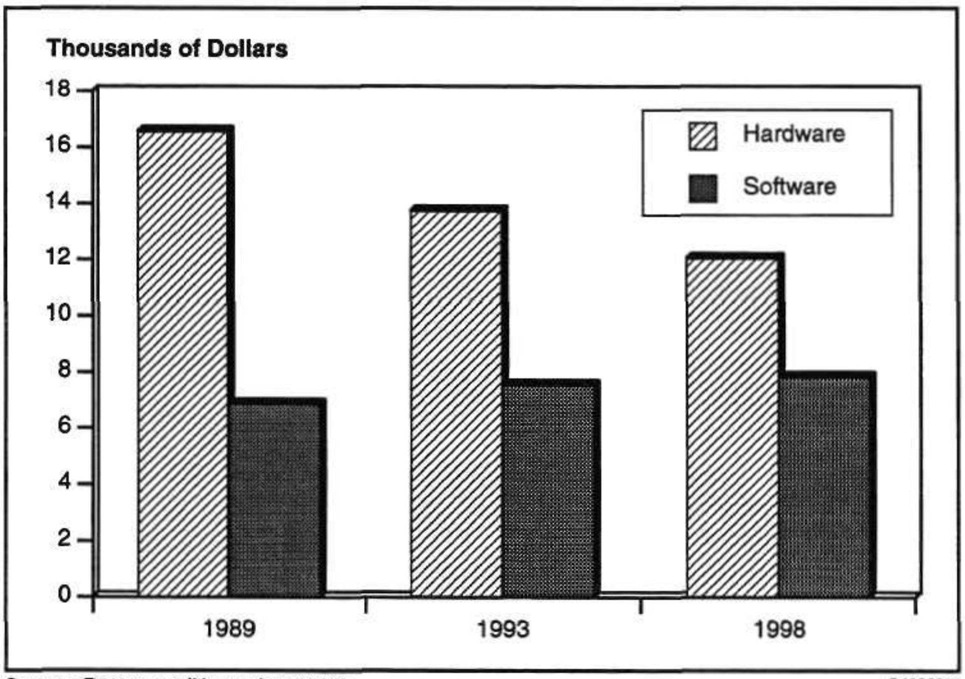
G4006050

Solid modeling was performed initially by adding and subtracting simple geometric shapes from one another. A very limited set of parts used in real-world product design can be accurately modeled in this way. The leading products being offered today have developed well beyond the plate-with-a-hole-in-it stage. However, we do not believe that any solid modeling vendor makes the claim to have solved all of the possible shape combinations necessary to accurately model any cast, molded, or formed part. If any vendor believes that it has reached this level of functionality, we will be happy to verify the results.

Cost per Seat

Historically, the cost per seat has been on a steady downward path. This trend continues, but at a slower rate of decrease. Figure 3-2 shows the average cost of hardware and software in 1989, 1993, and forecast for 1998. Considering all seat types, the average seat cost for hardware dropped from $16,570 to $13,740 in 1993. This is further expected to drop to $12,050 in 1998. The biggest reason for this change is the dropping average selling price (ASP), but the distribution among technical workstations, PCs, and host-based seats is also a factor. PCs have lost 3.6 percent in the last five years, dropping to 62 percent share of the market in 1993 based on unit seat count. Technical workstations have gained 7.7 percent market share, increasing to 29 percent share in 1993. This shift is expected to continue, with the workstation reaching 35 percent in 1998.

Figure 3-2
Distribution of Cost per Seat, by Hardware and Software



Source: Dataquest (November 1994)
G4006051

Software in this same period has increased in value on a per-seat basis. This overall trend is a balance among pressure to lower ASPs, a shift to higher-priced workstation-based solutions, and a slightly growing add-on market where new software is sold on existing hardware. The average amount of software shipped per seat has grown from $6,860 to $7,550 and is forecast to grow slightly to $7,830.

Dataquest expects the average value of software per seat to continue to rise as more sophisticated applications and more integrated solutions are implemented. Dataquest expects the performance level of the system to increase as the hardware ASP continues downward. Many of the seats installed have been purchased to run basic design and documentation applications. These platforms will not run the next generation of design optimization software in an effective manner. Users will plan to upgrade or replace these systems when the economics or new baseline requirements become compelling. It is worth noting the risk of releasing a new version of software that requires a significant upgrade in the typical seat configuration. The unplanned cost of such a move can delay the implementation of the new software release by a year or more.

Windows NT

The CAD/CAM/CAE industry has been around long enough that several operating systems have emerged, been implemented, and absorbed into the framework of the end-user environment. Each along the way has offered some benefit in improved middleware support, performance, or graphics support. This market has been eager to embrace anything that provides a real performance improvement, significant price benefit, or ease-of-use enhancement. The bottom-line opportunity for Windows NT is to address all of these issues.

The challenges for rapid Windows NT deployment are significant. So far any Windows NT-based application software brought to market also has been available on a UNIX platform for the same price. The result is little or no cost savings at the application level. Users comfortable in a workstation environment are not expected to risk networking problems, added security problems, and possible performance limitations.

A current PC owner will suffer some sticker shock when shopping for a new Windows NT-compatible system. For those willing to move to a new platform, a wide array of Windows NT or UNIX-based solutions are available. Any of these new systems will require training and new software to take advantage of the improved performance.

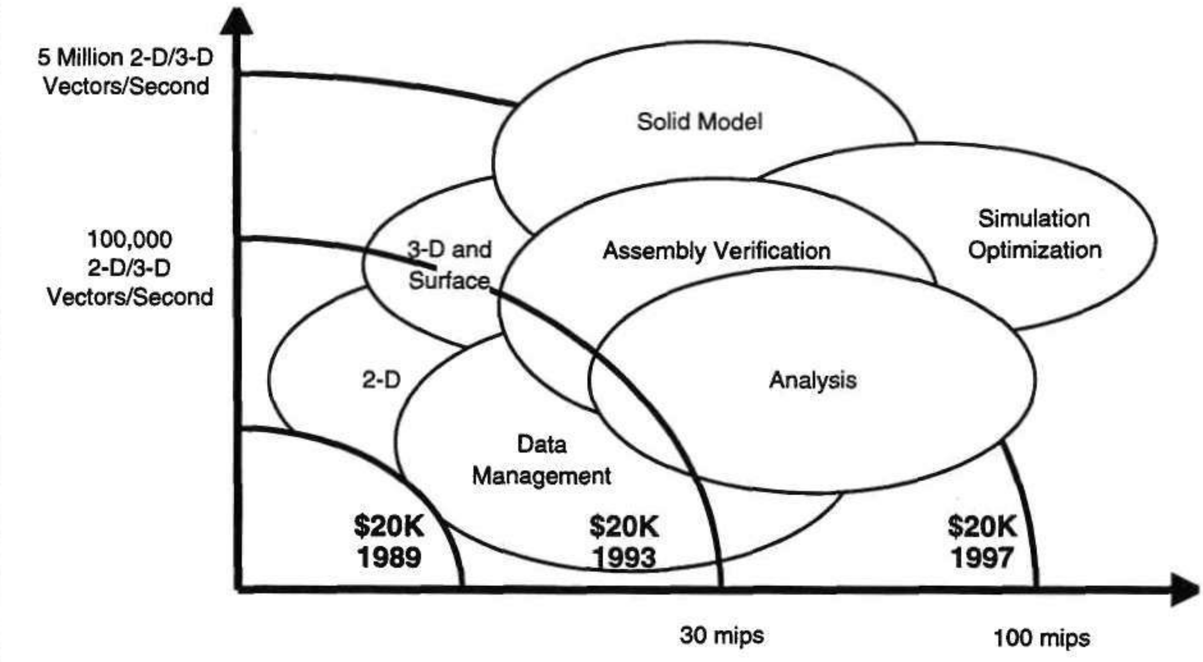
One ease-of-use issue is clear in making a UNIX to Windows NT comparison: Installation of the operating system is amazingly simple in comparison. This is appealing to the PC users and is, in fact, expected. Current UNIX users will be pleasantly surprised with this ease of use.

A market demographic issue adds to the softness of the Windows NT offering. Many of the workstation vendors have sold a large number of low-end workstations in the last year or two. These machines can migrate to the less needy while the power users will move up to the best price/performance package. A likely scenario then would find a system manager adding several high-end workstations to an existing operation and move the two- or three-year-old workstations to the new users, or they could buy Pentium-based tools for the new users. Both scenarios are easy to believe, but the new workstation purchases will move older hardware downward to the less needy. This will soften the opportunity for Windows NT-based new hardware.

Computing and Graphics Performance, by Task

The expected improvements in computing and graphics performance are fueling a dramatic growth in software development. What can be accomplished with reasonable interactive performance on a $20,000 workstation is evolving (see Figure 3-3).

Figure 3-3
Applications Performance Spectrum



Note: Oval size indicates current range of common expectation for performance.

Source: Dataquest (November 1994)

G3006052

In 1989, a $20,000 workstation could support only the basic applications of 2-D drafting and assembly design. Now, what is shown is the growth in user expectation for baseline functionality. These new requirements for complexity and performance would not be suitable for the "old" $20,000 seat.

In 1993, all of the basic and many of the advanced applications in mechanical CAD/CAM/CAE could be used effectively on a $20,000 workstation. As the performance improves, the 1997 version will handle all that and more. The important issue here is the accurate tracking of application growth in complexity and what is required for user-perceived acceptable performance. New applications will also evolve that will definitely require more computing and graphics performance. The widespread interest in design optimization is a prime example of this trend. New user interfaces developed for virtual reality products, coupled with styling and design optimization, will thrive in the new high-performance market. An almost insatiable need exists to continue to design more complex products in a more realistic, simulated environment. Making this full simulation capability a reality at an affordable price will keep developers busy for many years to come.

Office Automation

The vast majority of engineers, designers, and technicians work in an office environment, using a variety of office automation tools. The direct utility of these tools now has little impact on the CAD/CAM/CAE process, but the influence is growing. Users' expectations are influenced by their total computing experience. Spell-checking, document template, and spreadsheet operations all have potential value in a CAD environment. Supporting functions such as e-mail with attachments and file finding utilities are good examples of crossover functions that could directly impact a large design and manufacturing operation.

Pen-Based and Mobile Computing

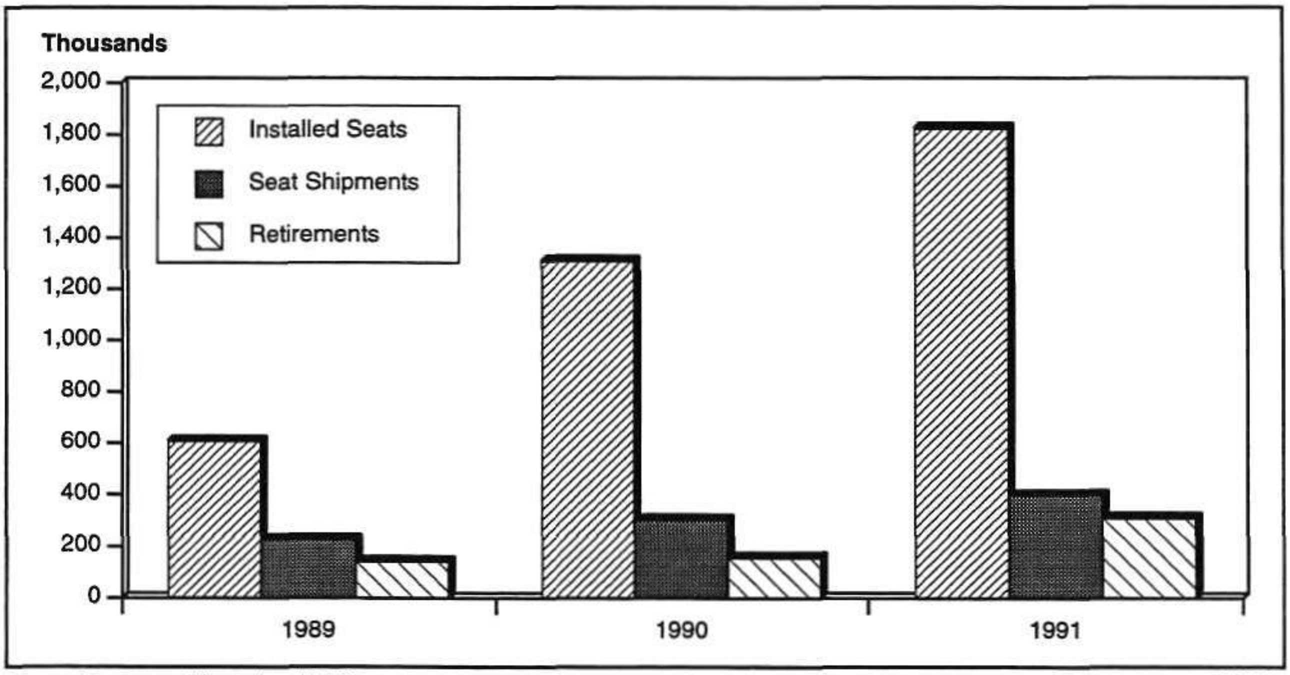
Other trends in mass market computing such as pen-based products will have utility in some special CAD applications. Ashlar Inc. announced the first pen-based CAD application in September 1994. Vellum, the 2-D and 3-D design and drafting application, is now available on Windows Pen. The user interface of Vellum is well oriented to this kind of operating environment. We expect other CAD/CAM/CAE products to be offered for mobile applications. Many applications in manufacturing can be envisioned, such as a tool setup, assembly verification, and training. Adding two-way communication with mobile communication could expedite the solution of many real-time problems between manufacturing and engineering. Going into the field opens up other potential uses. On-site customer support, field repair, and troubleshooting can all benefit from the combination of direct access to archival storage and retrieval of many kinds of reference material. We expect this area to evolve as the cost comes down and as the bandwidth of communication improves.

Market Penetration

The mainstream mechanical CAD/CAM/CAE market is evolving toward a replacement market with a total available market of about 2 million seats worldwide. We have passed a transition point where more than half of the new sales are being used to replace older hardware and software. Figure 3-4 shows the total installed base, new seat shipments, and retirements. In 1998, the percentage of retirements to new shipments is 78 percent based on units. This high level of penetration will change the expectations of many users. The telephone industry can be used as an example. Twenty years ago it would have been easy to predict market penetration of 100 percent at some time. Who expected the great variety of desktop, portable, in-car, and designer phones, in addition to normal home, office and public units? We are not expecting mechanical CAD/CAM/CAE systems to become as pervasive. However, uses of mechanical CAD/CAM/CAE will progress well beyond one per engineer and designer.

The retirement rate is an important component of any market penetration study. We expect the retirement rate in hardware to vary near 10 percent for the next few years. Retirements of software should be nearly the same but are occurring at a slightly lower rate, based on end-user survey data. The potential benefit to the users of these systems is significant when a 100 percent commitment can be made to the online and electronic databases. This value will push CAD/CAM/CAE technology into every nook and cranny where engineering information is used.

Figure 3-4
Mechanical CAD/CAM/CAE Installed Base



Source: Dataquest (November 1994) G4006053

Industry Consortia

AIT, a recent development in Europe coordinated by Daimler-Benz, has joined a group of automotive and aerospace companies in an industrial initiative. This initiative has a core team of Aerospatiale, Dassault, Renault, PSA, CASA, Alenia, Fiat, Magneti Marelli, Mercedes-Benz, BMW, DASA, AEG, VW, SAAB, British Aerospace, and Rover. The intention of this group is to recognize the need for shorter lead time, to react to market demands, to maintain quality, and to lower costs. These companies represent the full spectrum of manufacturing processes with the exception of the process industries. They share a dissatisfaction with the software industry in general. This is caused by a low level of understanding of the manufacturing environment, communications problems, and frequent delivery of less-than-optimal solutions. Because well more than 50 percent of all IT tools sold in Europe come from U.S. suppliers, this critical review of vendor performance is a strong call to action for the worldwide IT community.

Five major workgroups have been organized: Product Definition, Product Modeling, Manufacturing Engineering, Production Control, and Logistics and Information Management. Each is developing a technical work package to define a specification for future IT requirements. This pilot phase will lead to a later development phase that will extend a maximum of three years and will result in software prototypes conforming to the workgroup specifications. The following two years will see certification of the prototype environment and lead to implementation activity. The most significant benefit of this process in the short term will come to the vendors in the form of thoughtfully developed future requirements specification. Even if a specific company needs something special to meet unique requirements, the AIT deliverables will provide a valuable guide for all involved. The later development and implementation stages are not as well defined at this time. Ongoing research by Dataquest will monitor the progress of this important industry initiative.

Continuous Acquisition and Life-Cycle Support

As business competition becomes more international, both governments and industries need to be able to track information throughout a product's life cycle. Although companies continue to rely heavily on CAD/CAM systems, these systems can hinder the design process if information flow becomes a bottleneck. Companies need the ability to smoothly link information from one CAD system to another in the design and manufacturing of a product.

CALS is a collection of international standards being spearheaded by the International Standards Organization (ISO) and the U.S. Department of Defense. The standards that comprise CALS enable electronic access to information over the entire life cycle of a product, from initial design to manufacturing to maintenance and support. It is a very comprehensive set of standards, encompassing everything from the design of printed circuit boards to tooling for metal parts. CALS has its strongest backing in the

United States. Other nations in Europe and Asia are involved in CALS through their work with STEP.

CALS is a very industry-driven collection of standards. One of the original aims of the CALS committee was to work closely with industry vendors to draw upon the strengths of existing standards and to add features of its own to CALS. All those involved in the CALS initiative, including the ISO, CAD vendors, and end users, anticipate that CALS will improve product quality, reduce time to market, improve data reliability, and facilitate communication among various groups in a company.

CALS is being implemented in three phases:

- Current phase (1993 to 1996): Develops standards for technical manual production and delivery. Phase 1 includes implementing standards such as Initial Graphic Exchange Specification (IGES), Standard Generalized Markup Language (SGML), and Computer Graphics Metafile (CGM).
- Transition phase (1996 to 2000): Concentrates on the international development of STEP and its U.S.-based equivalent, Product Data Exchange Using STEP (PDES). The STEP standard, which is being developed by an ISO subcommittee responsible for STEP, is one of the largest and most comprehensive standards under CALS.
- Long-term phase (2000 and beyond): Covers electronic data interchange using fully distributed databases.

Although CALS is not expected to fully impact all manufacturing industries until the next century, the entire CALS initiative is continuing to march forward. CALS standards such as IGES have been in existence since 1979, and virtually all CAD vendors have some IGES read and write capability that aerospace and automobile companies are using.

STEP

STEP is a collection of international standards being developed by a large number of organizations worldwide. One of STEP's main visions is to have various systems accept and use product data so that suppliers, vendors, and manufacturers will be able to receive and supply information about product parts and the interrelationships of parts and materials.

In 1993, STEP was approved by the ISO as an International Draft Standard (DIS). The significance of this DIS version is that the STEP standard is now considered "technically complete," and vendors can begin development of STEP-compliant tools.

The initial focus of STEP has been on mechanical parts; however, at some of the various CAD/CAM/CAE conferences this year we have seen that STEP is making headway into the electronic design arena and process plant management. STEP has international backing from the United States, Europe, Japan, and even China.

STEP is viewed as a successor to IGES not only because it contains graphical information in a file-transferable format, but also because it incorporates manufacturing information on product features such as size, materials, properties, and part relationships. STEP consists of 19 application protocols that govern the technicalities of how files and data are represented and transferred. Table 3-1 shows a complete list of the application protocols.

Table 3-1
STEP Application Protocols

Application Protocol	Description
Explicit Drafting	Exchange of individual technical CAD drawings. Supports 2-D geometry.
Associative Drafting	Information requirements to exchange, access, and archive drawings.
Configuration Controlled Design	Structures for exchange between application systems of 3-D product data.
Mechanical Design Using Boundary Representation	Use and exchange of boundary representation models.
Mechanical Design Using Surface Representation	Representation and exchange of surface design data.
Mechanical Design Using Wireframe Representation	Transfer of wireframe models.
Sheet Metal Die Planning and Design	Specification and design of dies and associated tooling used in sheet metal part production.
Life-Cycle Product Change Process	Identification of a product anomaly, its causes, and approval and performance of resulting changes to the product.
Design through Analysis of Composite and Metallic Structures	Link of design, finite element, and detailed structural analysis applications to provide bidirectional information exchange capability.
Electronic Printed Circuit Assembly (PCA): Design and Manufacture	Building of printed circuit assemblies from a detailed design specifying all components of the PCA.
Electronic PCA: Test, Integrated Diagnostics, and Remanufacture	Testing, integrated diagnostics, and remanufacture of PCAs.
Electrotechnical Plants	Exchange of product data among computer systems used in design and engineering of electrotechnical plants.
Numerical Control Process Plans for Machined Parts	Product definition information for an NC process plan for a machined mechanical part.
Core Data for Automotive Mechanical Design Processes	Development and design of vehicle components and their tools.
Ship Arrangement	Commercial and naval shipbuilding design, engineering, and service life support.
Ship Molded Forms	Commercial and naval shipbuilding design, engineering, and service life support.
Ship Piping	Commercial and naval shipbuilding design, engineering, and service life support.
Ship Structures	Commercial and naval shipbuilding design, engineering, and service life support.
Inspection Process Plans	Exchange, access, and use of STEP for dimensional inspection of manufactured parts.

Source: Dataquest (October 1994)

Although companies are enthusiastic about the STEP standard and are working closely with the ISO to finish development of the application protocols, no vendor has yet released a commercial product meeting complete STEP compliance. In fact, because STEP is such a comprehensive standard, it is expected that no vendor will develop a software package that is fully STEP-compliant. Instead, vendors will implement those aspects of STEP pertinent to their customers' lines of business or product applications. Internal versions of STEP are being tested in some commercial arenas. Digital, Computervision, International TechneGroup, and STEP Tools are already debuting tools that are STEP-compliant in some aspect. Ford, General Motors, and Boeing are among the manufacturing companies working with the vendors to actually implement and test the standard. Also, a consortium known as ProSTEP, whose members include automobile companies from Europe, the United States, and Japan, is focusing on the impact of STEP in the automotive industry.

Chapter 4

High-Growth Areas

Styling and Industrial Design

Styling often takes the form of hand-drawn sketches and rendered illustrations. Stylists can create a photorealistic image of your next TV as easily as antigravity boots. The TV could be in your living room in six months. The development cycle for the antigravity boots will take some time longer.

The industrial design component of this early design activity brings in a critical first-level analysis of practicality. Can this design function as intended? Do we have the basic technology to make this practical? The expected higher growth in both application areas is based on continued pressure to create better products faster that cost less. The only way to reliably accomplish this feat is to increase the number of design starts and quickly refine, combine, and improve until the best solution is found. This will be accomplished in an interactive environment among styling, industrial design, engineering, manufacturing, and marketing. This collaborative design environment will be supported with next-generation user interaction techniques with rendering and analytical tools. The speed of iteration implied in this environment will preclude any form of data translation. Continued competitive pressures and a closer link to the design process will cause increased growth in styling and industrial design.

MCAE

MCAE is the logical combination of design and analysis. An important distinction was made between conceptual design and functional design and the interface to analysis tools such as finite element analysis (FEA). The trend toward easier-to-use design tools and closer integration of design and analysis functions are moving all these tasks closer together for the benefit of the user.

A growing need in manufacturing engineering for analysis is encouraging the use of MCAE for tool and fixture design. Shipping materials, in process fixturing, tools, and fixtures used in the fabrication process, can all benefit from faster and high-quality design and analysis. We expect MCAE to continue to be a growth application in the near term, especially in the manufacturing area.

Knowledge-Based Engineering (KBE)

KBE is a productivity multiplier for any mechanical CAD/CAM/CAE system. The rules developed can drive automated applications, capture design intent, and automate sharing of data between applications and departments. Every production operation has task and procedural structures that can be automated and optimized with KBE. The needed improvements in ease of use, cost of implementation, and availability of interface to a variety of mechanical CAD/CAM/CAE software products are improving. The pioneering end users have reported significant, sometimes amazing productivity improvements. We expect the remaining early adopters and the leading edge of the mainstream market to start pilot project activity in the next few years.

Product Data Management

The recent high level of interest in product data management is a predictable stage in the evolution of the mechanical CAD/CAM/CAE market. Two major forces have come together to create this activity. The first element is simply a function of technology penetration into the user base. The number of systems installed and the volume of work being produced has generated an average of 19,000 active CAD/CAM/CAE files per site. This may not seem like a tremendous amount, but consider that many preliminary files are generated before the design is finished. Also expect that every CAD/CAM/CAE file has 3 to 10 related files including forms, job orders, engineering change notice, and setup sheet, that are not counted in the number.

The second force in this environment is a result of the widespread effects of concurrent engineering and downsizing. The result of this activity is finding that a lot of new people are working at new jobs and need to use a distributed computing resource in a more effective way. They are not in a position to remember what happened five years ago. They need to know now what is in production and what procedures are involved. They need to have control of basic business information, for example: "We just had a product failure in the field. What products are involved? What is the value of this cost-cutting proposal?" And so on. Product data management has been identified as a tactical weapon in reducing cost and gaining control.

System Design Synthesis

System design automation (SDA) is a logical extension of the current trends in mechanical design automation (MDA) and electronic design automation (EDA). As design problems become more complex and the simulation tools more capable, the users will try to combine these activities into an integrated environment. This environment is easily defined, from a designer's viewpoint. As an example, suppose that a new sunroof for the latest model sedan is being designed. The motor needs to be strong enough to operate the roof under any normal condition but not so strong as to harm someone with a finger or arm in the wrong place at the wrong time. A better solution to this situation would be to add pressure sensors to the design. This is where SDA has significant potential value. The logic of the system can be verified in terms of electrical and mechanical engineering. The physical simulation can be operated to verify suitable results. The designer could actually simulate the obstruction and measure the squeeze force before the roof stopped. Automotive, aerospace, and consumer electronic industries are full of examples for this kind of integrated design: adaptive suspension, antilock breaking systems, and film and video cameras. To visualize the logical conclusion of this activity, imagine building a functional prototype of a camcorder. In the simulation, turn it on and point the camcorder toward an object. Then move around and look inside the viewfinder to see the simulated screen image. This might sound far-fetched, but the need for this level of simulation is very real.

Rapid Prototyping (RP)

The birth of a new industry is an exciting event. Rapid prototyping offers such an opportunity. Only a few years ago the first parts were swimming in the photo polymer broth of 3-D Systems' research lab. Now someone wanting a quick build of an evaluation part can select one of several manufacturers for this kind of operation. Part models built as a fully surfaced or solid model on any of the leading CAD/CAM/CAE products can be converted and transmitted to an RP machine for buildup. A one-of-a-kind part can be extracted from the machine in minutes or a few hours.

Several RP processes are available. Each has its own set of advantages and disadvantages in cost, selection of materials, accuracy, and so on. The leading vendor in this emerging market is 3D Systems. Others include DTM, Stratasys, and Cubital. Still more products are being developed and sold, some just in the local markets in Japan or Europe. It may not seem fair to the industry practitioners to describe the remarkable success of the technology and the benefits delivered as an emerging technology, but we believe that the potential of this exciting industry is well beyond the current level of performance. Vendors are actively developing new product offerings with significant improvements in cost per part and cycle time. New materials are being developed for direct part production, and other materials are being used in manufacturing tool fabrication processes. Building the master part model for investment casting or spray metal tooling are good examples.

We expect future RP tools to be used in an engineering office environment. Some will produce full-size functional mock-ups of automotive components; other advances will include new materials with advanced engineering properties. The CAD/CAM/CAE vendors will need to support more advanced data models to support this activity.

Virtual Reality

Enthusiasm for new technologies, especially those with remarkable potential, is difficult to ignore. In the case of virtual reality (VR), mainstream development is targeted in the consumer market. These technologies will progress quickly and will be available at a reasonable price. The clever will find a way to bring the best of this technology into the CAD/CAM/CAE world.

A brief scenario can highlight a potential application. A designer responsible for a die design for an aluminum casting is having a problem. The parts are not being formed correctly; porosity and incomplete filling of the mold is the problem. Using VR techniques with real-time interactive simulation, the designer can shrink and walk inside the mold. The simulation can dynamically represent the flow of the molten aluminum. As it moves into the mold, the designer can see and hear the process. He or she can feel the fluid velocity and decide to modify the shape of the mold, then run the simulation again. This scenario describes a real design problem, one that could be solved today in a few weeks. VR combined with the next-generation computing resource should reduce that design time to minutes.

As computing resources improve, the designer in the example could be joined by several friends. Representatives from manufacturing, marketing, and styling could all interact with the design to complete the design task. If this simulated design environment can be accessed in real time over a wide area network, this technology will have a profound impact on the nature of product design and manufacturing.

Imagination is becoming reality for some of the early adopters in this area. McDonnell Douglas has purchased a ProVision 100 VPX system from Division Inc. to enhance the company's design capabilities and to reduce costly prototypes. Using a Unigraphics II database, an F/A-18 tactical fighter engine, engine bay, and various maintenance equipment were imported into the Division dVISE system. A VR environment was created to evaluate various maintenance procedures. Engineers were able to immerse themselves in the VR environment, where they interacted with models to install and remove the engine and to evaluate interfaces. Using virtual tools, the step-by-step process is simulated to accomplish the maintenance operation. Maintenance procedures can be developed and tested on engines yet to be manufactured. Benefits include construction of fewer mock-ups and prototypes, earlier design testing, and reduced costs. Other applications are being evaluated.

Chapter 5
The Leading Vendors

Battle lines have been drawn among the largest CAD/CAM/CAE vendors. Each is providing a systems integrator role where they fight for account control. The biggest include IBM, Autodesk, Parametric Technology, Computervision, EDS, SDRC, HP, and others to a lesser extent. A large second group of vendors with complementary tools have formed alliances with most if not all of these systems integrators. These alliances are forged with the hope of leverage in the partner's installed base. The strategy seems to be working. MacNeal-Schwendler is a good example of a strong team member. Active with almost all systems integrators, MCS is the largest vendor in this group supplying FEA analysis tools. Add-on applications for manufacturing process simulation, quality control, testing, other analysis applications, related disciplines, component libraries, and niche applications are all used to enhance the core capability. Industry-specific tools exist for end-user customization as well. Multiple relationships are common in this highly dependent environment.

The growing complexity of this environment is creating an opportunity for something that sounds like a turnkey solution. We are not publicly stating the resurgence of turnkey solutions, however, numerous end users have told us of a need to have better support for system configuration, interoperability issues, and training. The mentioned systems integrators are in an excellent position to address these needs if the users are willing to pay for the service. The evolution of this support issue will have a profound impact on this industry.

IBM

IBM continues to lead the market with its CATIA and CADAM product offerings. It leads the market in most regions for total factory revenue, and for host-based, and in server revenue for both hardware and software. This represented $1.33 billion in total mechanical CAD/CAM/CAE revenue, with a 3.4 percent drop from 1993. CAEDS, the IBM private label name for SDRC products, has been dropped. Product sales by IBM has continued but revenue to SDRC through this channel has fallen off.

Strategic investments in a variety of software companies in mechanical CAD/CAM/CAE and other industrial applications promise to maintain IBM's position. Dassault, the primary software developer for IBM, continues to expand the application set in mechanical CAD/CAM/CAE. V4, the first major release of CATIA in several years, was released earlier this year. Innovative technology has been added with intelligence embedded in the sketching interface, whether working with new or old design. Surfacing and CAM applications continue to be above average in quality and features. In a surprise announcement mid-1993, Dassault moved toward a multiple-platform offering. As IBM grows the systems integration business, it will in fact sell other vendors' hardware if necessary to prove the level of commitment to the integrator mission. Dassault will port to HP, Sun Microsystems, and other platforms on a case-by-case basis. None of these alternative platforms has been announced for delivery at this time. IBM continues to make strategic investments in software companies to expand its influence and to add leading-edge software offerings around the CATIA core.

Autodesk

Autodesk has the No. 1 position in PC-based software in every major region. This is a newly won position in Asia, where a few of the local Asian products had edged it out of the lead. Worldwide, this represents $160.2 million in total mechanical CAD/CAM/CAE revenue, a 17.4 percent growth over the previous year. Aggressive acquisition and development strategies are in place to bring new technology into the company. Acquisitions of MES in Michigan and a relationship with Spatial Technology for the ACIS solid modeling technology are prime examples of this strategy. So far, the resulting AutoCAD Designer shipments have been below expectations, but revenue is reported to be growing at a rapid rate. The strength of the company is perceived to be in its market share and distribution channel. Enhancements to the recent release 13 were designed to improve performance and the user interface and add functionality to the product. Recent introduction of WorkCenter, a Windows-based technical document and workflow management product, is the first corporate sponsored offering for AutoCAD users.

Parametric Technology Corporation

A revenue growth of 86 percent in 1993 brings PTC over the $151 million mark for software. If PTC can maintain this growth rate for two more years, it will be the largest mechanical CAD/CAM/CAE software vendor in the world. Will this happen? If the testimonials from the steady stream of first- and second-time buyers are any indication, the odds are getting better. Recent changes in senior management will allow Mr. Sam Giesberg some free time away from the factory. The momentum in the development group is expected to continue unchecked. PTC is doing very well with a focused development team, a professional marketing program, and a pugnacious sales force. Shipments on Windows NT were reported to represent 15 percent of the company's total in the first quarter of 1994. This would position PTC as one of the early leading vendors in this environment. A recent end-user survey found the Pro/ENGINEER users to be above average in satisfaction with quality of software, with ease of use in terms of time required to become proficient.

Computervision

Computervision maintained its lead with top revenue share in software revenue on the technical workstation in Europe. Overall, Computervision's total software revenue dropped about 24 percent in 1993. The total factory revenue was stated at $465.3 million, with $147.5 million coming from software, $115.7 million from hardware sales, and the remaining $202 million in service revenue. The late 1993 release of CADDS5, the last major update, had some positive effect on revenue in 1993. The users as a group did not move toward the new user interface or purchase the required hardware to run CADDS5 as fast as expected. Aggressive competition in the U.S. market and a soft European market caused the revenue shortfall. Some reorganization and expense-cutting has taken place as a result. This is one case where the numbers do not tell the whole story. Computervision is well along in reinventing itself to be more successful in the next decade. This movement is being fed by the massive service revenue stream from days past. If the company can complete the next-generation build before this stream dries up, it can move briskly into the late 1990s.

EDS Unigraphics

EDS made significant progress in improving software revenue in 1993 with more than a 20 percent growth. At the same time growth in total revenue brought worldwide revenue to the $274.7 million level. It is second in software market share, behind PTC in North America. Software revenue has grown since the latest major release of Unigraphics V10. The level of quality of the V10 release is as good as or better than average. A list of strategic relationships is growing to add capability to the UG environment. New pricing strategies are in place to encourage users to move the new release and to use solid modeling technology. Equipment upgrades are often required when moving to V10. Enhancements to the manufacturing side of the business are next on the agenda.

SDRC

A published 27.9 percent revenue growth in software in 1993 illustrates the success of SDRC. Revenue slipped early in 1993 in anticipation of the next major software release and strong competitive pressures. Master Series has been proved to be a major improvement over earlier versions of the solid modeling-based design software. Many enhancements in the user interface, geometric manipulation, and workgroup function are in place. As could be anticipated, a rewrite of core software at this level can easily bring bugs into the process. The first release was buggy. In fact, a management letter to the stockholders suggested delayed shipments and a reduction in revenue because of this problem. But the problems have been solved, per the letter, and product shipments are back on track.

Another recent statement highlighted abnormal accounting practices in recording shipments to dealers as booked orders. This situation was revealed when significant bad debt levels were discovered. Litigation now in progress will identify the extent of inflation in the actual business performance and possible wrongdoing. Estimates of $30 million in uncollected revenue are spread over the last two-and-a-half years. The impact on growth cannot be estimated at this time because both 1992 and 1993 were affected.

MacNeal-Schwendler

MacNeal-Schwendler experienced better-than-average growth with a 24.6 percent increase, reaching $74.1 million in software sales. New product development, recent acquisition activity, and continued sales on host-based systems contribute to this growth. Some confusion during a recent staff reduction, inevitable after acquisition activity, has removed some valuable sales staff in Europe, as well as marketing and development people in the United States. Further reduction with the departure of President Larry McArthur indicates a high level of turmoil in the company. Well recognized for the depth of application base in the finite element analysis world, MSC has followed an evolutionary approach in product development. Growth in the next few years depends on a new set of strategies that will move MSC, Aries, and PDA Engineering together into a cohesive market force. This strategy is not evident at this time.

Hewlett-Packard

HP dropped slightly below the industry average in 1993. The $70.8 million in software sales was a negative 2.9 percent growth rate. The ME10-based products sold well. Sales of Precision Engineering SolidDesigner, the new ACIS-based solid modeler, got off to a slow start. It is integrated well with the drafting module. Users are looking for professional-level analysis and manufacturing applications to complete the offering. Alliances or HP-supported product development will be required to solve this issue. A sheet metal design package is a good example of some of the latest thinking along these lines. Ease of use based on knowledge-based techniques and obvious application expertise make this offering a high value for potential buyers in this niche market.

Europe has remained a stronghold for these products, where 51 percent of all software revenue is sold. North American sales are leading Asia slightly, indicating a worldwide appeal for the products. This revenue distribution begs the question of sales and distribution strength in the United States and Asia. Perhaps the latest PDM offering will get HP invited into more sales situations.

Intergraph

The 1993 software revenue of $70.5 million came with a 2.8 percent growth reduction. In marked contrast to significant growth in 1992, 1993 was a wait-and-see year for many Intergraph users. The Windows NT port was sufficient reason to delay any new purchases or an excuse to try something different. It is hoped that the waiting will generate some pent-up demand for a higher level of sales in 1994.

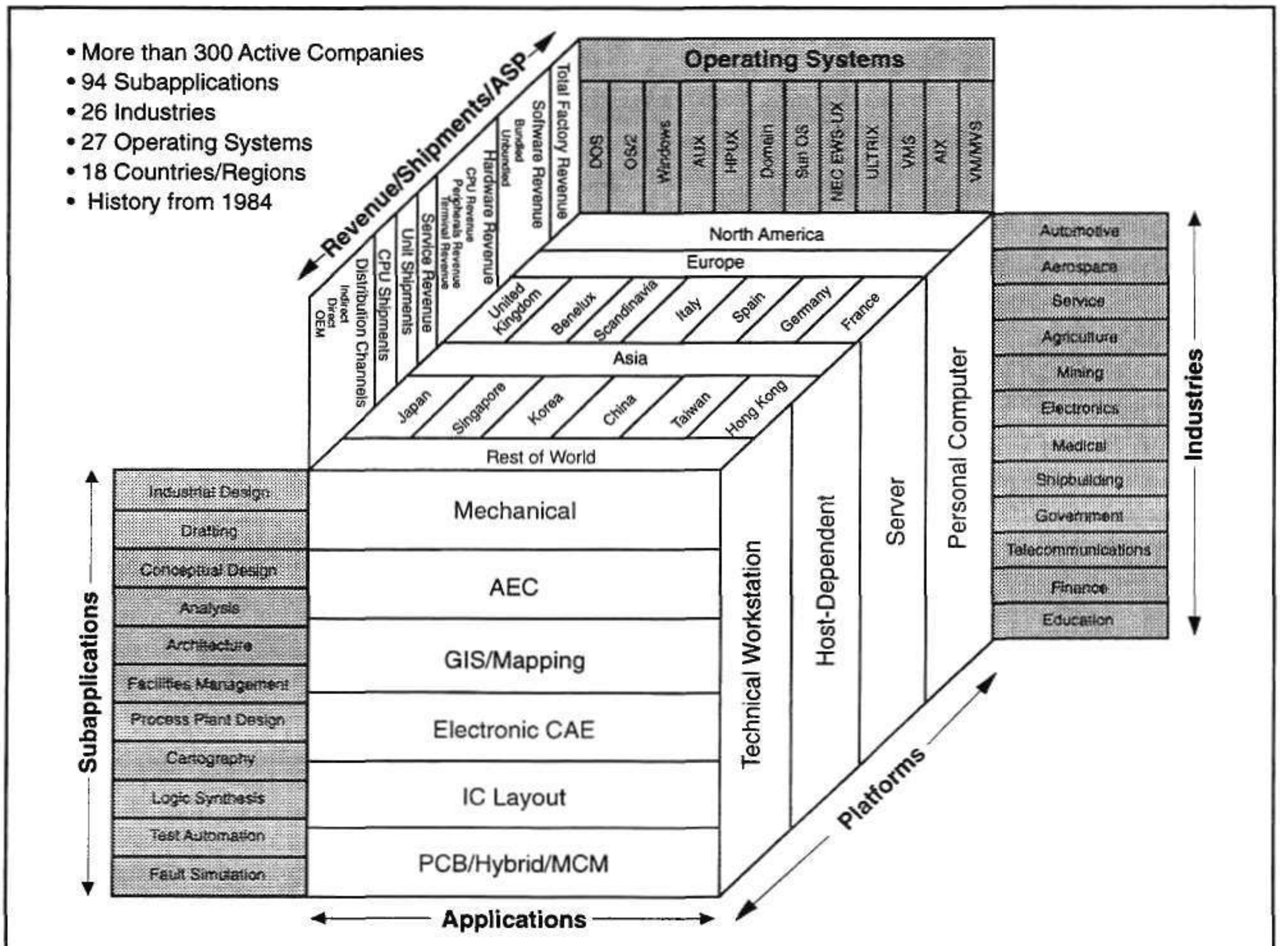
Third in North American sales for software, Intergraph continues to have pockets of strengths in the defense, automotive, and aerospace sectors. It also continues to have difficulty in turning these into large-scale success around the world. The integrated product data model approach embodied in I/EMS is a textbook implementation of contemporary user needs. The necessary supporting applications are available, as is a comprehensive product data management environment. What is missing are sales outside the friendly zone.

Chapter 6
Market Performance

Methodology

Every year the Dataquest CAD/CAM/CAE group makes two vendor surveys to define the market performance for the previous year. The process begins in the fourth quarter with direct contact of more than 360 vendors worldwide. This information drives the preliminary market share data published in February. Additional survey work is completed during the first and second quarters that qualifies the published preliminary data. This results in a final market share publication in July. The information described resides in a multidimensional database, as illustrated in Figure 6-1.

Figure 6-1
CAD/CAM/CAE Market Database



Source: Dataquest (November 1994)

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Having the benefit of detailed historical data, analysts generate a preliminary and final forecast using the market share results to make a sanity check on earlier assumptions. These final reports are distributed in May and October. This Market Trends report describes the 1993 market performance and forecast based on the most recent updates available.

Definitions

Subapplications

Dataquest defines the mechanical CAD/CAM/CAE market as where a set of computer-aided applications are used to design, analyze, document, and manufacture discrete parts, components, and assemblies. The computer applications used to accomplish these tasks are segmented into several functional areas. The mechanical application set includes:

- Documentation and drafting—This comprises a related set of applications that together define the documentation and drafting application. These include detail drafting, schematics, technical illustration, and charting applications.
- Conceptual design—Includes industrial layout, design layout, and styling applications.
- Functional design—Includes component design, assembly verification, and linkage/mechanism design applications.
- Analysis—Includes mass properties calculations, stack-up, fatigue, structural, thermal, vibration, magnetic, composite, and quality control applications.
- Manufacturing engineering—Includes tool design, fixture design, and part processing design applications.
- Manufacturing process simulation—Includes numerical control part programming, coordinate measuring machines, and offline robotics applications.
- System management and tools—Includes product structure or configuration management, engineering change management, network file management, user application tools, knowledge-based tools, and training tools applications.

Most of the users of these applications are found in the discrete manufacturing industries. These industries, such as automotive, aerospace, and machinery, represent about 50 percent of the total revenue of the market. The "others" category spans the full range of industry possibilities. Mechanical engineers can be found everywhere supporting the design activities of products and manufacturing processes in everything from toothpaste to billboard signs.

Computing Platforms

The computing platforms used for mechanical CAD/CAM/CAE include everything from pen-based portables to supercomputers. The Dataquest CAD/CAM/CAE database uses three platform designations—technical workstations, host-dependent systems, and PCs—to track the market:

- Technical workstations operate as a single-user computer with a large range of performance options; includes a virtual, multitasking operating system (UNIX, VMS, DOMAIN) and built-in functions for networking, high-performance graphics.
- Servers can be used for a variety of services that operate transparently for the user. Functions include file storage, database access, and compute capability.
- Host-dependent systems are shared logic devices with external workstations/terminals that are dependent on the host for operation.
- PCs are defined as single-user computers that have features similar to a technical workstation but are optional in the package, such as virtual operating system, networking, and high-performance graphics. Overall performance characteristics are generally positioned lower than a workstation.

Regions

The regions covered in the service database are defined as follows:

- North America—Includes United States and Canada
- Europe—Includes the United Kingdom, Scandinavia, Benelux, France, Germany, Italy, Spain, and the rest of Europe
- Asia—Includes Japan, Singapore, Taiwan, Korea, China, and Hong Kong
- Rest of World—All other countries including Australia, New Zealand, Oceania, Africa, Central America, South America, and the Middle East

The Mechanical CAD/CAM/CAE Market: 1993

Overall, the mechanical CAD/CAM/CAE market dipped slightly with a negative 1 percent growth in 1993, reaching $7.86 billion for total factory revenue. Total factory revenue is defined as 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 sold to another company for resale (OEM revenue). Total factory revenue is the sum of software revenue, hardware revenue, and services revenue. The software segment grew at a higher 5.8 percent rate, reaching $2.29 billion in worldwide shipments. Software revenue is revenue derived from the sale of unbundled and bundled (part of a turnkey system) application software.

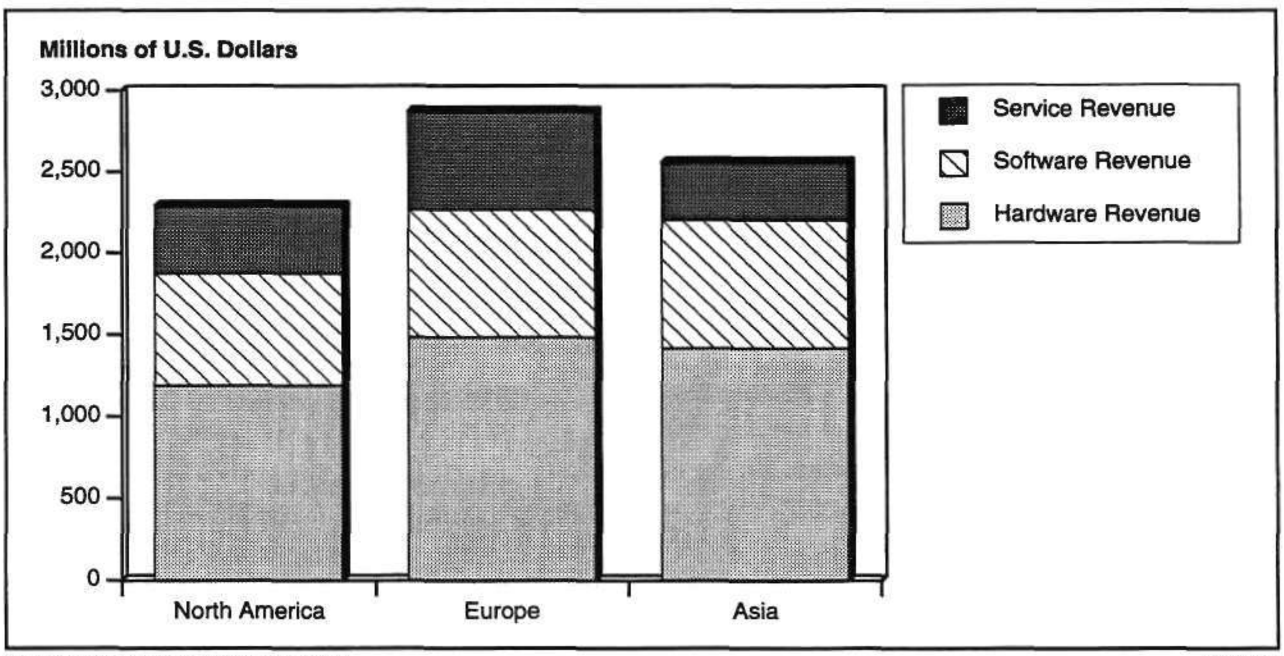
Mechanical CAD/CAM/CAE Market by Region

The shipments of mechanical CAD/CAM/CAE products reflect the global nature of the business. The major regions of the world are nearly balanced for revenue shipments, with Europe being the largest at 36.5 percent, then Asia and North America. This trend is expected to continue for the foreseeable future, with the European market leading consumption and the Asian and North American markets approaching the same size.

The sluggish economy in Europe caused a significant drop in mechanical CAD/CAM/CAE sales. The European market fell 13 percent in U.S. dollars. This view is misleading, however. Market growth is almost even if the European market is measured in local currencies. The distribution of platform types is similar in revenue to the U.S. market. The higher ASPs of technical workstations in Europe and the lower ASPs of PC-based solutions in the United States shift the unit distribution appropriately. Proportionally, a higher percentage of service revenue is paid in Europe, primarily because of the import of U.S.-based products into the region. Germany has the largest country market share in Europe, with a typical strong interest in using mechanical CAD/CAM/CAE tools in both product design and manufacturing applications.

The Asian market grew slightly in U.S. dollars at a 5 percent rate, reaching $2.61 billion. The adoption rate of the technical workstation is lagging the U.S. market. Both PC and host-based systems have a 4 to 5 percent higher revenue share of market. The average cost of a PC in Asia is two times as high as in the United States. Figure 6-2 shows the distribution by region.

Figure 6-2
1993 Mechanical CAD/CAM/CAE Market, by Region



Source: Dataquest (November 1994)

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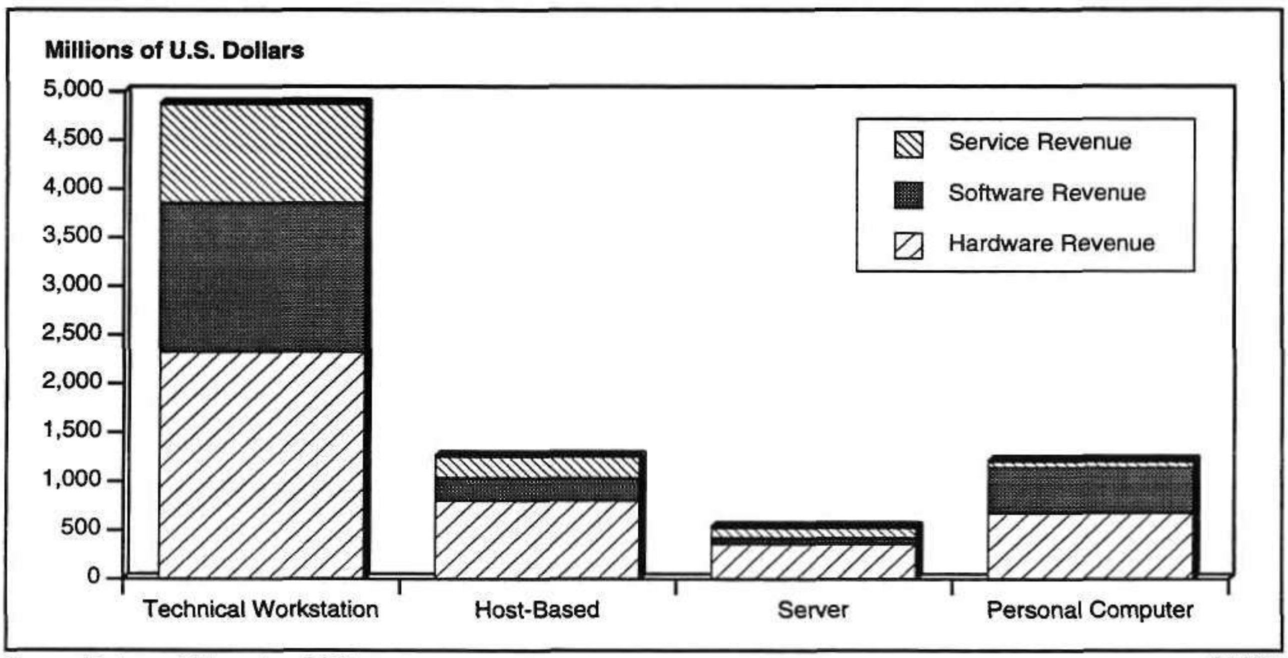
An interesting reference point comes from our worldwide analysis. This compares the total CAD/CAM/CAE consumption to the total sales volume of the manufacturing companies. This ratio is 0.3 percent. In other words, for every $100 of sales revenue in a manufacturing company, they spend 30 cents per year for use of mechanical CAD/CAM/CAE.

Mechanical CAD/CAM/CAE Market, by Platform

Almost 100,000 more PC-based seats are sold each year than technical workstations. About 87,000 technical workstations were shipped in 1993 versus 188,000 PCs. This ratio holds fairly constant until 1998, with the PC losing some share of market. From a revenue standpoint, the ratio is dramatically different. For every dollar spent in PC-based systems, 4.3 are spent on technical workstations-based solutions. The host environment is shrinking to only 9 percent of the total market (see Figure 6-3).

The mechanical CAD/CAM/CAE market has embraced the technical workstation as the platform of choice for system development. Technical workstations represent more than 62 percent of the total and more than 66 percent of the total software revenue. Continued advancements in application software are being developed to take advantage of the high-performance graphics, computing, and networking offered in this class of computing. Severe price pressure and enhanced performance has encouraged users to continue on this migration path.

Figure 6-3
1993 Worldwide Mechanical CAD/CAM/CAE Market, by Platform



Source: Dataquest (November 1994)

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The PC has experienced rapid growth and wide acceptance since the first product offerings supplied a low-cost drafting solution. The market perception of the PC as a more serious design and analysis tool has progressed slowly. Now, virtually all applications running on workstations or host-based systems are available on the PC. Many manufacturing applications have been implemented on the PC with good results. Numerical control part programming is probably the best example. The combination of low cost and focused application fit well in the shop floor environment. We expect the PC and workstation to continue to battle for the engineering desktop. It is worth noting that Windows NT shipments will be counted in both platform categories.

Host-based systems, once the basis for the entire mechanical CAD/CAM/CAE market, are evolving toward a minor role in the market. IBM owns a very large but shrinking 33.1 percent market share in total hardware revenue. The next four market share leaders—Digital, Nihon Unisys, NEC, and Fujitsu—together represent a similar 33.5 percent of the revenue in total factory revenue. Several Japanese vendors show considerable strength in the Japanese market with host-based offerings, but even in Japan the trend is the same: Revenue is flat to down. Dataquest expects the mainframe solution to continue to lose ground to the workstation and PC offerings. The server market, along with host-based solutions, will continue to supply the large system support and maintenance security blanket needed in some industries. The trend is clear, however: Host-based products will only represent about 9 percent of the market total by 1998.

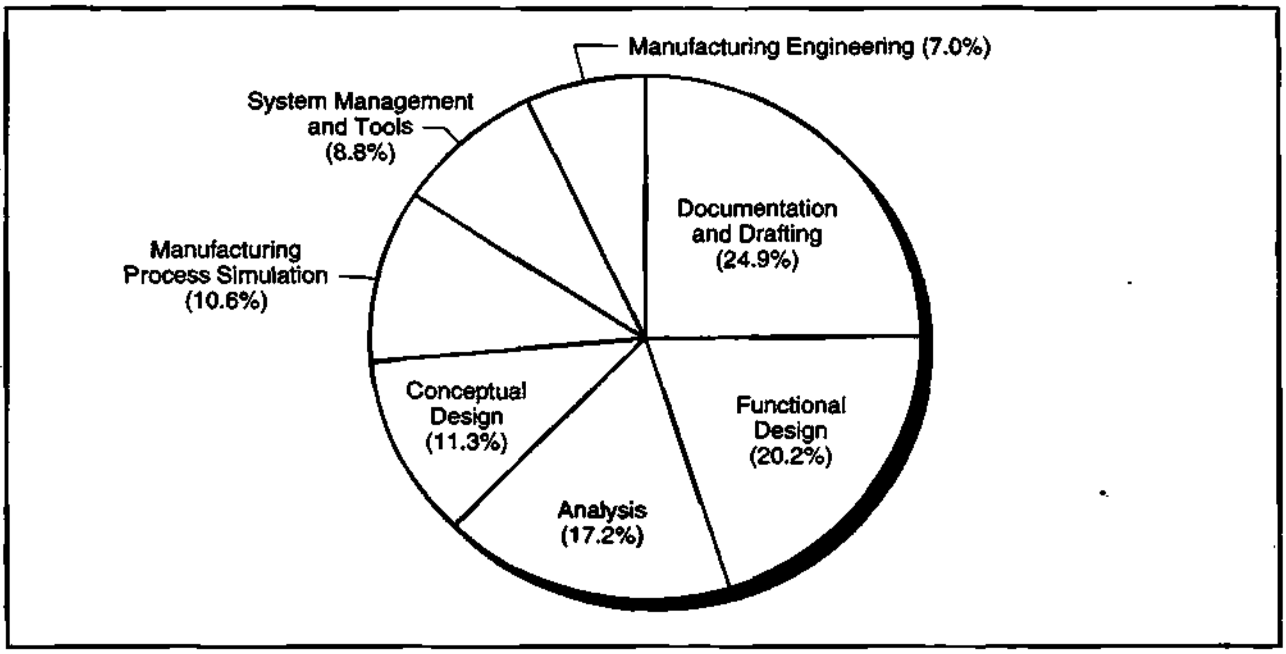
Mechanical CAD/CAM/CAE Market, by Subapplication

The forces at work in steering the development of CAD/CAM/CAE are universal. Drafting and design are the same in Spain, Singapore, or San Jose, California. The evolution of user demands is similar as well. The first application mastered usually produces detail design faster. This is followed by automated drafting techniques and more sophisticated uses of design, analysis, and manufacturing applications.

Documentation and drafting applications continue to be the most widely used and sold (see Figure 6-4). With an essentially flat growth, this is not an area of rapid change. However, this large share confirms the point that even after 25 years of mechanical CAD development this application area is still a fundamental requirement. The next three applications are often bundled together as MCAE. Together they represent almost half of the market and had more than a 17 percent growth rate in 1993. Functional design is the largest component of this area, with most of the application software being developed for component design and to a lesser degree for assembly verification and linkage design.

Analysis applications are dominated by structural analysis. Almost half of the total revenue in this area comes from this one application. This group had an 8 percent growth rate from 1992 to 1993. Thermal analysis is the next most common with 17 percent of the analysis software market.

Figure 6-4
1993 Worldwide Mechanical CAD/CAM/CAE Software Revenue, by Subapplication



Source: Dataquest (November 1994)

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Manufacturing engineering applications are dominated by tool design and fixture design activities. Fixture design in particular has seen a boost in growth with a 20 percent increase over the 1992 level.

Manufacturing process simulation has been a sleepy application area with little growth activity. An exception to this trend in 1993 came from the NC part programming area, which had a 20 percent growth. No obvious reason is offered to support this other than that a lot of development has been done in this area by all the major and many of the niche vendors in this application area. The efforts seem to have attracted the attention of a significant number of potential users.

Mechanical CAD/CAM/CAE Market, by Industry

Each country has a dominant industry or market segment that sets the tone for CAD/CAM/CAE use. The evolution of these industries has had an important impact on the growth of the CAD/CAM/CAE market in each region and has directed the success of many vendors trying to serve these markets. The automotive industries in Japan, the United States, Germany, Italy, and France have a major influence on the local CAD/CAM/CAE market (see "Industry Consortia" in chapter 3). Aerospace, a major force in the U.S. market, is less of a force in other regions and a minor but growing interest in Japan. All of the other manufacturing industries, such as fabricated metal, machinery, and consumer products have strongholds in various locations around the world. Specifically, the machinery industry in Japan and Germany represent a significant local CAD/CAM/CAE opportunity.

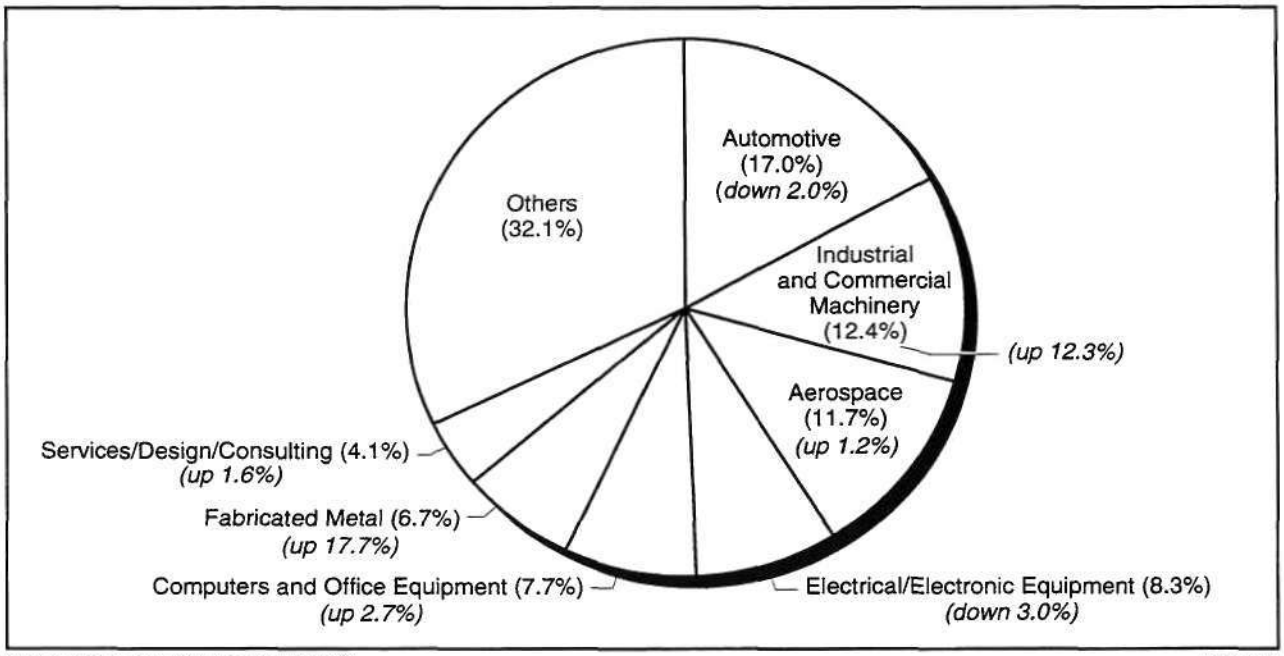
Automotive and Aerospace have been the two largest industrial user groups. In 1993, industrial and commercial machinery edged out aerospace for the No. 2 slot (see Figure 6-5). Neither automotive nor aerospace had significant growth. The highest growth industries of significant size were fabricated metal ($152 million and 17.7 percent growth) and industrial and commercial machinery ($281 million and 12.3 percent growth). Some of the smaller markets with surprising growth levels were telecommunications at 94.1 percent, government in national security and defense at 34.9 percent, and education at 27.1 percent.

Top 10 Market Share, by Total Factory Revenue

The total factory revenue for the worldwide market in 1993 was $7.86 billion. The U.S.-based vendors shipped almost three-fourths of the total, Asian vendors shipped 19 percent, and European vendors only 7.5 percent. The vast majority of products developed in Asia were sold in Asia.

As a group, the worldwide top 10 gained slight market share in 1993 (see Figures 6-6 and 6-7). In 1992, they had a 55 percent of total market. This grew slightly to 58 percent in 1993 with $4.57 billion in revenue. The names and positions on the list have not changed dramatically, with a few exceptions. Most of the top 10 gained slight market share except Intergraph, which fell to No. 12, and Computervision, based on revenue. The big gainers were Silicon Graphics, which gained 1.6 percent share in revenue, Sun Microsystems with 1.3 percent, HP at 1.2 percent, and Digital at 1.0 percent.

Figure 6-5
1993 Worldwide Mechanical CAD/CAM/CAE Software Revenue, by Industry



Source: Dataquest (November 1994)

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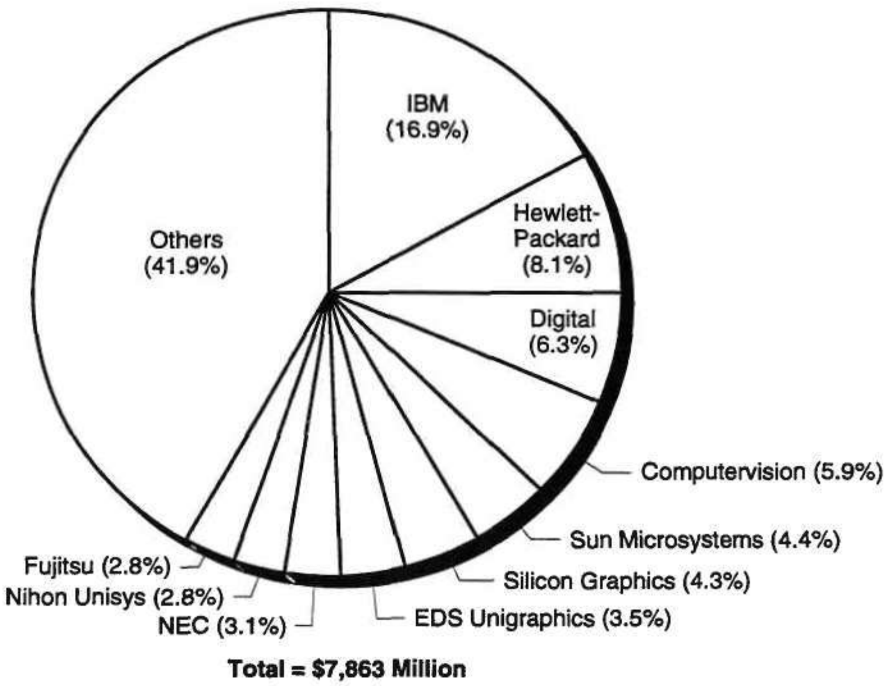
Figure 6-6
Worldwide Top 10 Market Share, by Total Revenue



Source: Dataquest (November 1994) G4006058

Top 10 Market Share, by Software Revenue

Figure 6-7 shows the market share held by the top 10 companies, according to software revenue, for all platforms.

Top 10 Market Share, by Hardware Revenue

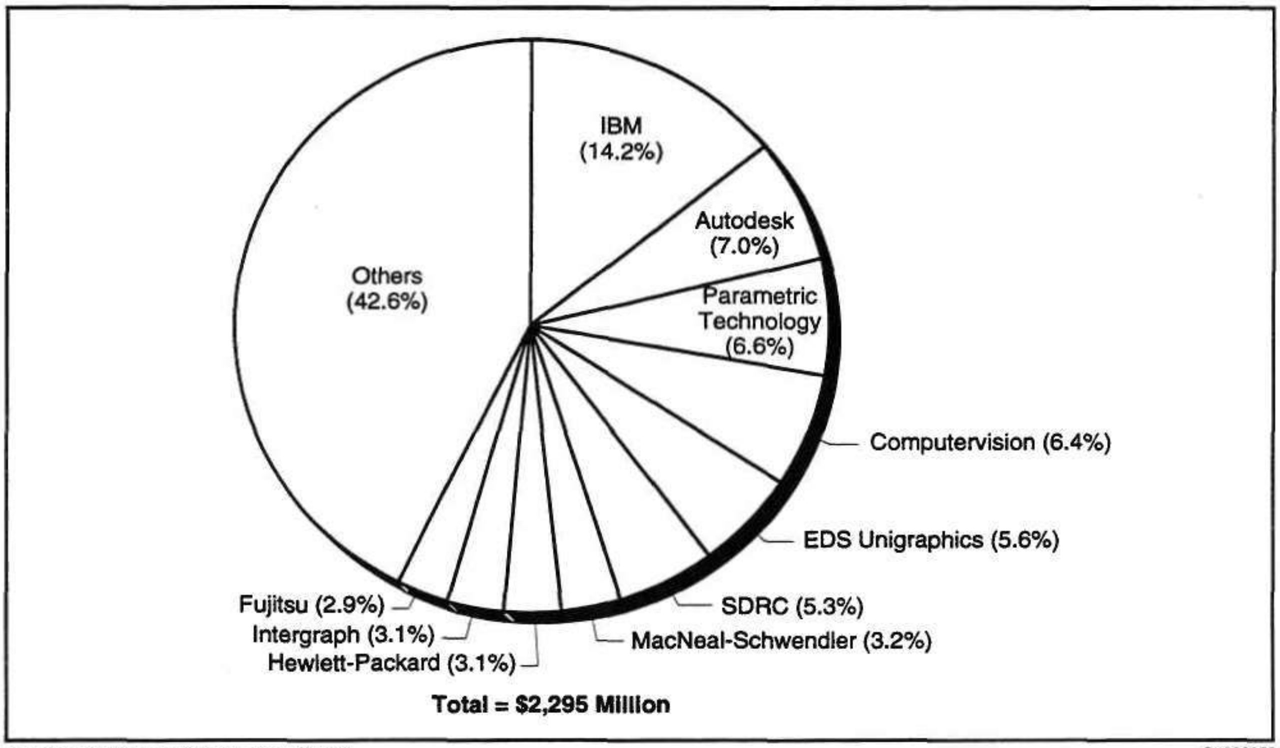
Figure 6-8 shows the market share held by the top 10 companies, according to hardware revenue, for all platforms.

Top 10 Market Share, in Major Market Segment

Figures 6-9 through 6-14 highlight and recognize the leading vendors around the world in each major market segment and in several selected segments of special interest.

- Asian software revenue—All platforms
- Asian hardware revenue—All platforms
- European software revenue—All platforms
- European hardware revenue—All platforms
- North American software revenue—All platforms
- North American hardware revenue—All platforms

Figure 6-7
Worldwide Top 10 Market Share, by Software Revenue (All Platforms)



Source: Dataquest (November 1994)

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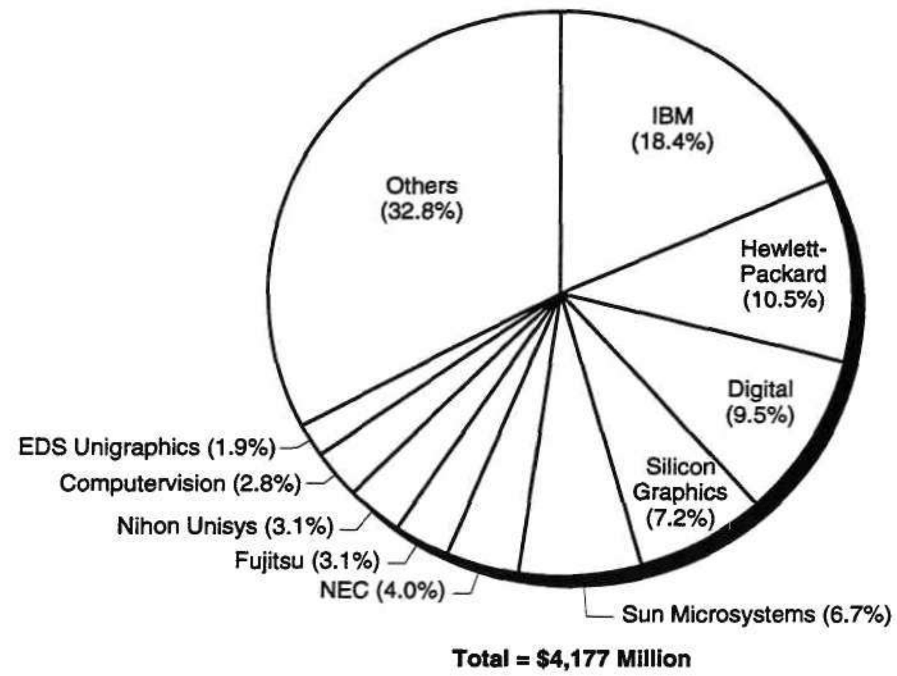
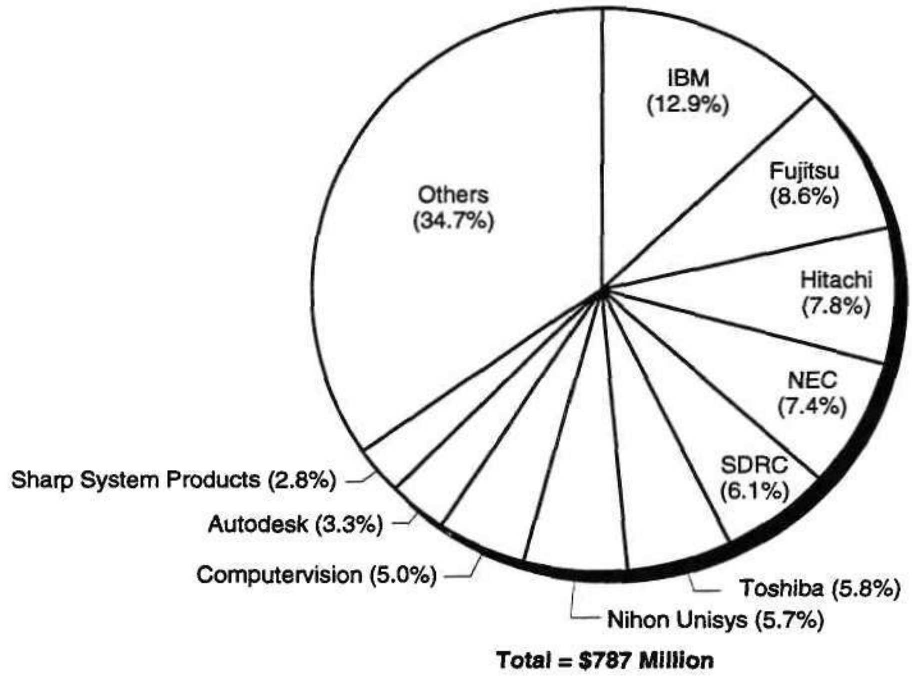
Figure 6-8
Worldwide Top 10 Market Share, by Hardware Revenue (All Platforms)



Source: Dataquest (November 1994) G4006060

Figure 6-9
Asian Top 10 Market Share, by Software Revenue (All Platforms)



Source: Dataquest (November 1994)

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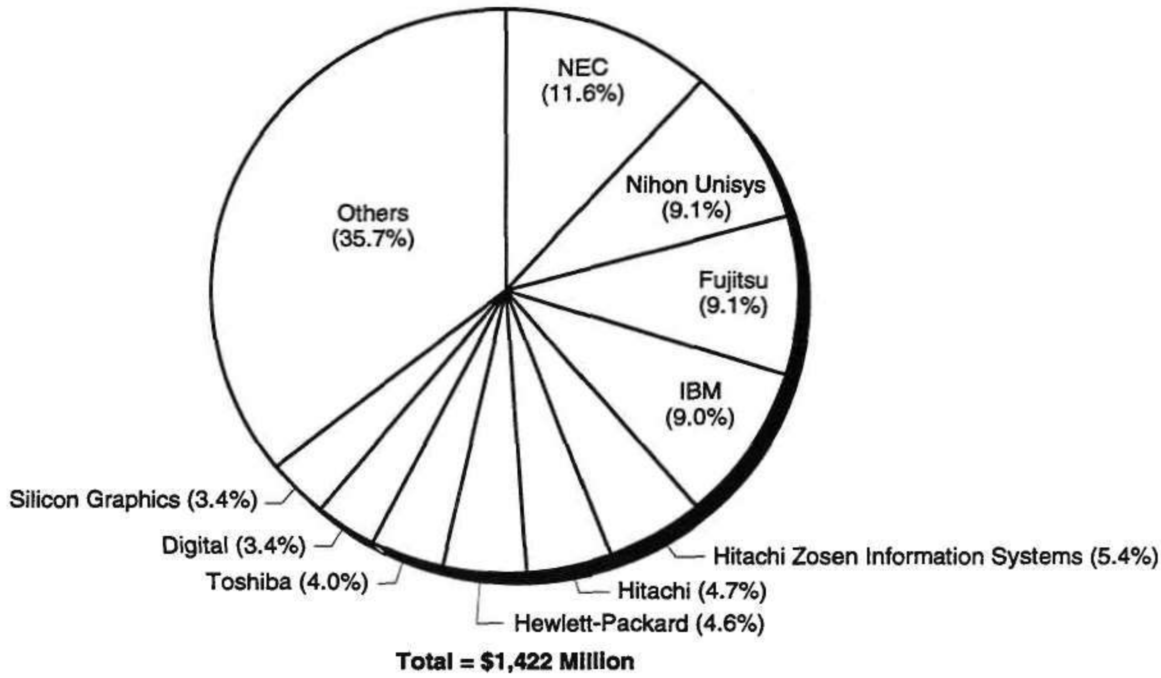
Figure 6-10
Asian Top 10 Market Share, by Hardware Revenue (All Platforms)



Source: Dataquest (November 1994)

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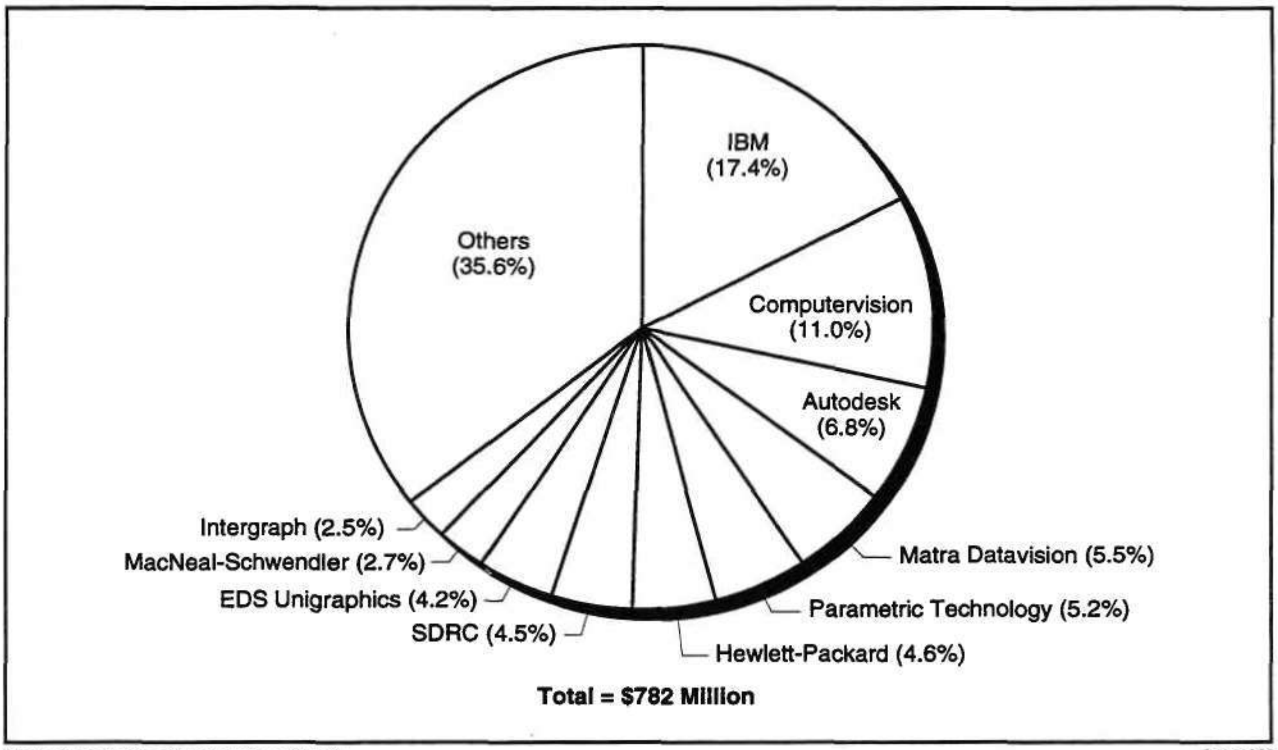
Figure 6-11
European Top 10 Market Share, by Software Revenue (All Platforms)



Source: Dataquest (November 1994)

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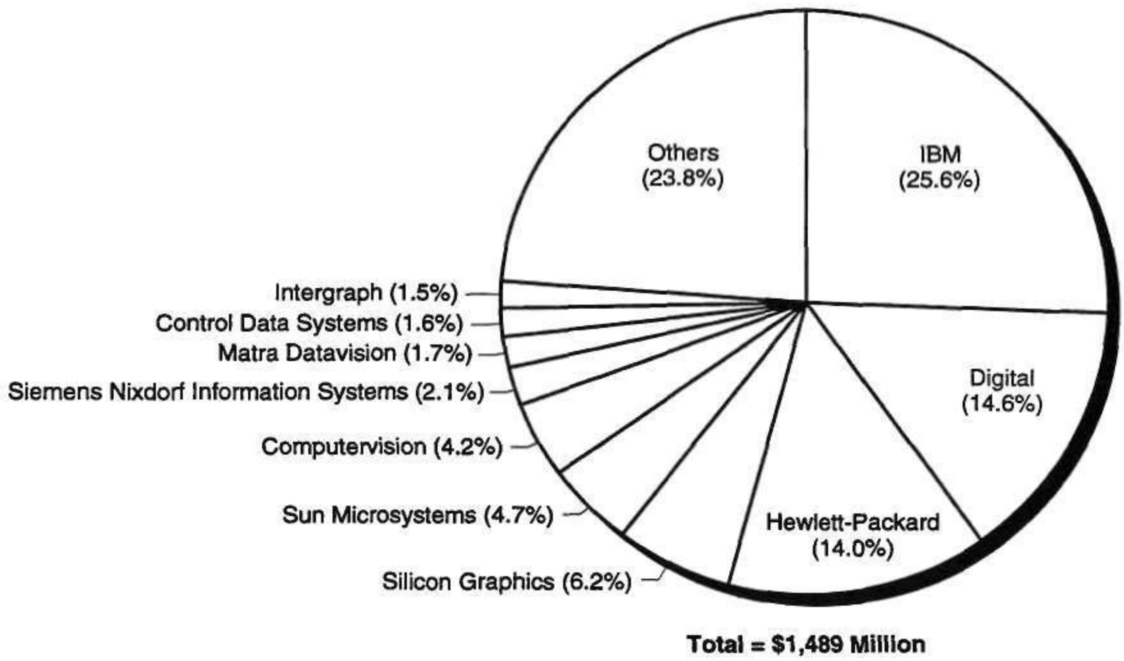
Figure 6-12
European Top 10 Market Share, by Hardware Revenue (All Platforms)



Source: Dataquest (November 1994)

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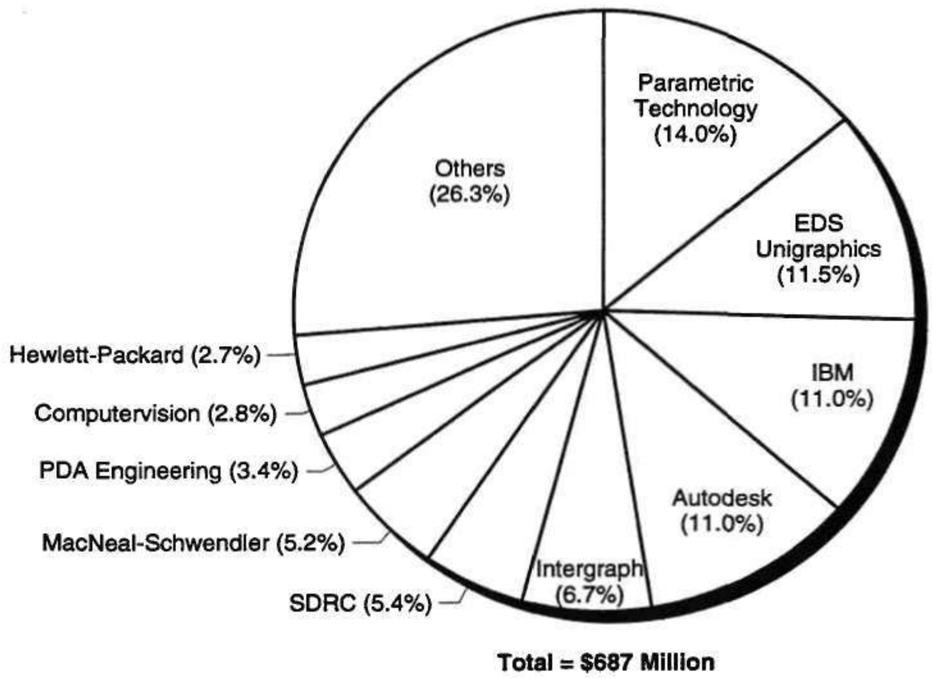
Figure 6-13
North American Top 10 Market Share, by Software Revenue (All Platforms)



Source: Dataquest (November 1994)

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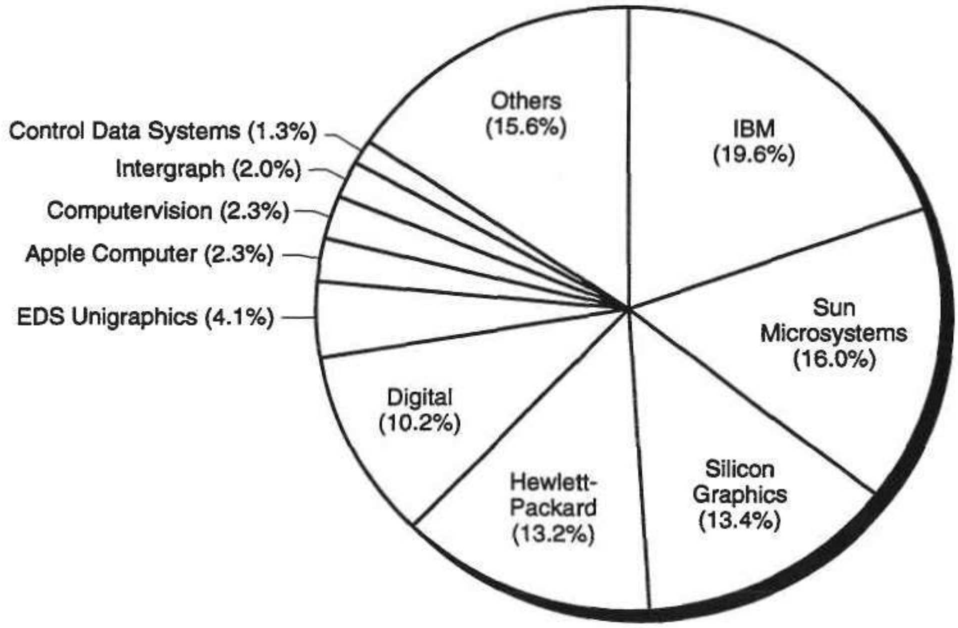
Figure 6-14
North American Top 10 Market Share, by Hardware Revenue (All Platforms)



Source: Dataquest (November 1994)

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Appendix A
Market Statistics—Mechanical CAD/CAM/CAE

Table A-1 shows the worldwide market leaders for all platforms.

Table A-1
Worldwide Market Leaders, All Platforms

Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Market Share (%) Total Factory Revenue	Market Share (%) Hardware Revenue	Market Share (%) Software Revenue	Market Share (%) Hardware Units Shipped
IBM	1,331.0	767.9	325.5	43,265	16.9	18.4	14.2	14.3
Hewlett-Packard	634.9	437.2	70.8	25,059	8.1	10.5	3.1	8.3
Digital	498.2	395.2	0.1	19,094	6.3	9.5	0	6.3
Computervision	465.3	115.7	147.5	6,143	5.9	2.8	6.4	2.0
Sun Microsystems	346.1	277.9	0	12,837	4.4	6.7	0	4.2
Silicon Graphics	335.1	300.1	0	10,285	4.3	7.2	0	3.4
EDS Unigraphics	274.7	80.3	129.2	4,735	3.5	1.9	5.6	1.6
NEC	245.8	165.4	58.4	11,515	3.1	4.0	2.5	3.8
Fujitsu	219.9	128.9	67.4	8,751	2.8	3.1	2.9	2.9
Nihon Unisys	218.2	129.2	44.5	1,014	2.8	3.1	1.9	0.3
Parametric Technology	184.1	0	151.0	0	2.3	0	6.6	0
Intergraph	179.0	51.5	70.5	2,218	2.3	1.2	3.1	0.7
SDRC	177.0	0	120.7	0	2.3	0	5.3	0
Autodesk	160.2	0	160.2	0	2.0	0	7.0	0
Hitachi	143.6	67.5	61.8	6,076	1.8	1.6	2.7	2.0
Toshiba—No OEM	113.3	56.7	45.3	3,663	1.4	1.4	2.0	1.2
Hitachi Zosen Info Systems	89.8	76.1	4.4	865	1.1	1.8	0.2	0.3
Matra Datavision	88.4	29.7	49.8	1,596	1.1	0.7	2.2	0.5
Control Data Systems	82.2	42.2	16.8	1,177	1.0	1.0	0.7	0.4
MacNeal-Schwendler	76.2	0	74.1	0	1.0	0	3.2	0
Applicon	70.0	23.1	27.4	792	0.9	0.6	1.2	0.3
Siemens Nixdorf Info systeme	64.3	31.7	12.1	2,993	0.8	0.8	0.5	1.0
Apple Computer	59.5	59.6	0	14,158	0.8	1.4	0	4.7
Mitsubishi Electric	50.3	39.3	6.3	795	0.6	0.9	0.3	0.3
Kubota Computer	45.0	34.2	7.2	515	0.6	0.8	0.3	0.2
Hakuto	43.1	25.4	17.6	1,006	0.5	0.6	0.8	0.3

(Continued)

Table A-1 (Continued)
Worldwide Market Leaders, All Platforms

					Market Share (%)			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Sharp System Products—No OEM	43.0	20.7	22.3	398	0.5	0.5	1.0	0.1
Mutoh Industries—No OEM	42.5	26.4	12.8	1,146	0.5	0.6	0.6	0.4
PDA Engineering	41.9	0	39.4	0	0.5	0	1.7	0
Technodia	37.9	30.3	0.4	425	0.5	0.7	0	0.1
Investronica SA	31.5	19.7	8.3	1,077	0.4	0.5	0.4	0.4
Cimatron	30.9	13.6	14.0	1,040	0.4	0.3	0.6	0.3
Graftek	30.7	12.6	11.6	938	0.4	0.3	0.5	0.3
Cisigraph	30.3	8.2	16.0	452	0.4	0.2	0.7	0.1
Swanson Analysis	30.1	0	26.7	0	0.4	0	1.2	0
ASCAD/ASCAM	28.2	16.7	8.7	436	0.4	0.4	0.4	0.1
Delcam International	28.1	9.7	12.2	363	0.4	0.2	0.5	0.1
Gerber Systems	26.8	12.6	11.5	433	0.3	0.3	0.5	0.1
Alias Research	26.5	0	24.4	0	0.3	0	1.1	0
Straessle Informationssysteme	25.7	4.1	15.7	421	0.3	0.1	0.7	0.1
Tokyo Electron—No OEM	25.6	8.7	11.3	124	0.3	0.2	0.5	0
CAD Lab	24.7	7.6	11.4	580	0.3	0.2	0.5	0.2
Cimlinc	23.5	1.0	11.7	55	0.3	0	0.5	0
Andor	23.1	5.1	17.1	421	0.3	0.1	0.7	0.1
Toyo Information Systems—No OEM	23.0	13.7	6.9	258	0.3	0.3	0.3	0.1
Mitsui Engineering	22.1	15.3	4.5	178	0.3	0.4	0.2	0.1
Marcus Computer Systeme	22.1	11.3	7.6	400	0.3	0.3	0.3	0.1
Kozo Keikaku Engineering	21.6	1.3	5.8	40	0.3	0	0.3	0
ADRA Systems	21.0	0.3	16.2	20	0.3	0	0.7	0
ISD Software	20.6	4.3	13.0	682	0.3	0.1	0.6	0.2
Wiechers Datentechnik	18.2	3.9	10.7	327	0.2	0.1	0.5	0.1
ICAD	17.5	0	14.1	0	0.2	0	0.6	0

(Continued)

Table A-1 (Continued)
Worldwide Market Leaders, All Platforms

					Market Share (%)			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Radan Computational	17.4	5.9	8.7	349	0.2	0.1	0.4	0.1
Sony	16.6	16.6	0	823	0.2	0.4	0	0.3
Digital Kienzle	16.4	8.2	4.6	248	0.2	0.2	0.2	0.1
Auto-Trol	16.1	5.5	6.5	199	0.2	0.1	0.3	0.1
Graphtec Engineering	15.3	7.5	7.0	404	0.2	0.2	0.3	0.1
Rasna Corporation	14.2	0	12.8	0	0.2	0	0.6	0
MARC	14.1	0	13.4	0	0.2	0	0.6	0
Tebis	13.7	3.6	2.1	92	0.2	0.1	0.1	0
Mechanical Dynamics	13.3	0	10.8	0	0.2	0	0.5	0
MCS	12.0	0.5	10.2	66	0.2	0	0.4	0
CADKEY	11.8	0	10.9	0	0.1	0	0.5	0
Adam Net	11.5	6.6	3.6	14	0.1	0.2	0.2	0
Isicad CAD/CAM Systeme	11.5	4.0	4.6	195	0.1	0.1	0.2	0.1
Omron	11.5	5.7	4.6	255	0.1	0.1	0.2	0.1
Exapt	10.9	5.2	3.8	210	0.1	0.1	0.2	0.1
Point Control	10.1	0	8.0	0	0.1	0	0.3	0
ICL	10.0	5.8	3.4	287	0.1	0.1	0.1	0.1
Framasoft + CSI	9.7	0.3	4.4	20	0.1	0	0.2	0
CAMAX Systems Inc.	9.6	0.9	6.1	88	0.1	0	0.3	0
PAFEC	8.6	2.6	4.9	107	0.1	0.1	0.2	0
Design Automation	8.6	1.8	6.5	295	0.1	0	0.3	0.1
ItalCad	8.4	2.4	3.5	185	0.1	0.1	0.2	0.1
Han Dataport	8.4	2.3	4.3	255	0.1	0.1	0.2	0.1
CADIX	8.3	3.6	4.1	46	0.1	0.1	0.2	0
Engineering Mechanics	8.1	0.6	7.0	42	0.1	0	0.3	0
Wacom	8.1	1.6	5.7	261	0.1	0	0.2	0.1

(Continued)

Table A-1 (Continued)
Worldwide Market Leaders, All Platforms

					Market Share (%)			
Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped
Sumitomo Denko Workstation	7.9	7.9	0	855	0.1	0.2	0	0.3
CNC Software	7.3	0	7.3	0	0.1	0	0.3	0
Ricoh—No OEM	7.2	0	6.1	0	0.1	0	0.3	0
Algor Interactive Systems	6.5	0	5.7	0	0.1	0	0.2	0
Ziegler Informatics	6.1	0	6.1	0	0.1	0	0.3	0
Serbi	5.1	0.6	4.5	200	0.1	0	0.2	0.1
CADSI	4.9	0.6	3.8	30	0.1	0	0.2	0
Moda CAD	4.7	1.0	3.3	46	0.1	0	0.1	0
Technische Computer Systeme	4.6	0.9	3.3	87	0.1	0	0.1	0
American Small Business Comp.	4.6	0	4.6	0	0.1	0	0.2	0
Whessoe Computing Systems	4.4	0	4.4	0	0.1	0	0.2	0
CAD Distribution	4.1	0.1	3.6	22	0.1	0	0.2	0
Pathtrace Engineering Systems	3.9	0.8	2.1	101	0.1	0	0.1	0
Anilam Electronics	3.9	0.7	2.8	46	0	0	0.1	0
Micrografx	3.6	0	3.6	0	0	0	0.2	0
Vero International Software	3.4	0	3.1	0	0	0	0.1	0
FEA	3.3	0.7	0.9	198	0	0	0	0.1
RoboCAD Solutions	3.3	0	2.6	0	0	0	0.1	0
Foresight Resources	3.1	0	2.9	0	0	0	0.1	0
debis Systemhaus	3.1	0.7	2.0	22	0	0	0.1	0
Superdraft	2.9	1.3	1.3	208	0	0	0.1	0.1
Century Research Center	2.9	1.5	1.1	14	0	0	0	0
CATALPA groupe Missler	2.8	1.2	1.2	84	0	0	0.1	0
Kloeckner-Moeller	2.8	0.6	1.9	0	0	0	0.1	0
Caroline Informatique	2.7	0.5	1.4	27	0	0	0.1	0
FEGS	2.2	0	0.9	0	0	0	0	0

(Continued)

Table A-1 (Continued)
Worldwide Market Leaders, All Platforms

Company	Total Factory Revenue	Hardware Revenue	Software Revenue	Hardware Units Shipped	Market Share (%) Total Factory Revenue	Market Share (%) Hardware Revenue	Market Share (%) Software Revenue	Market Share (%) Hardware Units Shipped
ISKA	2.1	0.9	0.9	39	0	0	0	0
Computational Mechanics	2.1	0	2.1	0	0	0	0.1	0
SPATIAL Technology	2.1	0	0	0	0	0	0	0
CAD Centre	2.0	0	1.7	0	0	0	0.1	0
Uchida Yoko	2.0	1.2	0.7	53	0	0	0	0
CAMTEK	1.8	0.4	1.2	159	0	0	0.1	0.1
Softronics	1.6	0.3	1.3	123	0	0	0.1	0
Evolution Computing	1.5	0	1.5	0	0	0	0.1	0
Ashlar	1.4	0	0	0	0	0	0	0
Valisys	1.3	0	0	0	0	0	0	0
Claris	1.2	0	1.2	0	0	0	0.1	0
GRAPHSOFT	1.2	0	1.2	0	0	0	0.1	0
Kreon	1.0	0.5	0.2	19	0	0	0	0
Zuken	1.0	0.3	0.5	6	0	0	0	0
Other Companies	513.0	481.0	17.6	107,822	6.5	11.5	0.8	35.5
All Companies	7,862.7	4,176.5	2,294.7	303,364	100.0	100.0	100.0	100.0
All N.A.-Based Companies	5,734.8	3,052.1	1,579.3	246,330	72.9	73.1	68.8	81.2
All Asian-Based Companies	1,532.8	909.3	445.9	40,649	19.5	21.8	19.4	13.4
All European-Based Companies	595.1	215.1	269.5	16,385	7.6	5.2	11.7	5.4
All Hardware Companies	2,335.7	2,059.2	0	218,526	29.7	49.3	0	72.0
All Turnkey & SW Companies	5,527.0	2,117.3	2,294.7	84,838	70.3	50.7	100.0	28.0

Source: Dataquest (November 1994)

For More Information...

Mike Seely, Director.. (408) 437-8178
Internet address .... mseely@dataquest.com
Via fax .... (408) 437-0292

0016386

Dataquest

a company of
The Dun & Bradstreet Corporation

Dataquest

a company of
The Dun & Bradstreet Corporation

Corporate Headquarters
Dataquest Incorporated
1290 Ridder Park Drive
San Jose, California 95131-2398
United States
Phone: 1-408-437-8000
Facsimile: 1-408-437-0292

Dataquest Incorporated
550 Cochituate Road
Framingham, Massachusetts 01701-9324
United States
Phone: 1-508-370-5555
Facsimile: 1-508-370-6262

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

Dataquest Korea
Trade Tower, Suite 3806
159 Samsung-dong
Kangnam-gu, Seoul 135-729
Korea
Phone: 82-2-551-1331
Facsimile: 82-2-551-1330

Dataquest Taiwan
3/F, No. 87 Sung Chiang Road
Taipei
Taiwan, R.O.C.
Phone: 886-2-509-5390
Facsimile: 886-2-509-5660

European Headquarters
Dataquest Europe Limited
Holmers Farm Way
High Wycombe, Buckinghamshire
HP12 4UL
England
Phone: 44-494-422722
Facsimile: 44-494-422742

Dataquest GmbH
Kronstadter Strasse 9
81677 München
Germany
Phone: 49-89-930-9090
Facsimile: 49-89-930-3277

Dataquest Europe SA
Tour Franklin
Cedex 11
92042 Paris-La-Défense
France
Phone: 33-1-41-25-18-00
Facsimile: 33-1-41-25-18-18

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

Representative Agencies in
Bangkok, Hong Kong,
Kronberg, North Sydney,
Singapore, and Tel Aviv

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Mechanical Applications Worldwide

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Software

Mechanical Applications Worldwide

User Wants and Needs

1994

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Chapter 1
Executive Summary

Dataquest forecasts the worldwide market for mechanical CAD/CAM/CAE tools to grow at a 6 percent compound annual growth rate (CAGR) during the next five years. The worldwide market for mechanical CAD/CAM/CAE software revenue was $2.3 billion in 1993; in Japan, this market reached $723 million. Growth is being fueled by the perception that this technology is indispensable in a design and manufacturing environment, independent of industry or region. CAD/CAM/CAE tools are no longer limited to the experts; these tools are now being used by employees in every job description and for hundreds of applications across the enterprise. The forces of downsizing are playing a significant role in forming changes in market penetration. This report explores the market for CAD/CAM/CAE tools in Japan, draws comparisons to the U.S. and European markets, and identifies future trends within this industry.

The diversity of tasks considered under the mechanical CAD/CAM/CAE umbrella is immense. All major subapplications are explored in this survey to better understand the work profile and market penetration in each industry.

Today's purchaser of CAD/CAM/CAE tools is dealing with a complexity of issues and technologies that was unimaginable a decade ago. Several issues measuring user importance and satisfaction evaluations are explored in this survey, from high-level strategic business issues to application and module integration issues. Easy-to-use software with strong vendor support will continue to motivate the mainstream buyer of CAD/CAM/CAE tools in Japan.

Study Objectives

Dataquest's goal is to provide a comprehensive understanding of the mechanical CAD/CAM/CAE market by collecting and analyzing data from vendor and end-user perspectives. This study examines the mechanical CAD/CAM/CAE market from the perspective of purchasers and managers of these resources in a corporate setting. The respondents for this survey were all Japanese companies.

Last year, Dataquest had completed a survey of U.S. and European CAD/CAM/CAE end users. Because of the similarity between the two surveys, we now have a worldwide database of end-user preferences and responses upon which to draw conclusions. The two surveys we conducted were nearly identical, with only slight changes made to the Japanese survey in order to capture trends that are specific to Japanese-based end users. In this report, we make comparisons and highlight differences on a regional basis wherever appropriate.

This study was designed with two broad objectives in mind:

- To provide a status report on the current work environment in Japan and to point to selected opportunities in sales and product development
- To compare and contrast end-user responses and to identify trends on a worldwide basis that includes Japan, the United States, and Europe

The specific study objectives include the following:

- Identify the demographic characteristics of today's mechanical CAD/CAM/CAE end users' implementation levels, experience base, and staffing expectations
- Determine the current work environment considering applications used, mechatronic activity, data file storage, and leading vendor analysis by subapplication
- Evaluate penetration of user access and use of mechanical subapplications
- Develop a forecast of planned purchases in platform, system peripherals, software modules, and modeling technologies
- Understand the level of outside consulting services used and planned in the next two years
- Identify the levels of highest need or missed expectations by using gap analysis of user-rated importance and satisfaction on a variety of business, system, and application issues

Major Findings

The major findings of this survey include the following:

- Many users are seasoned veterans, with the majority having more than five years of experience using mechanical CAD/CAM/CAE tools. Many users have learned three products or more, and have plans to learn approximately two more products during the next two years. The anticipated rate of learning new products is nearly twice that seen in the United States and Europe.
- The sites surveyed do more than just mechanical CAD/CAM/CAE design activity. Some mechanical CAD/CAM/CAE sites are doing electronic design, facilities design and management, and architecture/engineering/construction design activity. Training and education departments typically do electronic design work.
- About one-half of all mechanical design activity is mechanical only, and one-half of mechanical design activity is directed toward parts or products with electronic content. The leading industries for mechatronics work include the industrial machinery, consumer electronics, and computers and peripherals industries.

- All sites have a mix of 2-D, 3-D wireframe/surface and solid model files, although the proportion of 3-D wireframe/surface and solid models is growing slowly as the use of these tools increases. Use of solid modeling is lower in Japan than in the United States and Europe, although some industries (like the Japanese automotive industry) have a much greater percentage of 3-D files.
- No one vendor dominates all of the subapplications in the Japanese mechanical CAD/CAM/CAE industry, and few Japanese vendors appear in the top five subapplication listings.
- Less than 20 percent of respondents either have a product data management (PDM) system in place or have plans for one. The most promising use of PDM is seen in the electrical and electronic industry. The service/design/consulting industry lags far behind the rest of the end users in PDM plans.
- In an ideal situation, where a system is cheap, fast, and easy to use, those sites with a seat count increase anticipate a 43 percent increase in the number of users. The small group expecting a seat count decrease under these ideal conditions believes that it could live with 23 percent less users than it currently has. The labor-intensive work style of drafting-only CAD tools, commonly used in the Japanese market, is a fundamental issue contributing to this evaluation.
- Under ideal conditions, detail drafting is the subapplication having the largest unmet need, with a possible growth rate of 63 percent. Thermal analysis is next, with a substantially smaller anticipated growth rate of 17 percent. Specific subapplications for the service/design/consulting and electrical and electronic industries show high expected growth rates.
- Japan has tended to use fewer outside consulting services than the United States or Europe and plans to use fewer such services in the future.
- The purchase of new seats in the last two years in Japan was led by the PC platform and closely followed by technical workstation-based products. Mainframe-based solutions are falling in interest overall.
- The best market for servers are automotive, electrical and electronic, and industrial machinery sites.
- Printers and plotters are not expected to fare well in any industry, with the exception of automotive sites.
- Overall, approximately 60 percent of sites are anticipating an increase in seat count, and only 3 percent are anticipating a decrease. Of those anticipating an increase, the average annual rate during the next two years is 18 percent. Sites with an increasing seat count are planning on replacing 6 percent of the installed software modules.

- While 75 percent of respondents expect 3-D design to become the main method of design in the next two years, 63 percent of respondents already use some kind of 3-D CAD/CAM/CAE tools in their work. Automotive sites have the highest use of 3-D systems. The response rate for an integrated 2-D, 3-D, and solids-based solution varied widely by industry.
- Interest in using the STEP standard was reported by nearly 60 percent of sites, with the automotive industry leading the way.
- A gap analysis is a classic way to evaluate the relative importance and level of satisfaction among a number of related issues. It is important to note that for all software-related issues, the gap between the level of importance and the level of satisfaction is large to very large.
- The highest-rated importance items include the following:
  - Lowering design costs
  - Having an access to very easy to learn software
  - Supporting the design function
  - Supporting design manufacturing and combined design, analysis, drafting, and manufacturing
  - Supporting IGES and high-performance 3-D graphics
- The users are not happy with the ability of their automation tools to provide competitive advantage at the strategic level. Usually a gap of more than one on the scale of one to five in this type of analysis is viewed as significant. Nearly every one of these issues has a gap of more than one. Vendors with high-cost, difficult-to-use software should beware.
- The integrated system and the design/manufacturing combination garnered the highest rating of importance, while the use of CAD in a standalone mode in manufacturing received a lower rating. This suggests that the importance of the link to manufacturing is highly regarded. Japanese manufacturing companies are, in fact, more interested in a well integrated system with strong links to the manufacturing processes than U.S. or European end users.
- The most important issues, and the one with the highest gap indicating a low level of satisfaction, concern software quality. As users develop a higher reliance on the use of these tools, hard-fought gains in productivity can be quickly wiped out with buggy software, corrupted data files, and weak interface among modules. We believe that this issue could be the most serious in the minds of the users when it comes to making a future purchasing decision.

Methodology

This survey focuses on a set of respondents selected from a filtered but random population. More than 630 sites were selected in Japan. This large sample size is the result of over 6,000 surveys mailed to a list of vendor-supplied names. The interest level in answering the survey was high, as users in Japan have not been surveyed as much as those in the United States or Europe. Site size was not controlled nor was industry. The result gives a broad representation across the user environment.

The specific respondent sample characteristics desired include the following:

- People involved in the decision-making process of new system purchases
- Those who are currently or have been users of mechanical CAD/CAM/CAE tools
- People working in a major discrete manufacturing industry
- Employees in one of the major departments of potential use

We suggest that users of this information evaluate the results at two levels: first, consider the total group of respondents, and second, identify specific user groups or market segments of interest. The figures and tables in this report provide an overview analysis of each major topic of interest.

Several subsegments have been used throughout this report to highlight various points of analysis. These segments are divided by the following:

- Department of the person answering the questions
- Industry designation of the responding site
- Size of site based on the number of mechanical CAD/CAM/CAE users at that site

Custom Analysis

A follow-up study is offered as a consulting project for specific vendors that would like to make a more detailed analysis of this survey database. Analysis can be made by cross-tabulations of any group or market segment. Fees are based on a reasonable time and material usage. Anyone interested in such an analysis should contact Michael Seely at (408) 437-8178 or mseely@dataquest.com. User requests for anonymity will be honored.

Structure of Report

This report is divided into five major analysis sections—Site and Respondent Demographics, Current Work Environment, Penetration, Buying History and Plans, and Importance and Satisfaction Evaluation. These are preceded by an Executive Summary and succeeded by Findings and Recommendations. The figures show an overview analysis of survey results whereas the tables have more detailed information showing the variation of responses by submarket or user-group segment. In total, 638 interviews were completed.

Project Analysts: Michael J. Seely, Tamio Fukuda, and Sharon Tan

Chapter 2
Site and Respondent Demographics

The target respondents in this study are purchasing decision makers of mechanical CAD/CAM/CAE tools in Japan. There were a wide range of respondent job titles from all major departments in all major manufacturing industries.

Respondents' Role in Their Organizations

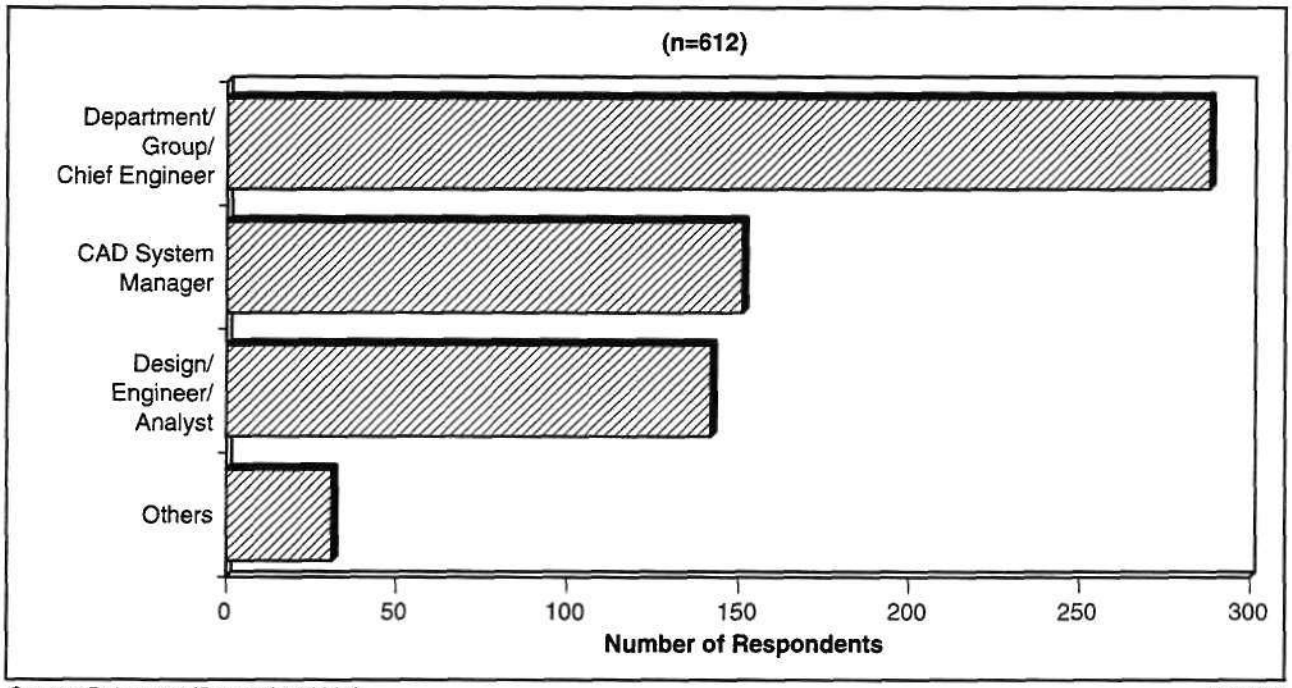
The majority of respondents to this survey hold the title of department, group, or chief engineer, followed by CAD system managers and the group of designers, engineers, and analysts. These respondent job classifications provide good insight into use of equipment, budgets, and site penetration levels. Table 2-1 shows the population of Japanese survey respondents, along with the population of survey respondents from our earlier U.S. and European survey, which was dominated by CAD system managers. Sufficient responses were given in each of these major job-title groups shown in Figure 2-1 to allow comparison among groups, providing further insight into the decision-making process and work environment in mechanical CAD/CAM/CAE.

Table 2-1
Respondents' Job Function

	Japan	United States	Europe
CAD System Manager	151	55	105
Department/Group/Chief Engineer	288	58	60
Designer/Engineer/Analyst	142	73	14
Others	31	14	22
Total	612	200	201
Distribution by Job Title (Percent)			
CAD System Manager	24.7	27.5	52.2
Department/Group/Chief Engineer	47.1	29.0	29.9
Designer/Engineer/Analyst	23.2	36.5	7.0
Others	5.1	7.0	10.9

Source: Dataquest (September 1994)

Figure 2-1
Respondents' Job Function



Source: Dataquest (September 1994)
G4004629

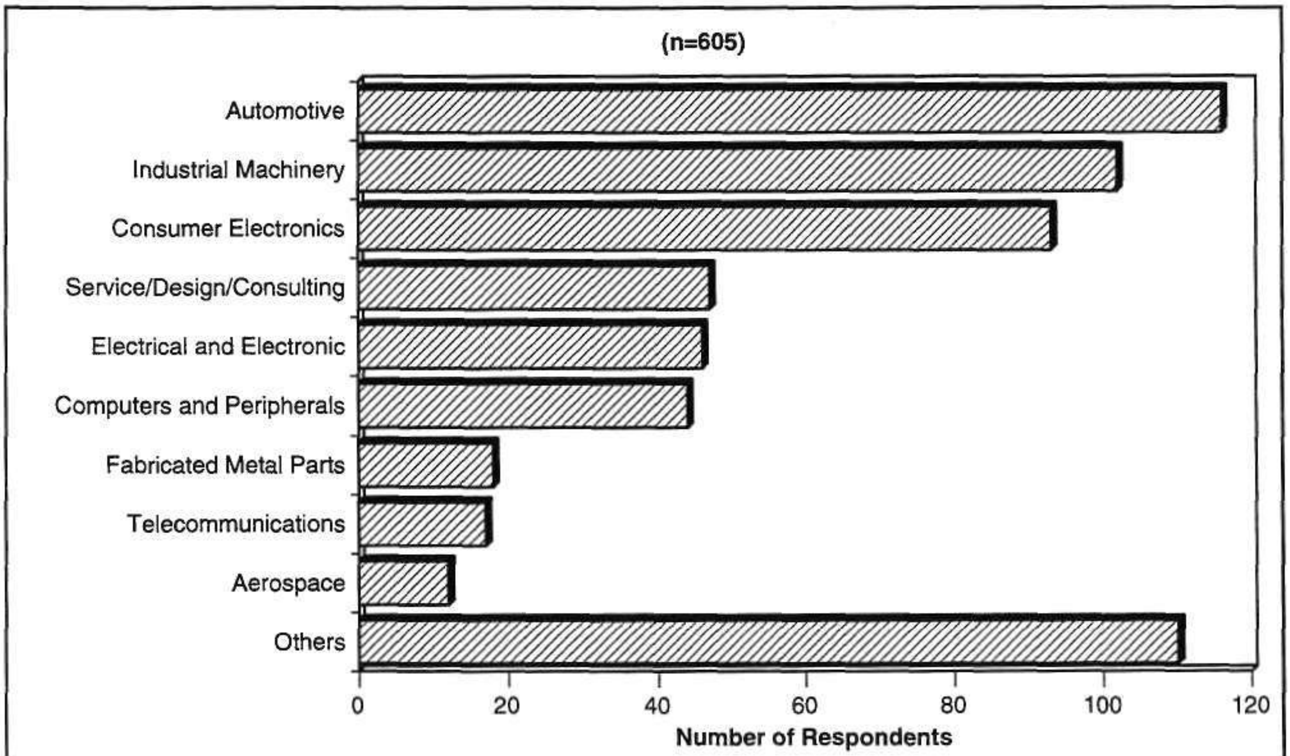
Respondents by Industry

Figure 2-2 and Table 2-2 show the distribution of the respondents' companies by industry. Almost all categories had sufficient responses to allow for a statistically valid comparison among industries. Comparison is made in the automotive, computers and peripherals, consumer electronics, electrical and electronic, industrial machinery, and service/design/consulting industries. The aerospace, fabricated metal parts, and telecommunications industries did not have a sufficient number of responses to be examined from an industry perspective. The relatively small size of these industries in Japan correlates with the low response rate. Responses from these groups, however, are included when looking at the aggregate survey data. The education and government sectors were intentionally excluded from this survey primarily because of the interest in comparing discrete manufacturing engineering activities.

Respondents by Department

Figure 2-3 and Table 2-3 show the distribution of responses by department. The R&D/new product development group was the largest, followed closely by product engineering. Very few respondents were in training and education. This is in contrast to our U.S./European survey, in which the largest group of respondents came from design and computing services.

Figure 2-2
Respondents' Primary Business



Source: Dataquest (September 1994) G4004630

Respondents' Experience

Figure 2-4 and Table 2-4 show the range of answers to the question "How long, in years, have you been using mechanical CAD/CAM/CAE software?" The average was 5.7 years, compared with 7.4 years from our U.S./European survey. Table 2-5 illustrates respondents' experience by department. No important distinction is made here other than that the Japanese respondent group as a whole is well experienced with several years of hands-on use. More evidence of this is shown later when the number of software products learned, used, and expected to learn are measured.

Summary

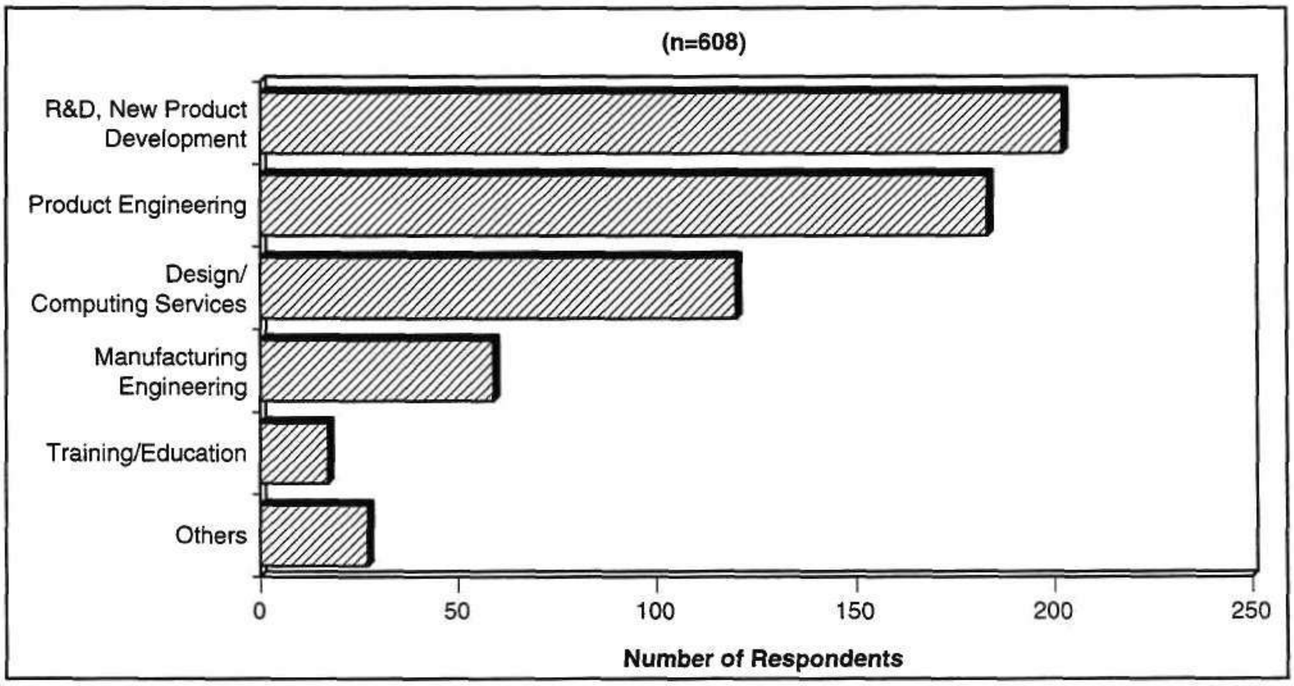
This survey group is judged to have significant experience in using mechanical CAD/CAM/CAE and should be well suited to provide the insight and opinion requested. Readers should keep in mind that the total population of this survey is dominated by department/group/chief engineers as well as a significant number of CAD system managers and designers/engineers/analysts. Most industries are well represented; in particular, automotive, industrial machinery, and consumer electronics industries have the largest number of respondents.

Table 2-2
Respondents' Primary Business

	Japan	United States	Europe
Aerospace	12	27	13
Automotive	116	18	61
Computers and Peripherals	44	5	2
Telecommunications	17	4	5
Consumer Electronics	93	7	3
Electrical and Electronic	46	32	16
Industrial Machinery	102	51	39
Fabricated Metal Parts	18	35	22
Service/Design/Consulting	47	9	17
Others	110	12	23
Total	605	200	201
Distribution by Industry (Percent)			
Aerospace	2.0	13.5	6.5
Automotive	19.2	9.0	30.3
Computers and Peripherals	7.3	2.5	1.0
Telecommunications	2.8	2.0	2.5
Consumer Electronics	15.4	3.5	1.5
Electrical and Electronic	7.6	16.0	8.0
Industrial Machinery	16.9	25.5	19.4
Fabricated Metal Parts	3.0	17.5	10.9
Service/Design/Consulting	7.8	4.5	8.5
Others	18.2	6.0	11.4

Source: Dataquest (September 1994)

Figure 2-3
Respondents by Department



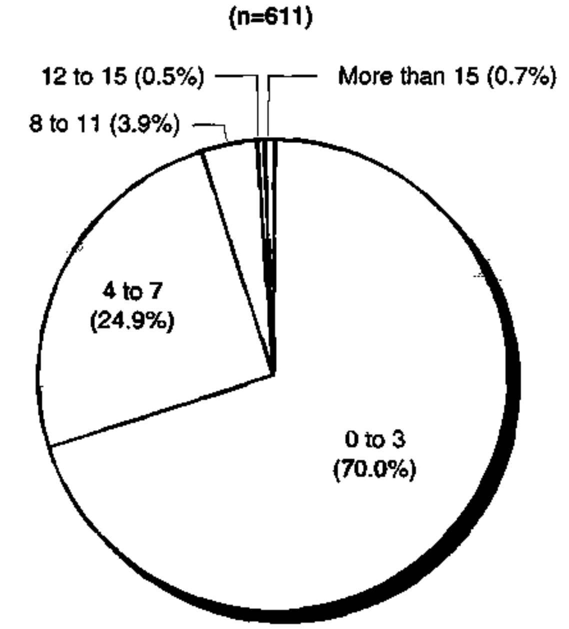
Source: Dataquest (September 1994)
G4004631

Table 2-3
Respondents by Department

	Japan	United States	Europe
Design and Computing Services	120	58	110
R&D/New Product Development	202	29	30
Product Engineering	183	75	20
Manufacturing Engineering	59	35	12
Training/Education	17	1	4
Others	27	2	24
Total	608	200	200
Distribution by Department (Percent)			
Design and Computing Services	19.7	29.0	55.0
R&D/New Product Development	33.2	14.5	15.0
Product Engineering	30.1	37.5	10.0
Manufacturing Engineering	9.7	17.5	6.0
Training/Education	2.8	0.5	2.0
Others	4.4	1.0	12.0

Source: Dataquest (September 1994)

Figure 2-4
Experience Base of Respondents



Source: Dataquest (September 1994)
G4004632

Table 2-4
Experience Base of Respondents

Years of CAD/CAM CAE Experience	Total Respondents		Total Percentage of Respondents	
	Japan	U.S. and Europe	Japan	U.S. and Europe
0	53	5	8.8	1.3
1	28	10	4.7	2.5
2	44	14	7.3	3.6
3	76	22	12.7	5.6
4	51	33	8.5	8.4
5	89	46	14.9	11.7
6	49	47	8.2	12.0
7	39	36	6.5	9.2
8	39	53	6.5	13.5
9	22	19	3.7	4.8
10	55	46	9.2	11.7
More than 10	54	62	9.1	15.8
Total	599	393	100	100

Source: Dataquest (September 1994)

Table 2-5
Respondents' Experience by Department

	Average Number of Years	
	Japan	U.S. and Europe
Training/Education	5.1	9.8
R&D and New Product Development	5.6	8.1
Design and Computing Services	5.6	7.8
Product Engineering	5.7	6.7
Manufacturing Engineering	6.2	6.9
Others	6.8	6.5
Average Experience	5.7	7.4

Source: Dataquest (September 1994)

Chapter 3
Current Work Environment

A series of questions were used to determine the overall use of all major CAD/CAM/CAE applications and to provide an understanding of the current work profile. Specific and focused questions determined the time spent in each application area, the number of files produced, the mix of mechatronic activity, and the leading vendors for each application area. For this survey, Dataquest considered the following major applications and subapplications:

- Major applications
  - Mechanical CAD/CAM/CAE
  - Electronic design
  - Facilities design and management
  - Plant engineering
  - Architecture, engineering, and construction (AEC)
  - Geographic information systems (GIS)
- Subapplications in the mechanical CAD/CAM/CAE area
  - Drafting
  - Design
  - Analysis
  - Manufacturing
  - Product data management

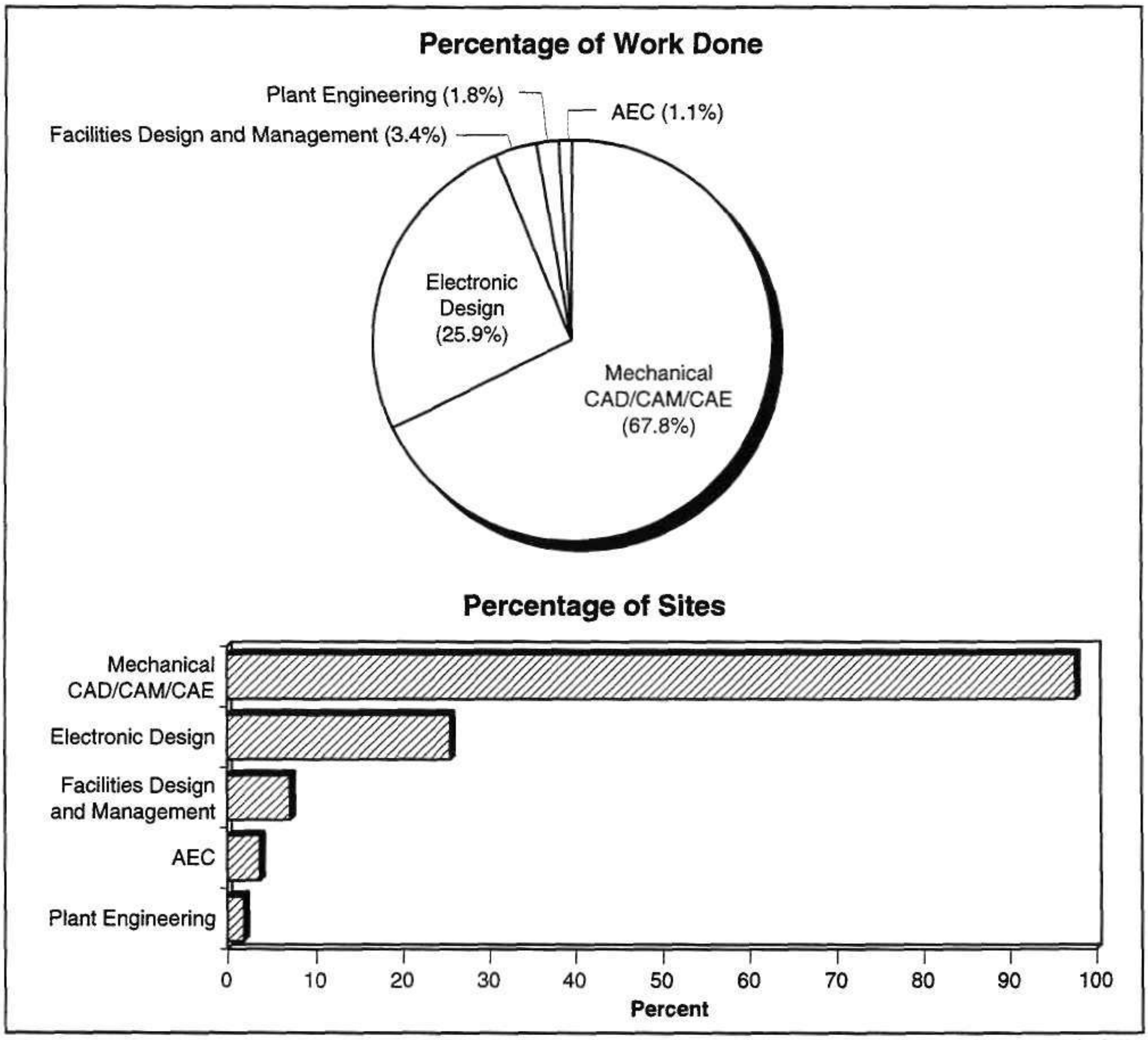
Applications Used and Target Market Opportunities by Major Application

For both the Japanese survey and the U.S./European survey, nearly 100 percent of the sites surveyed are, by definition, users of mechanical CAD/CAM/CAE tools. These sites are sometimes involved in other type of application work. Electronic design is going on at over one-quarter of the sites, and approximately 7 percent of the sites are also doing facilities design/management with their CAD/CAM/CAE tools. These results are outlined in Figure 3-1 and Table 3-1.

The distribution of actual hours of using these CAD/CAM/CAE applications is shifted toward mechanical tasks. Nearly 70 percent of the total hours spent on a system are directed toward mechanical activities. About 26 percent are electronic design, and 4 percent are for facilities and design and management tasks.

Overall, the Japanese survey shows a heavier work emphasis on using CAD/CAM/CAE applications for mechanical and electronic design, with some involvement in facilities design and management and AEC applications. In contrast, our U.S./European survey indicates more sites using multiple applications for electronic design, facilities design and management, and plant engineering.

Figure 3-1
CAD/CAM/CAE Applications Used by Site



Source: Dataquest (September 1994) G4004633

Table 3-1
CAD/CAM/CAE Applications Used by Site

	Sites Using Application (%)	Work Done with Application (%)
Mechanical CAD/CAM/CAE	97.6	67.8
Electronic Design	25.4	25.9
Facilities Design and Management	7.1	3.4
Plant Engineering	1.9	1.8
AEC	3.7	1.1
GIS	1	0

Source: Dataquest (September 1994)

Many market segments can be isolated and analyzed in this survey. We evaluated industry, company size, and department as potential interesting submarkets for all the major questions in the survey. These categories were used to find the highest use of each of the major applications. Table 3-2 illustrates the top five market segments in each major application area. Because all of the sites in this survey were chosen to answer the survey based on some use of mechanical CAD/CAM/CAE tools, we show only the other major applications in Table 3-2.

Over 80 percent of the training and education groups in the survey are involved with electronic design applications. Large sites with over 5,000 users, the automotive and consumer electronics industries, were the next most common users of mechanical and electrical applications, but to a much lesser extent.

Using CAD/CAM/CAE applications for facilities design and management work is most likely seen in the computers and peripherals industry. The use of this application in all of the other industries in the survey was very low. The data also shows that smaller sites, or those with under 100 users, more often do this kind of work.

Table 3-2
Top Five Market Segments by Application

	Percentage of Sites
Electronic Design Applications	
Training and Education	81.9
More than 5,000 Users	36.7
Automotive	20.1
Consumer Electronics	20.1
Other, Department	19.0
Facilities Design and Management Applications	
Computers and Peripherals	50.4
Other, Applications	12.0
Sites with 10 to 19 Users	9.9
Sites with 50 to 99 Users	7.7
Sites with 1 to 9 Users	7.6
AEC Applications	
Other, Applications	11.6
Sites with 20 to 49 Users	9.9
Sites with 1 to 9 Users	8.3
Sites with 50 to 99 Users	6.4
Service/Design/Consulting	4.6

Source: Dataquest (September 1994)

Architecture, engineering, and construction work is typically seen at smaller sites (those with under 100 users) and the service/design/consulting industry. This result is not a surprise.

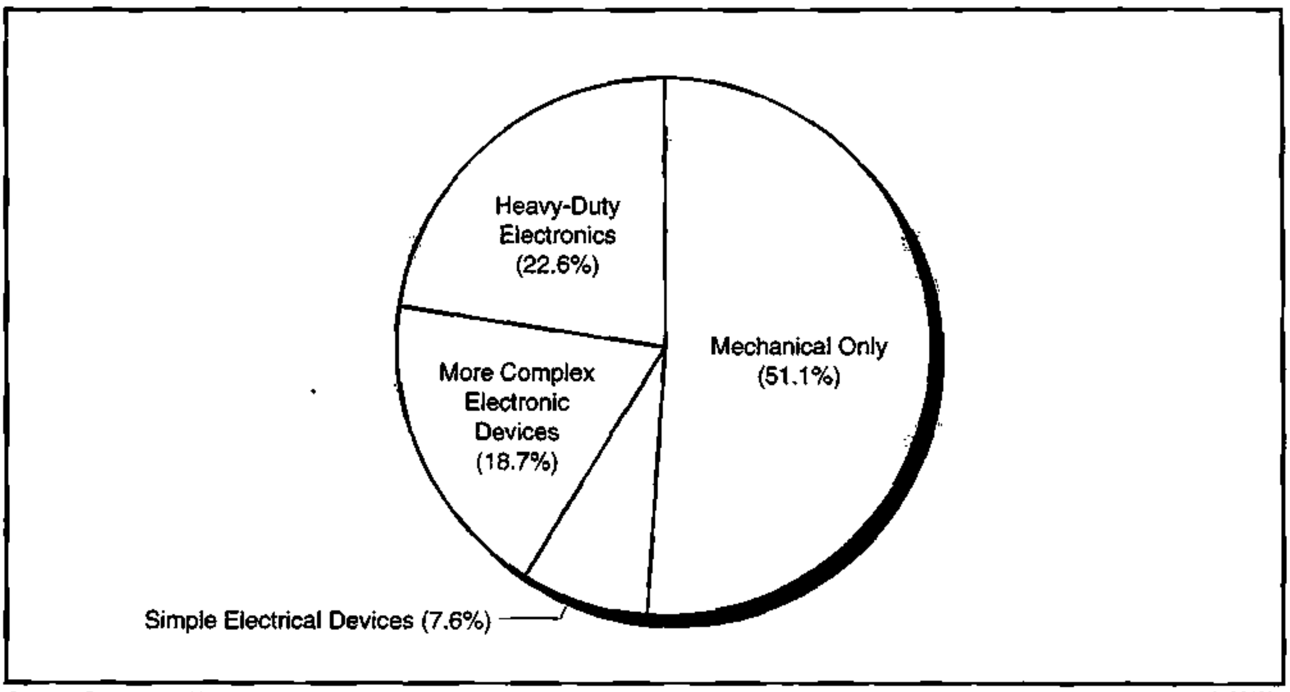
Mechatronics Activity and Target Market Opportunities

Mechatronics, or electromechanical applications, combine mechanical and electrical and electronic design activity. The amount of design work in each area, along with the relationship between the two design areas, has been a frequent topic of discussion. The respondents to the survey were asked to segment the percentage of mechanical design activity relative to the following four categories:

- Mechanical only, like hand-powered tools and bicycles
- Simple electrical devices, like motors
- More complex electronic devices, like VCRs
- Heavy-duty electronics, like computers and test equipment

Overall, about one-half of all mechanical design activity is mechanical only, and one-half of the mechanical design effort is directed toward parts or products with electronic content. These results are shown in Figure 3-2 and Table 3-3. In contrast, our previous survey showed that three-quarters of all mechanical design activity was solely mechanical, and one-quarter involved electronic content.

Figure 3-2
Mechatronics Activity



Source: Dataquest (September 1994) G4004634

Table 3-3
Mechatronics Activity

	Percentage of Sites
Mechanical Only (Hand-Powered Tools)	51.1
Simple Electrical Devices (Electric Motors)	7.6
More Complex Electronic Devices (VCRs)	18.7
Heavy-Duty Electronics (Computers and Test Equipment)	22.6

Source: Dataquest (September 1994)

Table 3-4 shows more of the mechatronics story, where the variation by industry and department is quite significant. The leading industry for mechanical-only work is the automotive industry. Electrical or electronic design is growing in the automotive sector, but this work is typically done by specialists in specific department or development groups. Mechanical-only tools were also popular with the more "traditional" mechanical industries, including industrial machinery.

Not surprising was the large amount of design work of simple electrical devices that is performed by the industrial machinery and consumer electronics industries.

The higher end of mechatronics (complex electronic devices and heavy-duty electronics) is dominated by consumer electronics and computers and peripherals companies. These results are not surprising, given the high percentage of electronic parts in these products. R&D/new product development groups tend to do a lot of the higher-end mechatronics design work, as well as design computing services and training/education services.

Data Files Active by Type and Segment

The issue of data file storage is interesting for several reasons. First, the disk manufacturers and systems integrators need to know the volume of files that need to be online to support the daily work activity. Also, the mix of data file types is important to gain understanding of the level of use of the various modeling technologies and to suggest the level of graphics performance necessary to view and edit the information as it is retrieved.

Figure 3-3 shows the total number of files stored in each group, sorted by type of modeling technology used to create the files. All sites have a mix of 2-D or 3-D wireframe/surface and solid model files. 2-D-generated information dominates, with some sites having nearly all their files in 2-D, while others having approximately one half of their files in 2-D. The share of 3-D wireframe/surface, and solid model files is growing slowly as use of these tools increases. This is shown later in chapter 5 in which we discuss the mix of modeling technologies planned to be purchased in the next two years. It is interesting to note that, in general, the use of 2-D files in Japan is about the same as in the combined entity of the United States and Europe. Approximately 72 percent of files are 2-D files for sites in

Table 3-4
Top Five Mechatronics Market Segments by Application

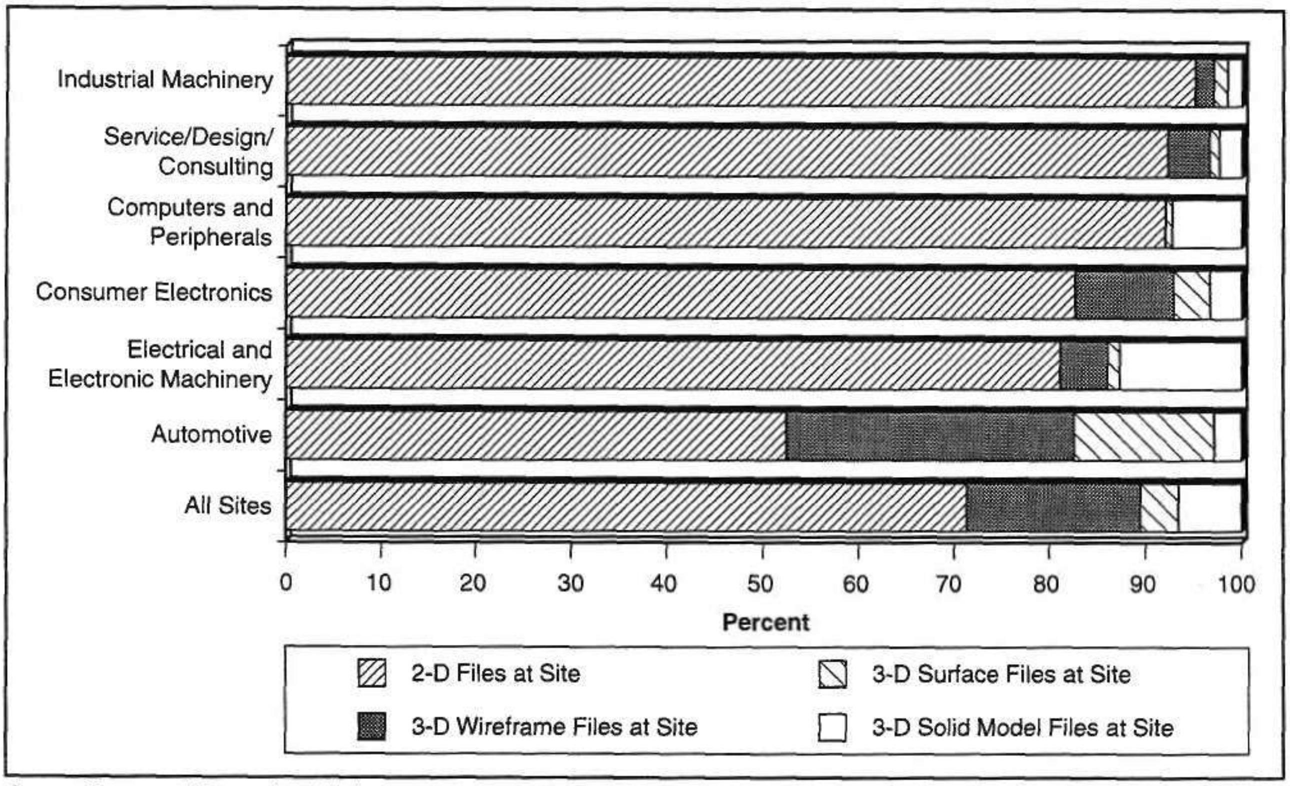
	Percentage of Sites
Mechanical Only (Hand-Powered Tools)	
Automotive	79.3
Industrial Machinery	71.7
Manufacturing Engineering	70.7
Product Engineering	57.0
Other, Applications	55.2
Simple Electrical Devices (Electric Motors)	
Industrial Machinery	11.4
Consumer Electronics	9.9
Other, Applications	9.5
Electrical and Electronic	9.1
Training and Education	8.8
More Complex Electronic Devices (VCRs)	
Consumer Electronics	56.1
Electrical and Electronic	38.3
Design and Computing Services	21.3
R&D/New Product Development	21.3
Product Engineering	17.6
Heavy-Duty Electronics (Computers and Test Equipment)	
Computers and Peripherals	74.7
Service/Design/Consulting	48.6
Training/Education	37.9
Other Departments	29.8
Design Computing Services	27.8

Source: Dataquest (September 1994)

Japan or in the United States/Europe. However, there are notable exceptions for certain industries such as service/design/consulting and industrial machinery, where Japanese sites have a lower percentage of 3-D files, and other industries such as automotive, where Japanese sites have a much larger percentage of 3-D files. The average use of solid modeling is also lower in Japan.

The volume of files varies widely, with the computers and peripherals industry producing the largest number of active files per user. Table 3-5 shows all the detail behind the illustration in Figure 3-3. As one might guess, larger sites obviously have more active files than smaller sites.

Figure 3-3
Data Files Active at Site by Type



Source: Dataquest (September 1994) G4004635

Leading Vendors by Subapplication

User opinion varies widely concerning the feature/function and value of a certain software product for a certain task. Many of the vendors are offering a full range of products that address some utility in each of the major subapplication areas. In our survey, we asked "Which vendor makes the primary software tool used for drafting, design, analysis, and manufacturing applications?" Figure 3-4 and Table 3-6 show the leading vendors in each subapplication based on a percentage of those end users who answered the question.

It appears that no one vendor dominates all of the subapplications in the mechanical CAD/CAM/CAE industry. Also, with the exception of NEC and Toyota, no Japanese vendors appear in the top five subapplication listings. Additionally, many of the leading analysis vendors may not be well represented in this survey because the primary focus is on higher-level integration issues.

Table 3-5
Active Data Files by Type

	Total Active Files in Group	Average Active Files per User	2-D (%)	3-D Wireframe (%)	3-D Surface (%)	3-D Solid Model (%)
All Sites	404,427	42.7	71.4	18.1	4.0	6.5
Computers and Peripherals	140,814	395.2	92.1	0	0.7	7.2
Sites with 500 to 999 Users	58,946	106.5	89.3	0.1	0.4	10.2
Sites with 1 to 9 Users	10,404	64.7	99.6	0.3	0.0	0.1
Service/Design/ Consulting	12,456	60.1	92.3	4.3	1.1	2.4
Sites with 20 to 49 Users	2,123	59.34	97.5	0.5	1.2	0.9
Sites with 100 to 499 Users	79,094	53.7	98.0	1.8	0.1	0.2
Sites with More than 5,000 Users	142,335	40.3	63.2	20.5	10.2	6.1
Industrial Machinery	74,177	35.8	96.4	1.9	0.2	1.5
Sites with 50 to 99 Users	6,250	22.1	98.6	0.4	0.7	0.1
Sites with 1,000 to 4,999 Users	104,960	18.8	47.5	40.3	1.2	11.0
Automotive	93,678	17.6	52.4	30.2	14.5	2.9

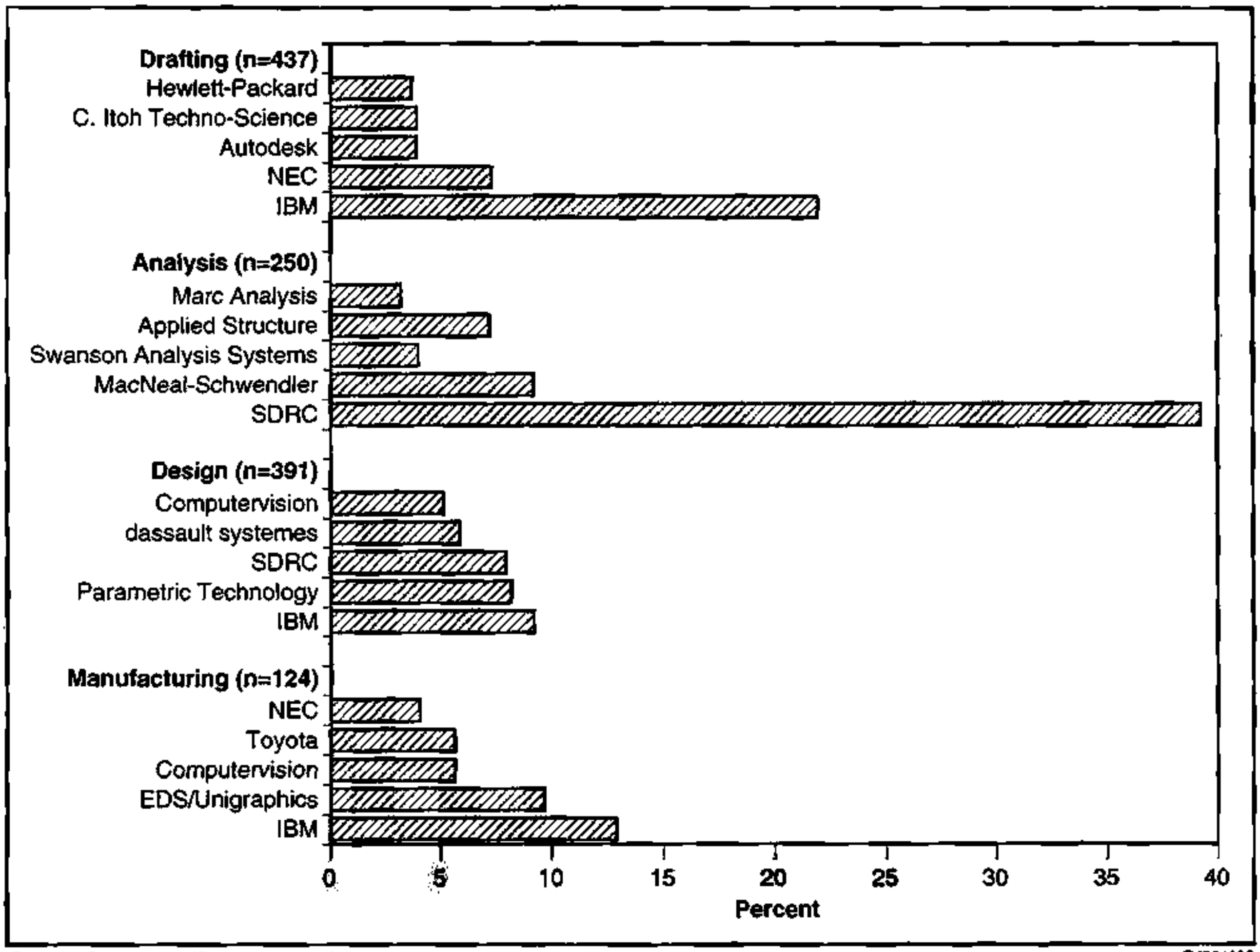
Source: Dataquest (September 1994)

Product Data Management

As engineering projects become more involved, and products become more complex, product data management (PDM) becomes a pressing issue. Only recently have companies in Japan, the United States, and Europe begun to look at this issue seriously. Figure 3-5 shows a summary of Japanese PDM usage and plans over all sites. Only 14 percent of respondents have PDM system plans, and only 5 percent are currently using some type of a PDM system. The results vary by industry, as indicated in Table 3-7. The most promising use of PDM is seen in the electrical and electronic industry, where 34 percent of respondents either have a PDM system or have plans to implement one. The computers and peripherals industry closely follows in its use of or plans for PDM systems. Service/design/consulting lags far behind the rest of the end users in PDM plans: only 5 percent of respondents have a PDM system or have plans for implementation.

Further examination of the survey data reveals that nearly 70 percent of those end users using a PDM system have developed their own system. Commercial vendors make up the balance. Surprisingly, the penetration rate of vendors with PDM products, such as Sherpa, SDRC, EDS, and Intergraph, appears to be quite low, according to the survey responses revealed here.

Figure 3-4
Leading Vendors by Subapplication



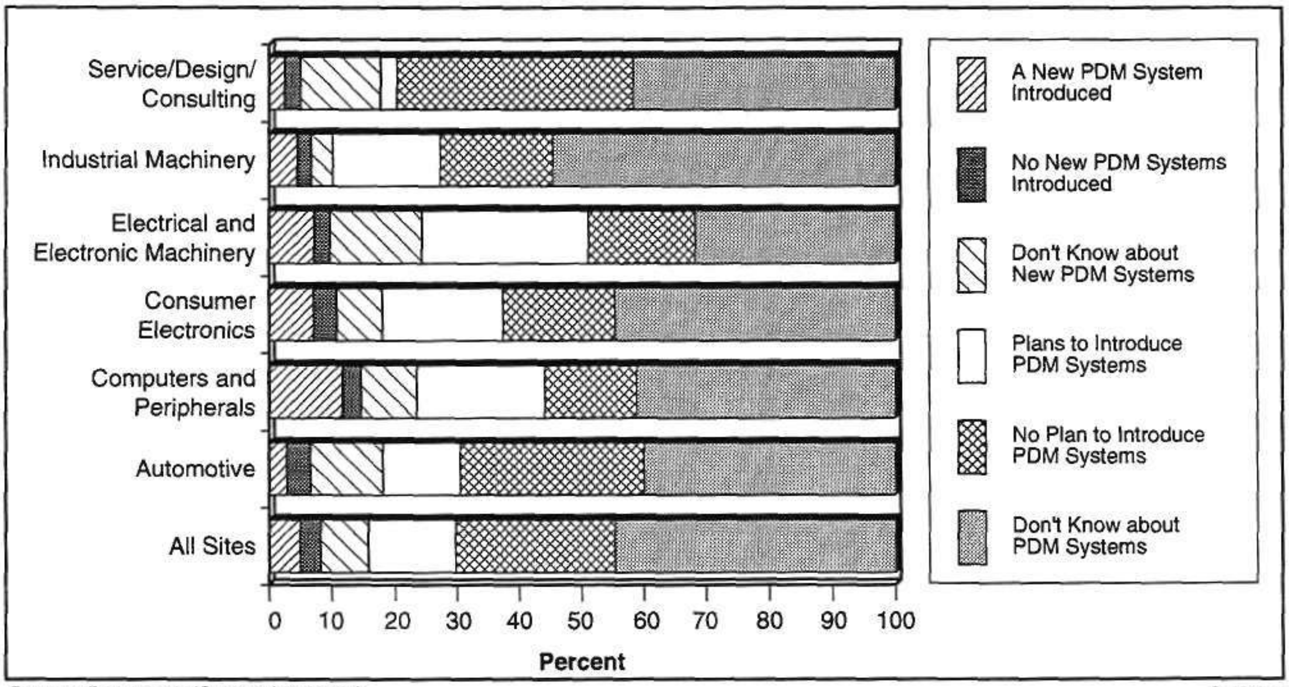
Source: Dataquest (September 1994) G4004636

Table 3-6
Leading Vendors by Subapplication

Subapplication Vendor	Percentage of Respondents Using This Vendor
Drafting	
IBM (CADAM and MicroCADAM)	22.0
NEC	7.3
C. Itoh Techno-Science	3.9
Autodesk	3.9
Hewlett-Packard	3.7
Design	
IBM (CADAM)	9.2
Parametric Technology	8.2
SDRC	7.9
dassault systemes	5.9
Computervision	5.1
Analysis	
SDRC	39.2
MacNeal-Schwendler	9.2
Applied Structure	7.2
Swanson Analysis Systems	4.0
Marc Analysis	3.2
Manufacturing	
IBM	12.9
EDS/Unigraphics	9.7
Toyota	5.6
Computervision	5.6
NEC	4.0

Source: Dataquest (September 1994)

Figure 3-5
PDM Plans



Source: Dataquest (September 1994)

G4004637

Table 3-7
PDM Plans by Industry

	All Sites	Automotive	Computers and Peripherals	Consumer Electronics	Electrical and Electronic	Industrial Machinery	Service/ Design/ Consulting
Introduced a New PDM System	5.0	2.9	11.8	7.2	7.3	4.5	2.4
No New PDM System Introduced	3.2	3.8	2.9	3.6	2.4	2.3	2.4
Don't Know about New PDM Systems	7.6	11.4	8.8	7.2	14.6	3.4	12.2
Plan to Introduce PDM Systems	13.8	12.4	20.6	19.3	26.8	17.0	2.4
No Plan to Introduce PDM Systems	25.7	29.5	14.7	18.1	17.1	18.2	36.6
Don't Know about PDM Systems	44.6	40.0	41.2	44.6	31.7	54.5	43.9

Source: Dataquest (September 1994)

Chapter 4
Penetration

One of the fundamental issues driving the mechanical CAD/CAM/CAE market is understanding the penetration of this technology into every subapplication and task. Changing user dynamics and expectations make this a moving target. One way to examine this issue is to analyze the number of trained users compared to the number of seats installed and the distribution of user time over each of the major subapplication tasks. In this chapter, we examine the experience base of the survey respondents and current and future site penetration by subapplication and industry.

Change in Product Use Over Time

One element of the issue of market penetration concerns the idea that users are reluctant to learn new products. Conventional wisdom suggests that a user will find something that works and then continue to use that product until forced to do something different. The results of this survey show a different picture.

We asked the following questions:

- How many different vendors' products have you learned to use?
- Of these, how many are you using on a regular basis?
- How many new vendors' products do you think you will learn in the next two years?

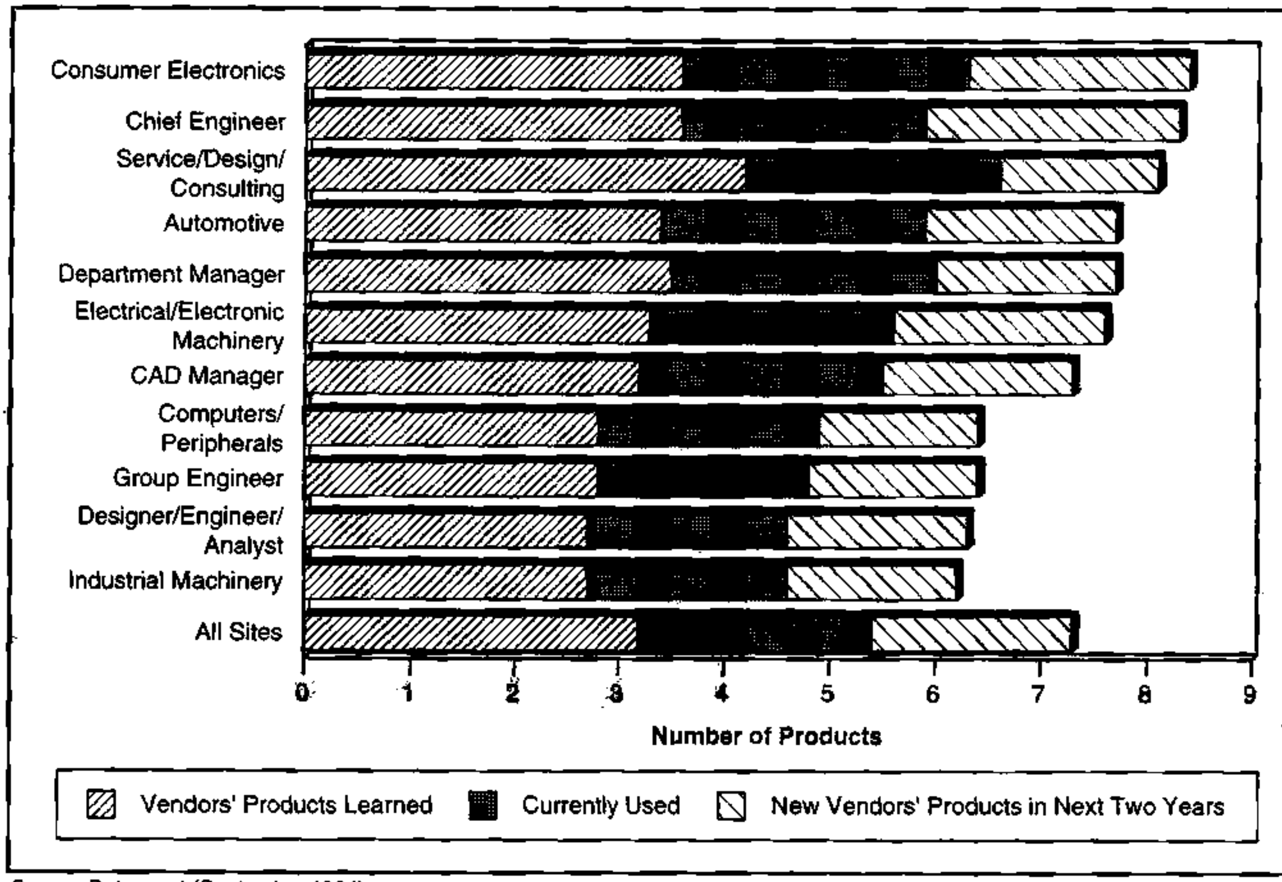
For all industries combined, Japanese end users have learned 3.2 products, currently use 2.2 products, and plan to learn 1.9 products in the next two years. This compares with our previous U.S./European survey results of 3.7 products learned, 1.9 products currently used, and 1.0 new products to be learned in the next two years. Figure 4-1 and Table 4-1 show the split by industry for Japanese respondents. Users in the service/design/consulting industry have learned to use more than four different products on average. Of these, 2.4 are still in use. At the other end of the spectrum, users in industrial machinery have learned 2.7 products on average, and plan to learn among the fewest number, 1.6 products, in the future.

Clearly, demand is building for significant new software sales in Japan. Current economic pressure will tend to delay the purchase of new tools, but demand and user expectation will continue to build. The fact that the group of chief engineers have a very high expectation for the use of new products supports this view.

Site Penetration under Ideal Conditions

Rather than ask users to estimate the ratio of users to seats and to the total population of potential users (as a measure of site penetration), we asked "How many current mechanical CAD/CAM/CAE users are there at this site?" Then we asked them to imagine an ideal situation in which a system

Figure 4-1
Change in Product Use by Industry



Source: Dataquest (September 1994) G4004638

Table 4-1
Change in Product Use by Industry

	Vendors' Products Learned	Currently Used	New Vendors' Products in Next Two Years	Retirement Rate
All Sites	3.2	2.2	1.9	10.4
Service/Design/Consulting	4.2	2.4	1.5	7.6
Consumer Electronics	3.6	2.7	2.1	12.3
Automotive	3.4	2.5	1.8	13.7
Electrical/Electronic	3.3	2.3	2	11.3
Computers/Peripherals	2.8	2.1	1.5	10.4
Industrial Machinery	2.7	1.9	1.6	8.3

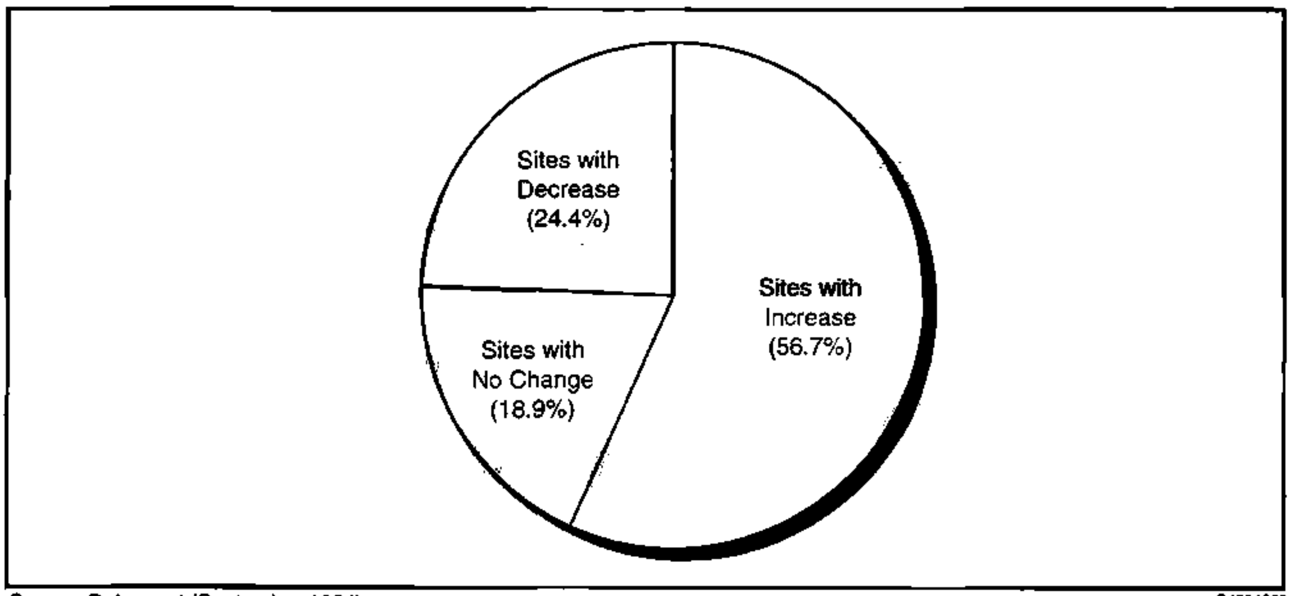
Source: Dataquest (September 1994)

would be cheap, fast, and easy to use and would have complete and highly productive functionality. We asked "What would be the maximum number of users with this ideal system in 1995?"

Each survey respondent was asked to estimate the change in total users under these ideal conditions. The change in users was divided into three groups: those that were growing seat count, those that were expecting seat count to stay the same during the next two years, and those that were decreasing seat counts. Figure 4-2 shows the theoretical change by site given the ideal system scenario. Under these ideal conditions, approximately 57 percent of all the sites would increase the number of users. About 19 percent would have no change planned, and nearly 24 percent would decline. The detail behind these numbers, which varies widely by industry, is shown in Table 4-2. The industry envisioning the greatest percentage increase in users is the service/design/consulting industry, and the one envisioning the greatest percentage decrease in users is the consumer electronics industry.

When comparing these results to last year's U.S./European responses, we see that the Japanese respondents are much more optimistic in considering the value of the "ideal" system—this group, as a whole, envisions far more sites with a decrease in users (24 percent for Japanese respondents versus 7 percent for U.S./European respondents). The labor-intensive work style of drafting-only CAD tools, popular in the Japanese market, is a fundamental factor contributing to this evaluation.

Figure 4-2
Site Penetration under Ideal Conditions



Source: Dataquest (September 1994) G4004639

Table 4-2
Site Penetration by Industry under Ideal Conditions

	Sites (%)	Current Users	Users under Ideal Conditions	Percent Change
All Sites				
Sites with Increase	56.7	28	40	42.9
Sites with No Change	18.9	58	58	0
Sites with Decrease	24.4	39	30	-23.1
Automotive				
Sites with Increase	66.1	46	61	32.6
Sites with No Change	16.5	160	160	0
Sites with Decrease	17.4	27	16	-40.7
Computers and Peripherals				
Sites with Increase	56.4	18	25	38.9
Sites with No Change	28.2	65	65	0
Sites with Decrease	15.4	12	12	0
Consumer Electronics				
Sites with Increase	61.7	34	51	50.0
Sites with No Change	18.5	31	31	0
Sites with Decrease	19.8	51	15	-70.6
Electrical and Electronic				
Sites with Increase	53.5	41	56	36.6
Sites with No Change	20.9	148	148	0
Sites with Decrease	25.6	44	33	-25.0
Industrial Machinery				
Sites with Increase	53.2	19	25	31.6
Sites with No Change	14.9	20	20	0
Sites with Decrease	31.9	55	52	-5.5
Service/Design/Consulting				
Sites with Increase	41.5	10	17	70.0
Sites with No Change	26.8	10	10	0
Sites with Decrease	31.7	10	5	-50.0

Source: Dataquest (September 1994)

Site Penetration by User Forecast

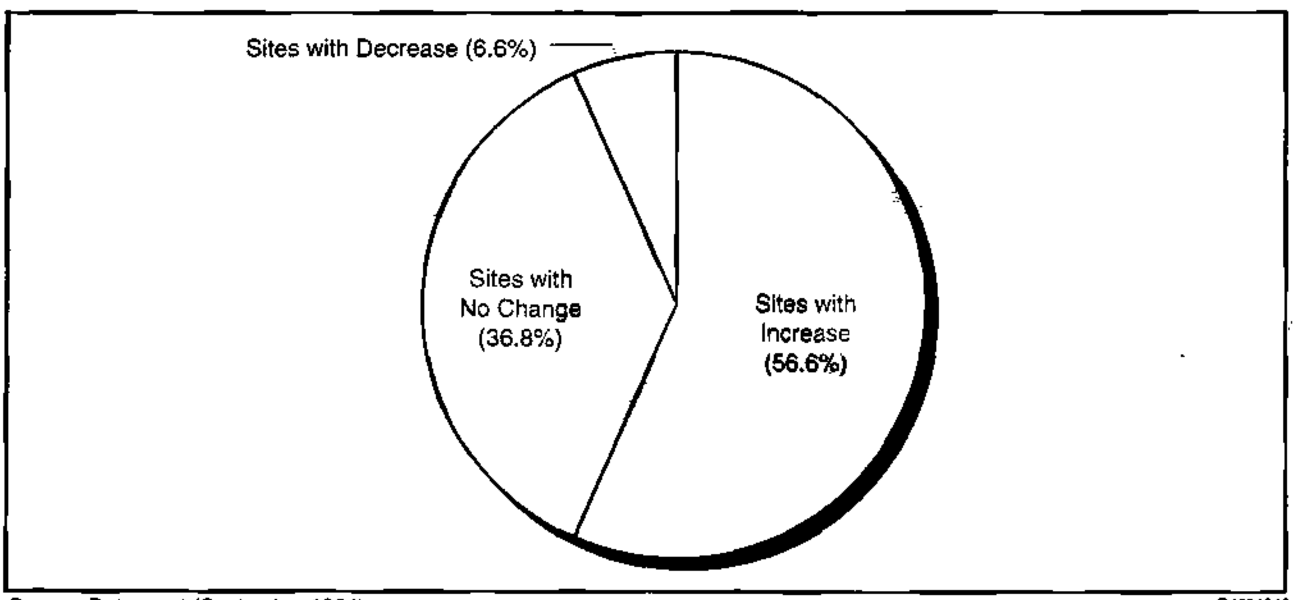
Figure 4-3 illustrates the response to the second part of the penetration question: "How many current users are there and what actual number do you expect in 1995?" The ideal conditions scenario does not apply here. The results are similar to what we saw with the U.S./European respondents. The number of sites expecting user growth was nearly 57 percent, those expecting no change was 37 percent, and those anticipating a decrease was almost 7 percent.

It is interesting to compare the results of these two sets of responses (Japanese users versus U.S./European users). The group expecting to grow is almost the same in each case. The possibility of finding that idea system doesn't appear to be a significant growth factor. Perhaps the vision of the ideal system is too strongly influenced by the latest specification of the leading products offered in the market. Either way, the allure of the best system for the job doesn't seem to affect current growth plans.

The sites with constant or declining seat count are a different story. Almost 20 percent of the sites thought that an ideal system would allow them to reduce total seat count. This implies a needed improvement in productivity and efficiency when replacing the old systems.

Table 4-3 shows the changes expected by industry. Most of the industries thought that 40 to 60 percent of these sites would increase user head count. Of the few sites expecting a decrease in users, the anticipated percentages of decrease are large, including a 10 percent decrease for the computers and peripherals industry, a 40 percent decrease for the automotive industry, and a dramatic 88 percent decrease for the consumer electronics industry.

Figure 4-3
1995 Forecast of Site Penetration



Source: Dataquest (September 1994) G4004640

Table 4-3
Forecast of Site Penetration by Industry

	Sites (%)	Current Users	Expected Users in 1995	Percent Change
All Sites				
Sites with Increase	56.6	35	42	20.0
Sites with No Change	36.8	39	39	0
Sites with Decrease	6.6	39	27	-30.8
Automotive				
Sites with Increase	58.7	53	61	15.1
Sites with No Change	34.9	81	81	0
Sites with Decrease	6.4	30	18	-40.0
Computers and Peripherals				
Sites with Increase	48.7	20	26	30.0
Sites with No Change	43.6	46	46	0
Sites with Decrease	7.7	10	9	-10.0
Consumer Electronics				
Sites with Increase	56.8	44	55	25.0
Sites with No Change	37.0	21	21	0
Sites with Decrease	6.2	66	8	-87.9
Electrical and Electronic				
Sites with Increase	58.1	46	54	17.4
Sites with No Change	41.9	90	90	0
Sites with Decrease	0	0	NA	NA
Industrial Machinery				
Sites with Increase	62.8	31	37	19.4
Sites with No Change	33.0	26	26	0
Sites with Decrease	4.2	71	50	-29.6
Service/Design/Consulting				
Sites with Increase	41.5	10	18	80.0
Sites with No Change	46.3	9	9	0
Sites with Decrease	12.2	13	NA	NA

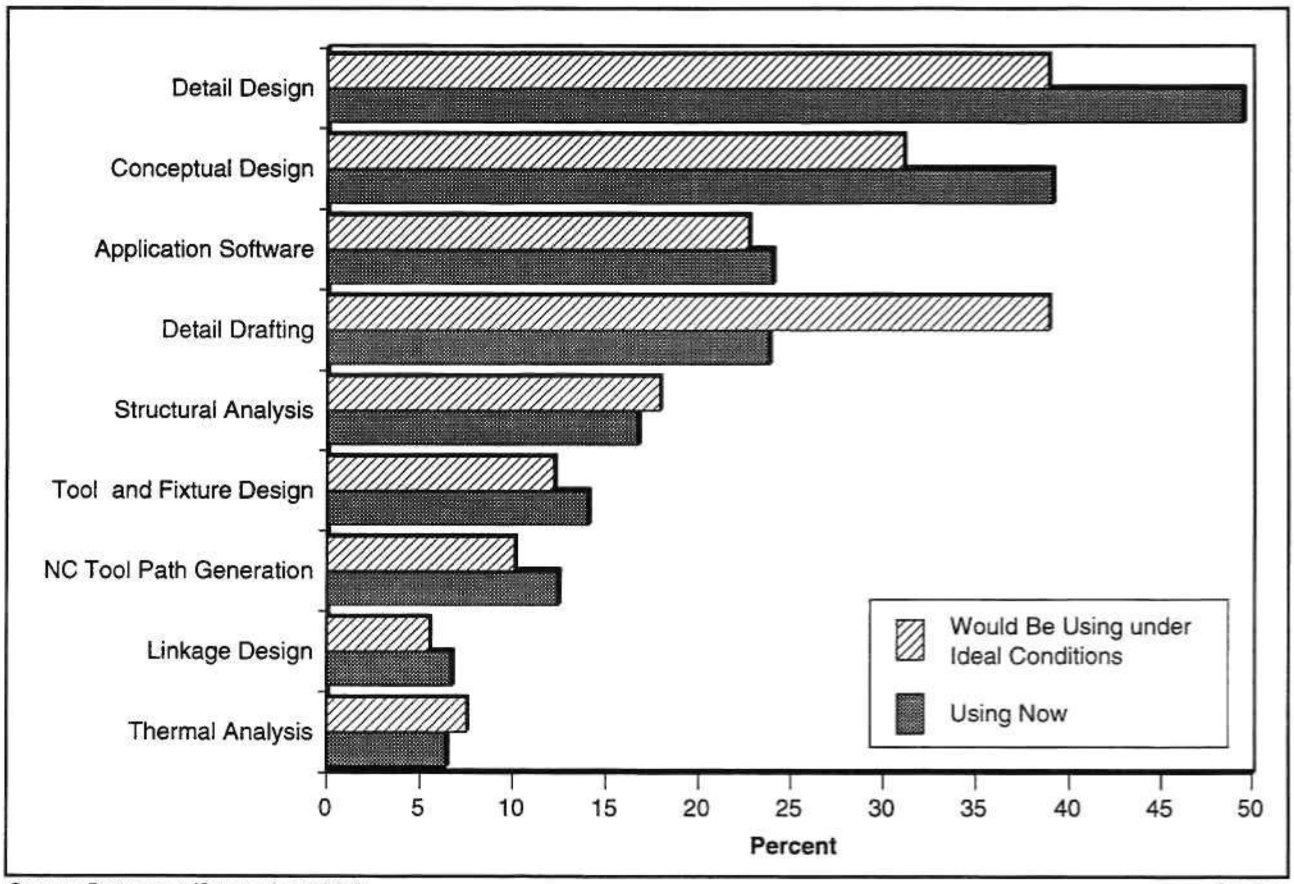
NA = Not available
Source: Dataquest (September 1994)

Site Penetration by Subapplication

For each of the major subapplications, we asked an important series of questions such as "How many people are using mechanical tools in each of these areas? How many would be doing this kind of work using CAD/CAM/CAE tools under ideal conditions, with highly functional tools?" Figure 4-4 shows the highest potential growth areas. In last year's survey, structural analysis had the largest unmet need. This year, our Japanese respondents stated that detail drafting has the largest unmet need, with a possible potential growth rate of over 63 percent. A significant drop in potential users for design tasks was also found. The other applications for analysis and manufacturing applications have minor growth or decline potential.

Growth in drafting and decline in design are not felt to be general trends in the market. Careful consideration of the wording of the question in the survey indicates a likely scenario. The primary value of the CAD/CAM technology is to provide a communications medium for engineering information. The drawing is the official document of reference. We interpret

Figure 4-4
Site Penetration by Subapplication



Source: Dataquest (September 1994)

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the results of this question as follows. The ease-of-use issue was ranked highly in importance. The importance of access in the engineering environment to the drawings coupled with ease-of-use issues is believed to be behind the large potential increase in the number of users for this application. The growth expectation for analysis and the decline in users doing design suggest that productivity in these areas from the use of the most advanced tools would require fewer specialists to be involved with the work.

Table 4-4 shows the results by subapplication. Unlike last year when such industries as the automotive industry showed an amazing 700 percent growth potential, this year's numbers were much more modest. Specific subapplications for the service/design/consulting industry and the electrical and electronic industry show high growth rates.

The growth expectations described earlier at the site level are mirrored in the results when looked at by subapplication. Overall, the value of the ideal system seems to be perceived as a means of increasing access to a wider base of users and to reduce the number of users in the specialists areas. Some of the traditional subapplications of NC programming and tool and fixture design were all shown to drop in usage and could be examples of this trend.

Table 4-4
Site Penetration by Subapplication

	Current Users	Users under Ideal Conditions	Possible Growth (%)	Decrease	Increase
Conceptual Design					
All Sites	39.1	31.1	-20.5	X	
Industrial Machinery	43.6	37.4	-14.2		
Automotive	32.9	28.1	-14.6		
Electrical and Electronic	34.1	27.7	-18.8		
Computers and Peripherals	45	33.5	-25.6		
Service/Design/Consulting	50.8	36.6	-28.0		
Consumer Electronics	40.1	23.4	-41.6		
Detail Design					
All Sites	49.5	38.9	-21.4	X	
Electrical and Electronic	49.8	45.2	-9.2		
Industrial Machinery	52.9	44	-16.8		
Automotive	50	38.1	-23.8		
Consumer Electronics	54.9	39.5	-28.1		
Service/Design/Consulting	40.6	28.6	-29.6		
Computers and Peripherals	62.4	42.5	-31.9		

(Continued)

Table 4-4 (Continued)
Site Penetration by Subapplication

	Current Users	Users under Ideal Conditions	Possible Growth (%)	Decrease	Increase
Structural Analysis					
All Sites	16.7	17.9	7.2		X
Industrial Machinery	15.1	19.2	27.2		
Automotive	12	15.2	26.7		
Consumer Electronics	12.7	15.1	18.9		
Service/Design/Consulting	33.1	32.1	-3.0		
Electrical and Electronic	14.7	12.2	-17.0		
Computers and Peripherals	19.8	15.6	-21.2		
Thermal Analysis					
All Sites	6.4	7.5	17.2		X
Consumer Electronics	4.2	6.9	64.3		
Automotive	2.3	3.6	56.5		
Computers and Peripherals	10.5	12.8	21.9		
Industrial Machinery	8.5	10.2	20.0		
Service/Design/Consulting	8.6	10.2	18.6		
Electrical and Electronic	6	6.2	3.3		
Detail Drafting					
All Sites	23.8	38.9	63.5		X
Service/Design/Consulting	12.7	28.6	125.2		
Electrical and Electronic	21.4	45.2	111.2		
Industrial Machinery	25	44	76.0		
Automotive	27.3	38.1	39.6		
Computers and Peripherals	31.9	42.5	33.2		
Consumer Electronics	30	39.5	31.7		
Tool and Fixture Design					
All Sites	14.0	12.2	-12.9	X	
Service/Design/Consulting	24.4	32.3	32.4		
Automotive	17.9	17.1	-4.5		
Industrial Machinery	14	11.8	-15.7		
Electrical and Electronic	12.1	8.3	-31.4		
Consumer Electronics	12.8	8.2	-35.9		
Computers and Peripherals	13.8	7.7	-44.2		

(Continued)

Table 4-4 (Continued)
Site Penetration by Subapplication

	Current Users	Users under Ideal Conditions	Possible Growth (%)	Decrease	Increase
Linkage Design					
All Sites	6.7	5.5	-17.9	X	
Service/Design/Consulting	2.7	6.5	140.7		
Industrial Machinery	6.7	7.2	7.5		
Automotive	5.9	5.6	-5.1		
Computers and Peripherals	12.9	10.1	-21.7		
Electrical and Electronic	2.3	1.7	-26.1		
Consumer Electronics	3.8	2	-47.4		
NC Tool Path Generation					
All Sites	12.4	10.1	-18.5	X	
Industrial Machinery	4.6	4.9	6.5		
Automotive	18.1	16.9	-6.6		
Computers and Peripherals	10.9	9.8	-10.1		
Electrical and Electronic	10.9	8.4	-22.9		
Consumer Electronics	6.6	3.9	-40.9		
Service/Design/Consulting	4.9	2.6	-46.9		
Application Software Development					
All Sites	24.0	22.7	-5.4	X	
Automotive	6	7.7	28.3		
Service/Design/Consulting	122.6	151	23.2		
Industrial Machinery	15.5	17.3	11.6		
Computers and Peripherals	8.2	6.9	-15.9		
Consumer Electronics	15.8	11.4	-27.8		
Electrical and Electronic	22.8	14.7	-35.5		

Source: Dataquest (September 1994)

Chapter 5
Buying History and Plans

Several questions were asked in the area of buying history and plans in order to better define the expectations of the users in future system purchases. We asked several in-depth questions on the current mix of hardware (platforms and peripherals) and planned decreases or increases in hardware, including seat counts. The use of consulting services was explored, as were software module changes and the future mix of modeling types.

External Consulting Services Use and Expectations

The high-level use of CAD/CAM/CAE tools to improve productivity and time to market is complemented by various services in systems integration support, custom software development, and product design. The first question we asked concerned the use of outside consulting services for such issues.

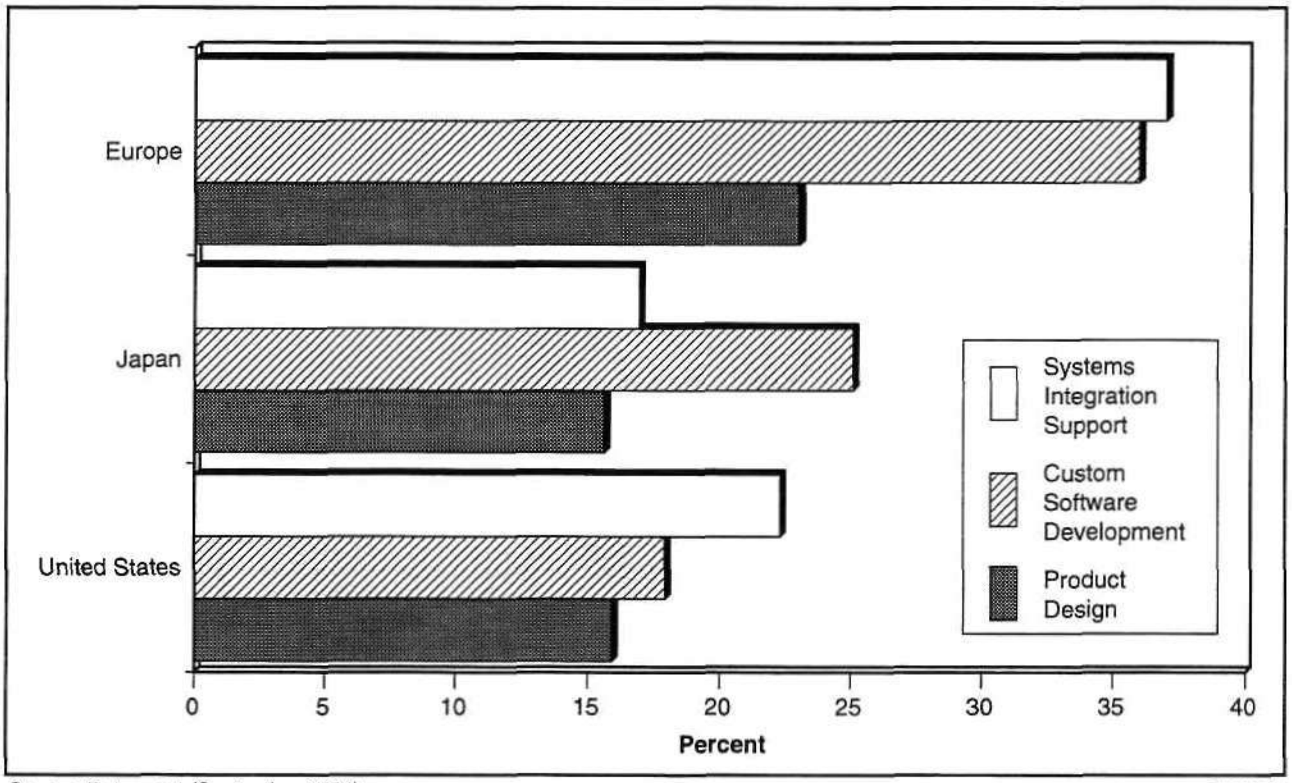
The amount of outside consulting services in Japan is growing. Figure 5-1 shows the distribution of respondents that answered "yes" to the question "In the last two years has your site used external consulting for systems integration support, custom software development, and product design?" Overall, it appears that Japan has tended to use fewer outside consulting services, whereas Europe has used the most. More specifically, for systems integration support, only 17 percent of Japanese respondents have used consultants in the past, while the number for Europe is 37 percent. Similar contrasts can be drawn for outsourced product design. Custom software development was the dominant outsourced activity.

We also asked the survey respondents if they believed that they would use these services in the next two years. Figure 5-2 shows the results of this question. All areas are expected to grow. Consistent with the answers to the previous question, Japan plans to use about the same consulting services in the next two years in comparison to the United States. The planned use of outside systems integration support is a bit less in Japan than in the United States, whereas custom software development is almost 10 percent higher on a per-site basis. Table 5-1 summarizes the responses to the consulting services questions.

Computing Platform and Peripherals Forecasts

The purchase of new seats in the last two years in Japan was led by the PC platform (51.4 percent), closely followed by technical workstation-based products (47.1 percent), and lagged by mainframe-based products (1.6 percent). The mainframe-based product percentage (of the total purchases) is expected to remain approximately the same during the next two years. A slight 4 percent shift in computing mix is expected, with more PC-based solutions being purchased and fewer workstation solutions being

Figure 5-1
Percentage of Respondents Who Have Used External Consulting



Source: Dataquest (September 1994)
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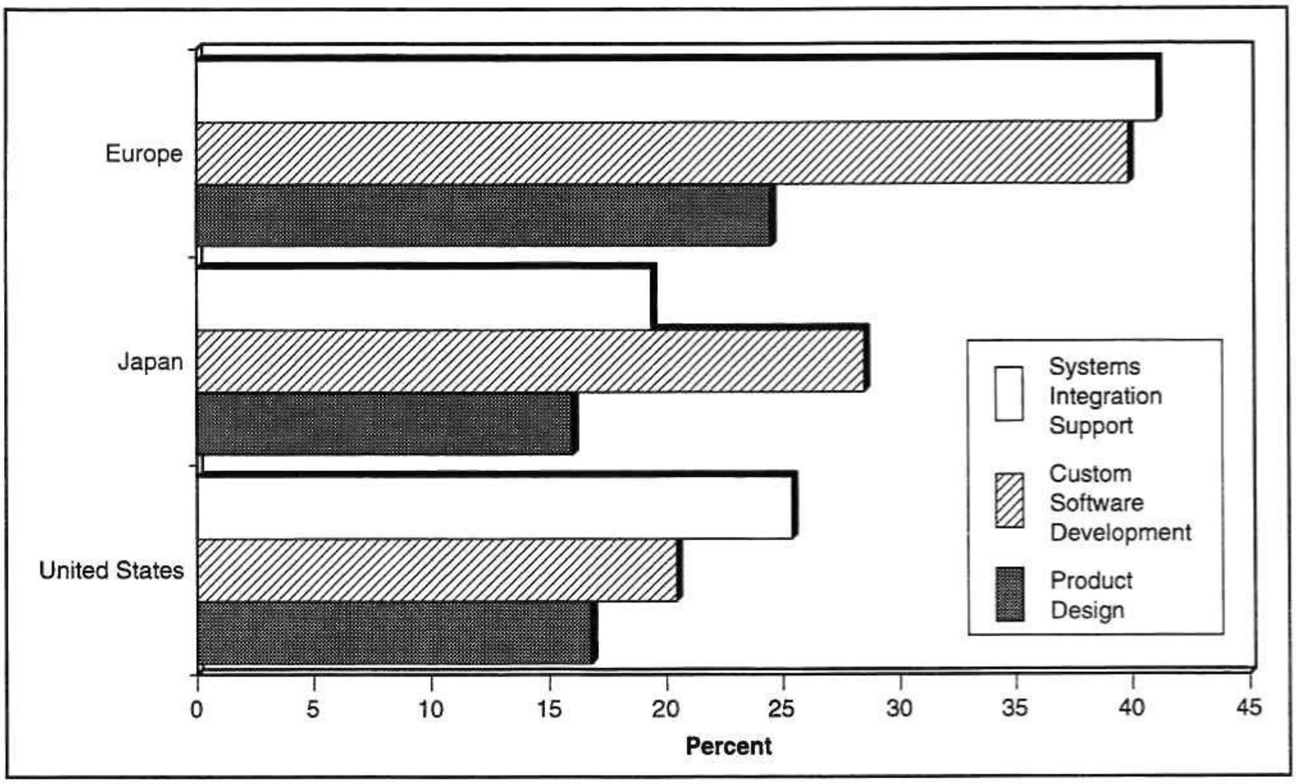
purchased during the next two years. Figure 5-3 and Table 5-2 illustrate these growth rates.

In comparison to the U.S./European responses from last year's survey, mainframe-based purchases in Japan have composed a very small percentage of computing purchases during the past two years and are expected to compose even less of the total percentage of computing purchases in the next two years. This result is surprising, given the relatively large installed base of mainframe-based computing systems in Japan.

Table 5-2 shows the results by seat purchases by industry. PC-based systems are expected to have the highest growth in consumer electronics, followed by the industrial machinery. The computers and peripherals industry is expected to have the greatest decline in PC-based systems.

Workstation-based systems are expected to sell well in service/design/consulting and computers and peripherals sites. Last year, consumer electronics was rated highly in this area; however, with the Japanese end users, consumer electronics showed the greatest decline (21 percent) among all industries.

Figure 5-2
Percentage of Respondents Who Expect to Use External Consulting by 1995



Source: Dataquest (September 1994)

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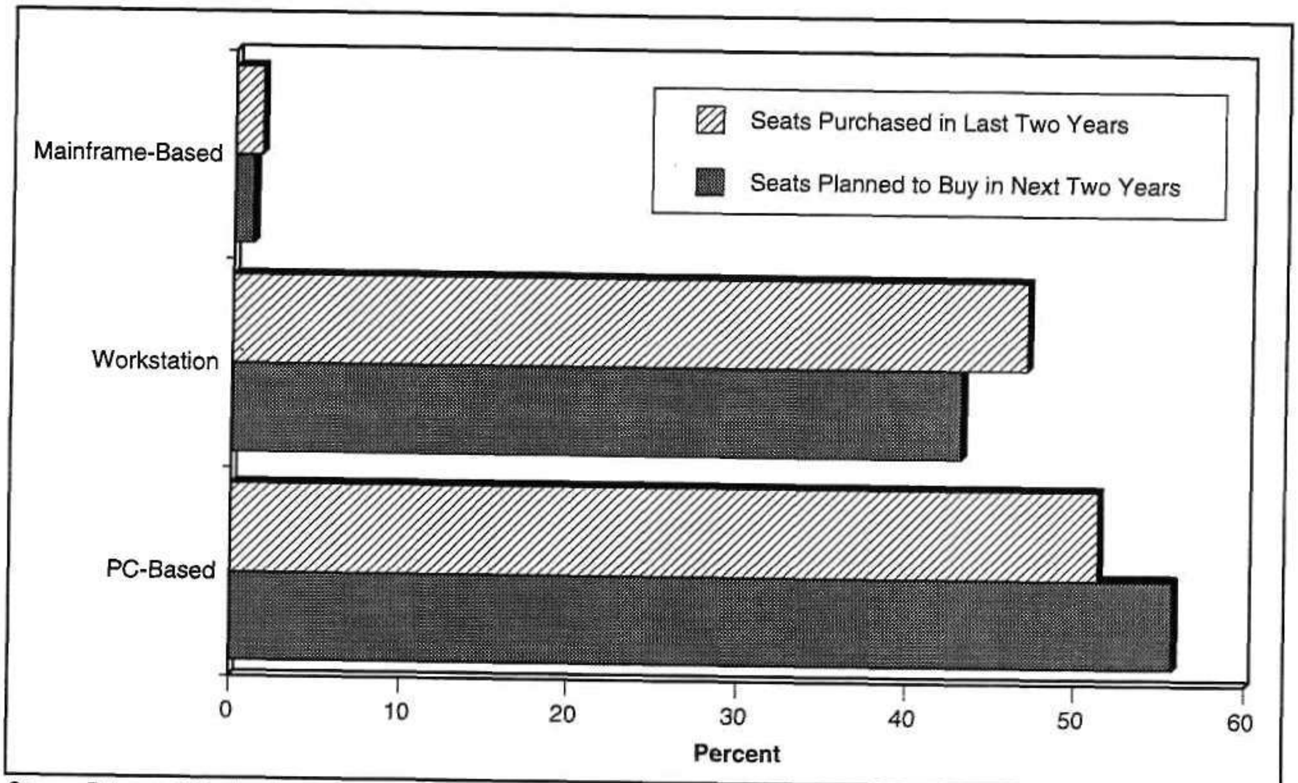
Table 5-1
Percentage of Respondents Who Have Used and Expect to Use External Consulting

	Japan	United States	Europe
Users in the Past Two Years (%)			
Systems Integration Support	16.9	22.3	37.0
Custom Software Development	25.1	17.9	36.0
Product Design	15.6	15.9	23.0
Expect to Use in Next Two Years (%)			
Systems Integration Support	19.4	25.4	41.1
Custom Software Development	28.5	20.4	39.9
Product Design	16.0	16.8	24.5
Percent Change			
Systems Integration Support	14.8	13.9	11.1
Custom Software Development	13.5	14.0	10.8
Product Design	2.6	5.7	6.5

Source: Dataquest (September 1994)

Figure 5-3
Forecast of Hardware Seats



Source: Dataquest (September 1994)
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Mainframe-based solutions are falling in interest overall. This result was also seen among the U.S. and European respondents, with the exception of Italy, primarily because of its large installed base.

We also asked what the last two years looked like for various peripherals, such as plotters, printers, and servers. Approximately one server was purchased for every 20 PCs or workstations. (This is in contrast to the United States and Europe, where one server was purchased for every nine PCs or workstations). One plotter was purchased for every 16 PCs or workstations, and one printer was purchased for every five PCs or workstations.

According to this survey, the purchase rate for servers will decrease to approximately 1:15 in the next two years; however, this purchasing ratio is still lower than what is predicted for the United States and Europe (1 server for 12 PCs or workstations). The plotter purchase rate will decrease to about one plotter for every 20 PCs or workstations, and the printer number will decrease to approximately one printer for every six PCs or workstations.

The best market for servers are the automotive, electrical and electronic, and industrial machinery industries.

Table 5-2
Respondents' Hardware Buying Plans by Platform

	Seats Purchased in Last Two Years	Seats Planned to Buy in Next Two Years
All Sites		
PC-Based	51.4	55.7
Workstation	47.1	43.2
Mainframe-Based	1.6	1.1
Automotive		
PC-Based	53.4	55.7
Workstation	44.4	42.8
Mainframe-Based	2.2	1.5
Computers and Peripherals		
PC-Based	34.4	27.1
Workstation	62.5	72.5
Mainframe-Based	3.1	0.4
Consumer Electronics		
PC-Based	49.2	59.2
Workstation	50.5	40.0
Mainframe-Based	0.4	0.7
Electrical and Electronic		
PC-Based	50.1	54.3
Workstation	49.4	45.7
Mainframe-Based	0.5	0.0
Industrial Machinery		
PC-Based	50.2	54.7
Workstation	48.7	45.1
Mainframe-Based	1.1	0.2
Service/Design/Consulting		
PC-Based	71.6	59.9
Workstation	27.4	40.1
Mainframe-Based	0.9	NA

NA = Not available
Source: Dataquest (September 1994)

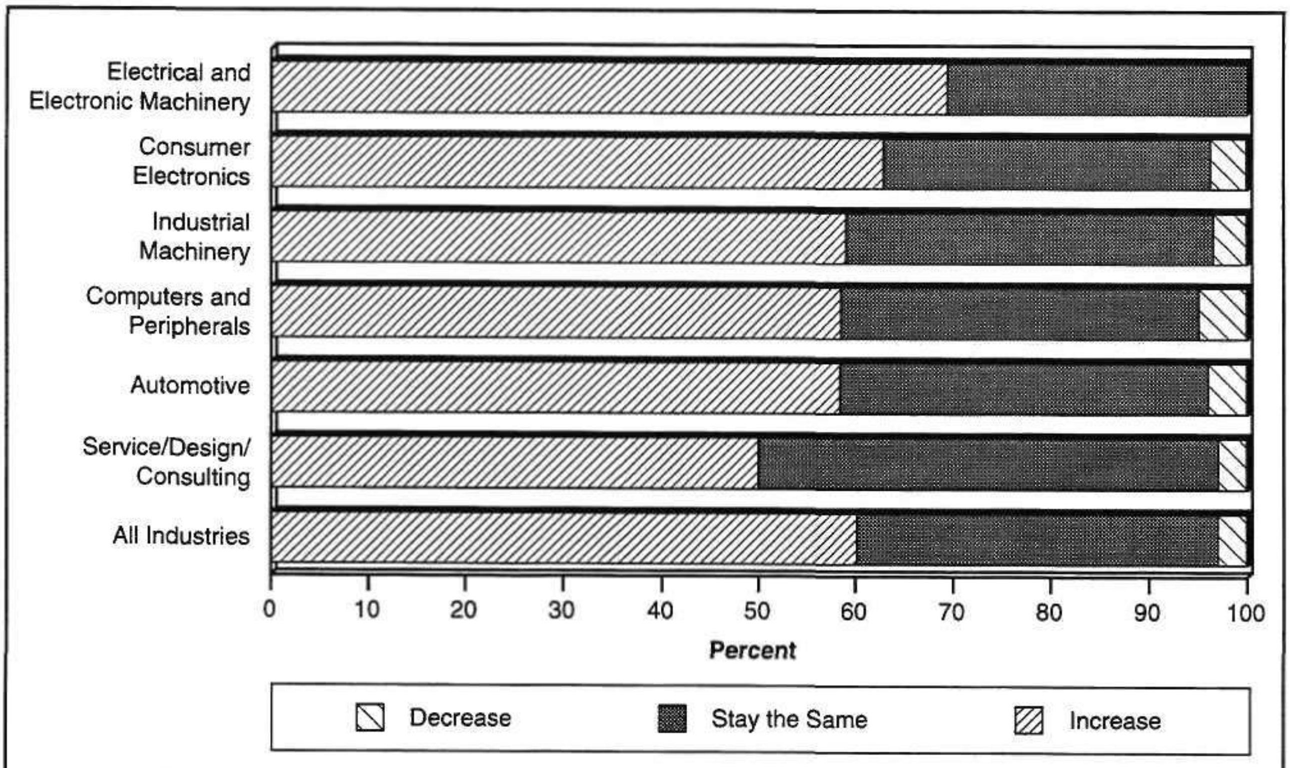
Both printers and plotters are not expected to fare well in any industry, with the exception of the automotive sites. These sites are expecting far more plotter purchases than printer purchases.

Seat Count Forecast

Will the seat count for mechanical CAD/CAM/CAE applications increase, stay the same, or decrease in the next two years? The answer to this question, with analysis by industry, is shown in Figure 5-4 and Table 5-3. Overall, approximately 60 percent of sites are anticipating an increase in seat count, 37 percent are anticipating no change, and 3 percent are anticipating a decrease. More electrical and electronic sites are growing, with nearly 70 percent of these sites expecting an increase in seat count.

Very few sites are expecting a decrease in seat count. Of those that are, the largest anticipated decrease is in the consumer electronics industry (33 percent), but this is expected at less than 4 percent of the sites. For all Japanese sites, the actual amount of the expected decrease is quite small, on average 16 percent at only three percent of the sites.

Figure 5-4
Expected Change in Mechanical CAD/CAM/CAE Seat Count by Site (Percent of Sites)



Source: Dataquest (September 1994)

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Table 5-3
Expected Change in Mechanical CAD/CAM/CAE Seat Count by Industry
(Percentage of Sites)

	Increase	Stay the Same	Decrease	Amount of Increase	Amount of Decrease
Electrical and Electronic	69.4	30.6	0	28.4	NA
Consumer Electronics	63.0	33.3	3.7	27.3	-33.3
Industrial Machinery	59.1	37.5	3.4	36.8	-10.0
Computers and Peripherals	58.5	36.6	4.9	33.9	-20.0
Automotive	58.4	37.6	4.0	30.3	-5.0
Service/Design/Consulting	50.0	47.1	2.9	68.8	NA
All Sites	60.2	36.8	3.0	35.5	-16.2

NA = Not available
Source: Dataquest (September 1994)

New Seat Opportunities by Segment

Further questions were asked about the planned changes in the next two years for the number of replacement seats and the number of seats to be upgraded. Table 5-4 details the results. As stated earlier, sites that are increasing seat counts are expecting some fairly high growth rates, with the average rate approaching 18 percent. It is interesting to note that the Japanese respondents are anticipating very similar growth in replacement and upgrade seats in the next two years to the U.S. or European rate. On average, those sites anticipating an increase in seat count are expecting slightly over four replacement and two upgrade seats per year. In comparison, U.S. and European respondents are expecting five replacement and upgrade seats each per year. The variations among industry are wide, as shown in Table 5-4.

Software Opportunities by Segment

A similar analysis was done for each segment by asking what percentage of existing software modules would be retired in the next two years. Each industry was evaluated further to determine potential growth for software. This was done by considering software replacements made for retired modules. In our software model, these retired modules were assumed to be replaced with new software. Additionally, new seat shipments were also assumed to bring along new software modules. The results, by industry, are shown in Table 5-5, where the detail for each segment of the market is sorted by site type. Specifically, each line in the table shows the planned percentage change in seat count and software module increase or decrease, depending on if the site was planning to increase, decrease, or stay the same in seat count. The resulting total module change is shown as well.

Overall, the sites with increasing seat count are planning on replacing 5.7 percent of the installed software modules. They are also expecting a

Table 5-4
New Seat Opportunity

	Percent of Sites	Expected Change (%)	Replacement Seats	Upgrade Seats
All Sites				
Sites with Increase	60.2	17.8	4.3	4.3
Sites with No Change	36.8		2.4	2.4
Sites with Decrease	3.0	-8.1	2.6	1.9
Automotive				
Sites with Increase	58.4	15.2	10.4	8.2
Sites with No Change	37.6		2.9	2.0
Sites with Decrease	4.0	-2.5	4.8	3.7
Computers and Peripherals				
Sites with Increase	58.5	17.0	4.0	4.2
Sites with No Change	36.6		1.0	1.3
Sites with Decrease	4.9	-10.0	4.5	4.5
Consumer Electronics				
Sites with Increase	63.0	13.7	3.1	3.7
Sites with No Change	33.3		2.2	1.4
Sites with Decrease	3.7	-16.7	1.5	0
Electrical and Electronic				
Sites with Increase	69.4	14.2	5.6	4.7
Sites with No Change	30.6		13.1	11.2
Sites with Decrease	0	NA	NA	NA
Industrial Machinery				
Sites with Increase	59.1	18.4	2.8	2.7
Sites with No Change	37.5		3.2	2.4
Sites with Decrease	3.4	-5.0	0.7	0.7
Service/Design/Consulting				
Sites with Increase	50.0	34.4	1.5	1.8
Sites with No Change	47.1		0.4	0.9
Sites with Decrease	2.9	NA	NA	1.5

NA = Not available
Source: Dataquest (September 1994)

Table 5-5
New Software Module Opportunity

	Percentage of Sites	Expected Change in Seat Count (%)	Module Change (%)	Total Module Increase (%)
All Sites				
Sites with Increase	60.2	17.8	5.7	23.4
Sites with No Change	36.8		4.7	4.7
Sites with Decrease	3.0	-8.1	8.4	0.3
Automotive				
Sites with Increase	58.4	15.2	7.5	22.7
Sites with No Change	37.6		5.9	5.9
Sites with Decrease	4.0	-2.5	8.9	6.4
Computers and Peripherals				
Sites with Increase	58.5	17.0	4.0	21.0
Sites with No Change	36.6		3.9	3.9
Sites with Decrease	4.9	-10.0	7.5	-2.5
Consumer Electronics				
Sites with Increase	63.0	13.7	7.8	21.5
Sites with No Change	33.3		4.0	4.0
Sites with Decrease	3.7	-16.7	19.4	2.7
Electrical and Electronic				
Sites with Increase	69.4	14.2	4.2	18.4
Sites with No Change	30.6		8.7	8.7
Sites with Decrease	0	NA	NA	NA
Industrial Machinery				
Sites with Increase	59.1	18.4	4.6	23.0
Sites with No Change	37.5		4.0	4.0
Sites with Decrease	3.4	-5.0	5.0	0
Service/Design/Consulting				
Sites with Increase	50.0	34.4	5.0	39.4
Sites with No Change	47.1		4.0	4.0
Sites with Decrease	2.9	NA	5.0	NA

NA = Not available
Source: Dataquest (September 1994)

17.8 percent growth in seat count. This should net close to a 24 percent software-module growth rate per year during the next two years.

At sites with no seat-count change expected, they were expecting to replace over 4.7 percent of the installed software modules. A surprising number, nearly 8.4 percent, in planned software modules was found at sites with seat-count reductions. It would appear that new software is being brought in to make the existing seats more productive.

Service/design/consulting has some of the highest planned module increases for sites with increasing seat count. This is primarily owing to the fact that this industry is planning a very high change in seat counts (which are assumed to bring along new software), as opposed to a high retirement in existing software modules (which are assumed to be replaced).

Modeling Technology Planned for New Software Purchases

A fundamental issue in understanding the planned software acquisition activity concerns the core modeling technology supporting the application modules. We asked several questions concerning the future use of 3-D applications. First, we asked if 3-D design will become the main method of design in the next two years. Approximately 75 percent of respondents answered "yes" to the question. The answers varied somewhat by industry, with industrial machinery holding the low ground (60 percent of respondents said "yes") and consumer electronics and automotive industries holding the high ground (approximately 87 percent). Table 5-6 summarizes these responses by industry.

A related question asked if the end user has already been using a 3-D CAD/CAM/CAE system, plans to use such a system in the future, or has no plans to use a 3-D system. The results are shown in Table 5-7. Approximately 63 percent of respondents have already been using some sort of 3-D CAD/CAM/CAE tools in their work, and nearly one-quarter have plans to do so. The results did not vary widely by industry, with the exception of the automotive sites, of which 80 percent use 3-D systems and only 8 percent of sites do not have plans for a 3-D system.

Table 5-6
"Will 3-D Design Become the Main Method of Design?"

	Yes (%)	No (%)
All Sites	76.2	23.8
Consumer Electronics	87.7	12.3
Automotive	86.0	14.0
Service/Design/Consulting	79.5	20.5
Computers and Peripherals	77.8	22.2
Electrical and Electronic	75.7	24.3
Industrial Machinery	59.5	40.5

Source: Dataquest (September 1994)

Table 5-7
Plans to Use 3-D CAD/CAM/CAE

	Already Use 3-D Software	Plan to Use	No Plan to Use
All Sites	63.1	23.3	13.6
Automotive	79.1	12.7	8.2
Consumer Electronics	68.6	20.9	10.5
Service/Design/Consulting	59.0	30.8	10.3
Computers and Peripherals	53.8	33.3	12.8
Electrical and Electronic	48.9	31.9	19.1
Industrial Machinery	48.9	28.4	22.7

Source: Dataquest (September 1994)

We then asked that, of all new software planned for purchase in the next two years, what percentage falls into each of the following categories:

- 2-D only
- 3-D wireframe
- 3-D surface modeling
- Solid modeling-based
- A fully integrated 2-D, 3-D, and solids-based product

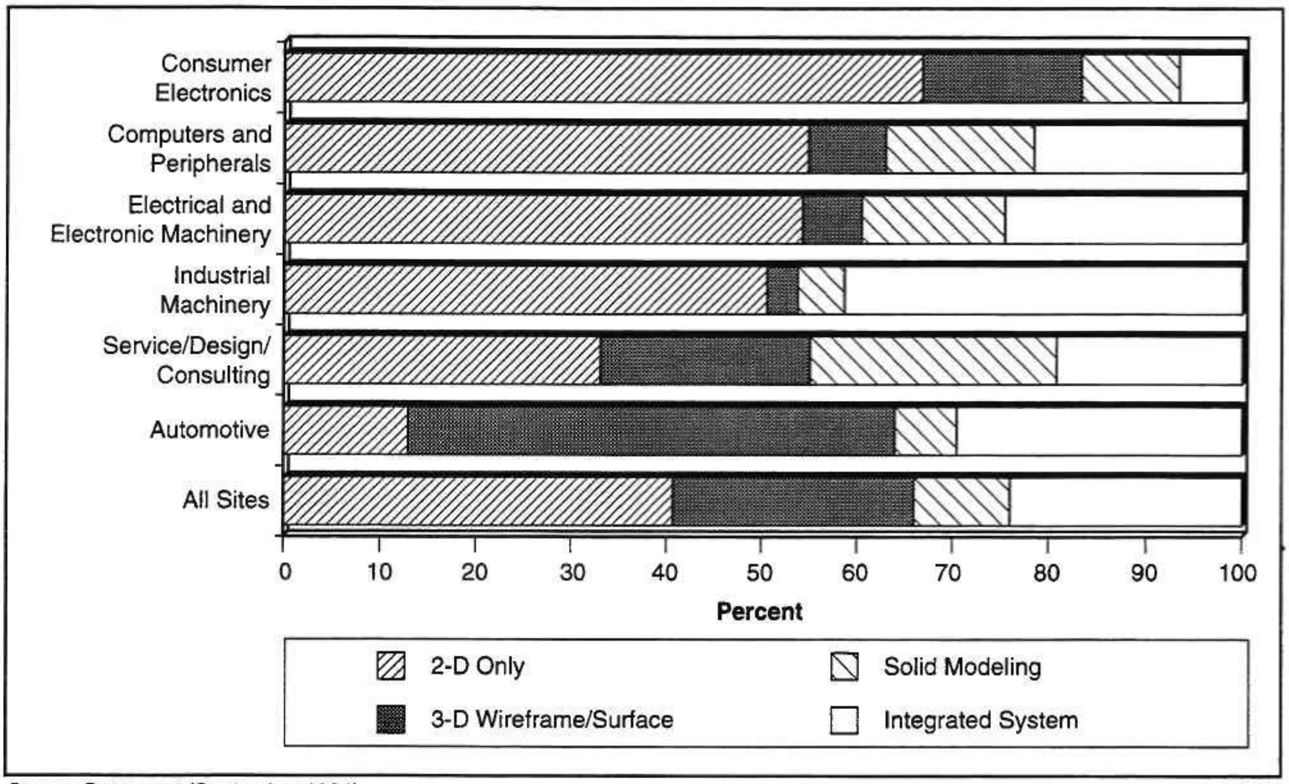
Figure 5-5 and Table 5-8 show the variation in responses. Almost 25 percent of all respondents said that they need a fully integrated solution. This contrasts sharply with the U.S./European users, of whom 36 percent stated that they needed a fully integrated solution. The response rate for an integrated solution among Japanese end users varied from 7 percent (consumer electronics) to 41 percent (industrial design). Like last year, 3-D-wireframe/surface and solid-modeling products do not attract much attention, with the remainder being 2-D products. The Japanese consumer electronics industry led the way, with more than 65 percent planning on 2-D products. Similar to last year, industrial machinery and electrical and electronic industries have a higher than average interest as well.

Reasons that were cited for not using 3-D CAD/CAM/CAE tools are illustrated in Figure 5-6. The most common reason for all sites was that 2-D CAD was enough (29 percent), followed by the reason that 3-D systems are very expensive (21 percent) or very difficult to use (21 percent).

Interest in STEP

One of the most promising initiatives toward a standard for product data interchange has been found to be the Standard for the Exchange of Product Data/Product Data Exchange Using STEP (STEP/PDES) being developed concurrently by several worldwide organizations, including companies, governments, and user groups. Table 5-9 outlines Japanese end-user interest in STEP. The "do not know" responses were included in this table because these responses capture two types of end users: those

Figure 5-5
Future Seats by Modeling Type



Source: Dataquest (September 1994)

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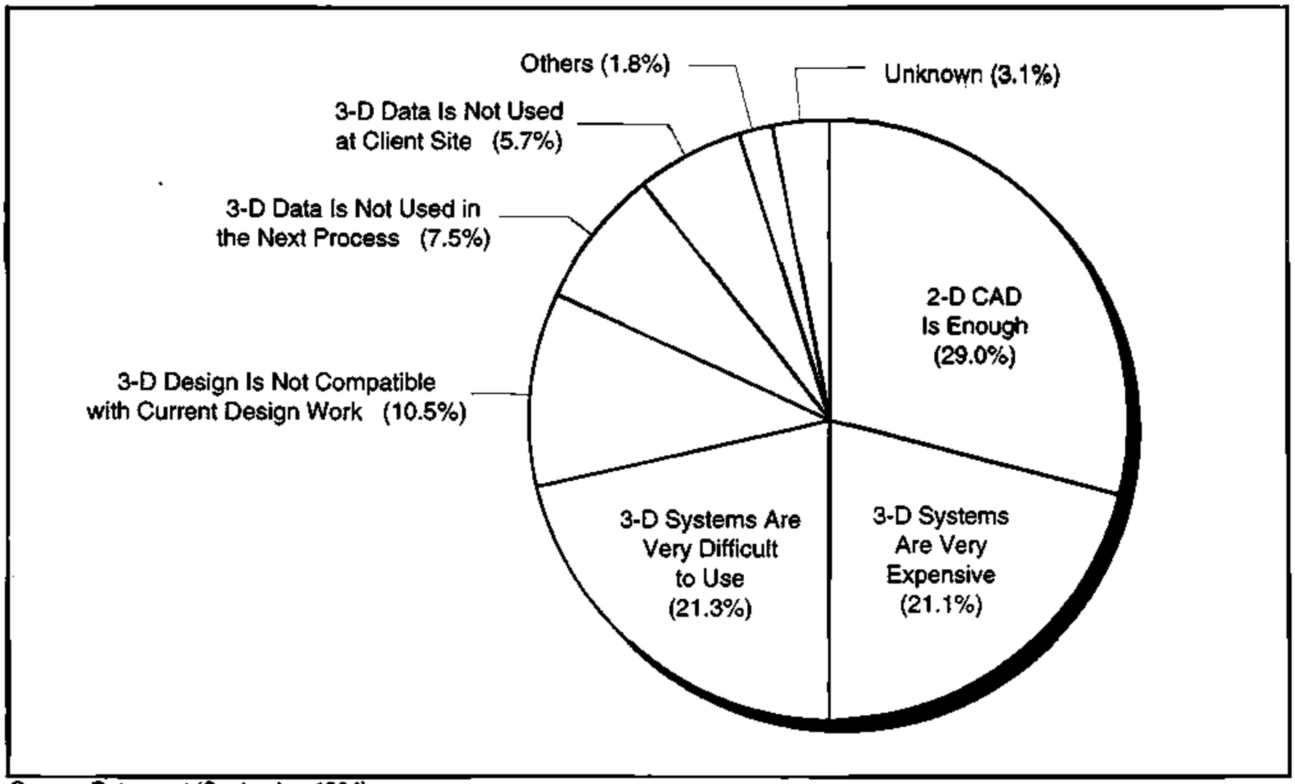
Table 5-8
Percentage of Future Seats by Modeling Type

	2-D Only	3-D Wireframe/ Surface	Solid Modeling	Integrated System
All Sites	40.7	15.3	10.0	24.0
Consumer Electronics	66.8	16.5	10.1	6.6
Computers and Peripherals	54.9	8.1	15.4	21.5
Electrical and Electronic	54.3	6.2	15.0	24.5
Industrial Machinery	50.6	3.2	4.9	41.2
Service/Design/Consulting	33.1	22.0	25.7	19.1
Automotive	12.9	51.1	6.4	29.5

Source: Dataquest (September 1994)

Figure 5-6
Reasons Cited for Not Using 3-D CAD/CAM/CAE



Source: Dataquest (September 1994) G4004647

Table 5-9
Interest in STEP

	Very Interested	Interested	Not Interested	Do Not Know
All Sites	16.4	41.5	13.2	28.9
Consumer Electronics	48.3	24.5	10.9	16.3
Automotive	33.3	43.9	9.6	13.2
Service/Design/Consulting	20.5	36.4	6.8	36.4
Computers and Peripherals	20.0	47.5	10.0	22.5
Industrial Machinery	10.2	31.6	16.3	41.8
Electrical and Electronic	6.8	52.3	9.1	31.8

Source: Dataquest (September 1994)

that do not know about STEP and those that are not able to gauge their own interest or their group's interest in STEP. It is clear that this "do not know" group can make up a sizable portion of the responses, as indicated by the 42 percent response in the industrial machinery industry. Overall, 58 percent of sites report having some interest in STEP. The automotive industry, not surprisingly, has one of the largest interests in STEP, along with consumer electronics sites. The automotive group, as a whole, is also one of the more active proponents of the STEP standard, both in Japan and worldwide. Industrial machinery sites had the lowest interest in STEP (42 percent).

Chapter 6
Importance and Satisfaction Evaluation

Gap analysis is a classic way to evaluate the relative importance and level of satisfaction among a number of related issues. We felt that it would be useful to analyze end-user perceptions on several issues within each of the following categories:

- Strategic business issues
- Software issues
- Point solutions
- Integrated solutions
- Future acquisition issues

We asked the respondents to rate these issues on a scale of one to five with five being very important or satisfied and one being not at all important or satisfied. A rating of three is viewed as neutral.

Table 6-1 shows the highest-rated importance items seen in this survey and last year's survey for each major category. Two important observations can be drawn from these survey results when viewed collectively. First, for nearly all issues evaluated, the level of satisfaction was below the level of importance. This is unusual for an analysis of this type and indicates a general performance of a given product below expectations or needs. Second, the Japanese end users tended to show greater dissatisfaction with their software (as evidenced by the relatively low satisfaction scores) and tended to have greater importance/satisfaction gaps than the U.S./European end users.

Table 6-1
Summary Table of Top Ranked Importance Issues

Category	Highest-Rated Importance Issue, Japan	Highest-Rated Importance Issue, United States/Europe
Strategic Business Issues	Lowering design costs	Improving product quality
Software Issues	Easy to learn software	High-quality software
Point Solutions	Supporting the design function	Supporting the design function
Integrated Solutions	Supporting integrated design and drafting solutions/design manufacturing	Supporting integrated design and drafting solutions
Future Acquisition Issues	IGES support/high-performance 3-D graphics	Offering integrated product data management

Note: On a scale of 1 to 5, 1 is not important or satisfied; 5 is very important or satisfied.
Source: Dataquest (September 1994)

The dynamics of this situation create an opportunity for innovative developers to make the installed products obsolete and to be chosen as the next supplier in the technology food chain. Vendors with high-cost, difficult-to-use stale products, buggy software, or poor performance should beware because the market pressure to improve has never been higher.

Strategic Business Issues

A variety of issues can be used to evaluate the importance of strategic issues in the success of a business. Reducing time to market is often used as a justification issue for CAD/CAM/CAE tool acquisition. This item, however, was rated fourth on the list behind the following:

- Lowering design cost
- Improving product quality
- Lowering manufacturing cost

The Japanese companies interviewed in this survey see lowering design costs as the top strategic business issue. It is no wonder that lowering costs is a top issue because Japanese companies tend to market a large number of innovative and diverse products. This degree of innovation can be readily observed in the consumer electronics and automotive industries of Japan. Earlier questions in the survey indicate a large workforce as a major contributor to design cost.

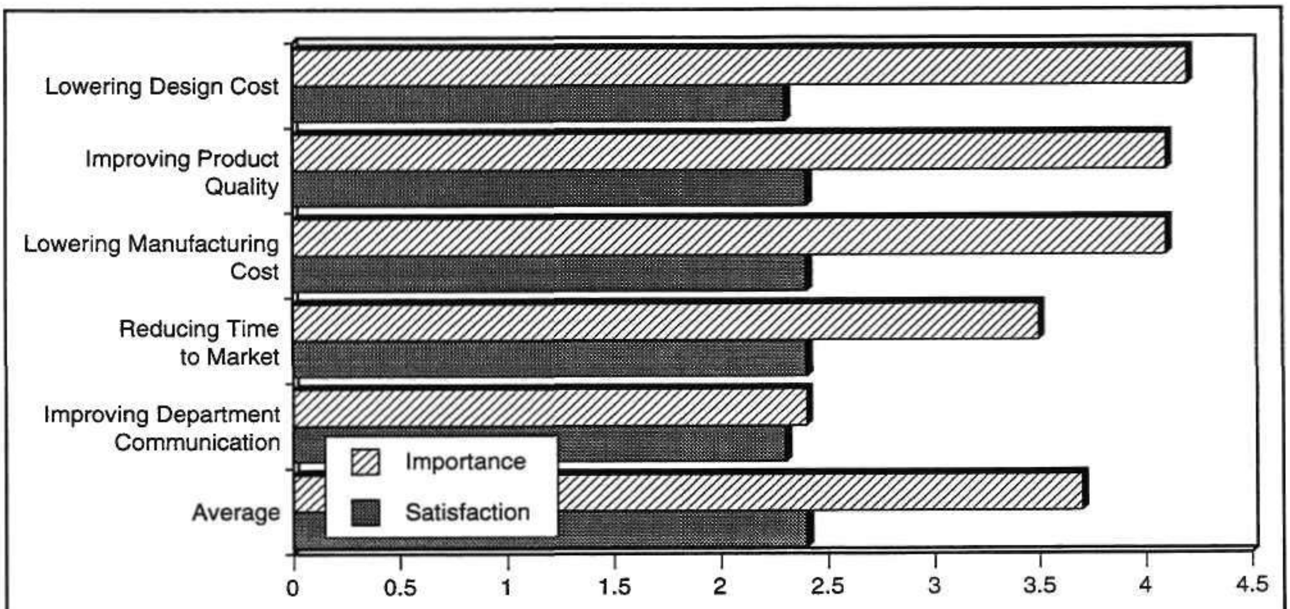
Improving product quality, which was ranked first by U.S. and European respondents, came in a very close second for this survey of Japanese respondents and was tied with lowering manufacturing costs. Clearly, one of the more important benefits of using CAD/CAM/CAE tools is to improve the quality of the end product. Perceived product quality can justify higher purchase pricing, while real product quality can lower potential litigation expense.

The gap, or difference, between importance and satisfaction ratings was fairly high, as shown in Figure 6-1 and Table 6-2. Usually a gap of more than one in this type of analysis is viewed as significant. In this case, the top three strategic reasons for CAD/CAM/CAE justification all had a gap rating of 1.7 or higher. We believe that these end users are not happy with the ability of their automation tools to provide competitive advantage at the strategic level. Vendors that can demonstrate an ability to provide these tools will have a significant advantage in the next five years.

Software Issues

Again, our Japanese survey respondents have a slightly different perception of importance and a large difference in satisfaction with regard to software issues than our U.S./European respondents. On average, the level of dissatisfaction was twice as large compared with the earlier survey. The results are shown in Figure 6-2 and Table 6-3. Here, the most important software issue was having access to very easy to learn software, while in

Figure 6-1
Importance and Satisfaction Evaluation of Strategic Business Issues



Note: On the scale of 1 to 5, 1 is not important or satisfied; 5 is very important or satisfied.
Source: Dataquest (September 1994)
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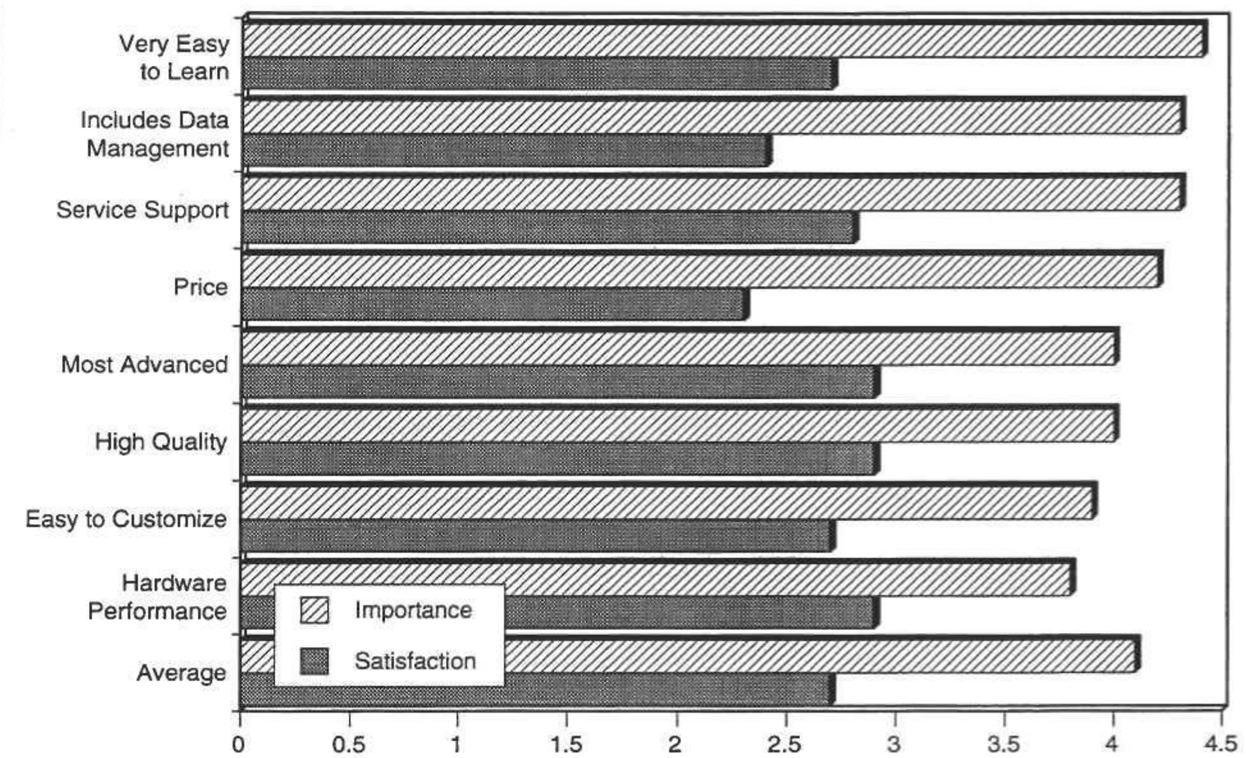
Table 6-2
Importance and Satisfaction Evaluation of Strategic Business Issues

	User-Rated Importance	User-Rated Satisfaction	Gap
Lowering Design Cost	4.2	2.3	-1.9
Lowering Manufacturing Cost	4.1	2.4	-1.7
Improving Product Quality	4.1	2.4	-1.7
Reducing Time to Market	3.5	2.4	-1.1
Improving Department Communication	2.4	2.3	-0.1
Average	3.7	2.4	-1.3

Note: On a scale of 1 to 5, 1 is not Important or satisfied; 5 is very important or satisfied.
Source: Dataquest (September 1994)

Figure 6-2
Importance and Satisfaction Evaluation of Software Issues



Note: On the scale of 1 to 5, 1 is not important or satisfied; 5 is very important or satisfied.

Source: Dataquest (September 1994)

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Table 6-3
Importance and Satisfaction Evaluation of Software Issues

	User-Rated Importance	User-Rated Satisfaction	Gap
Very Easy to Learn	4.4	2.7	-1.7
Service Support	4.3	2.8	-1.5
Includes Data Management	4.3	2.4	-1.9
Price	4.2	2.3	-1.9
High Quality	4.0	2.9	-1.1
Most Advanced	4.0	2.9	-1.1
Easy to Customize	3.9	2.7	-1.2
Hardware Performance	3.8	2.9	-0.9
Average	4.1	2.7	-1.4

Note: On a scale of 1 to 5, 1 is not Important or satisfied; 5 is very important or satisfied.
Source: Dataquest (September 1994)

our previous survey, the most important issue was software quality (that is, buggy software, corrupt data files, and weak interfaces among modules). Many vendors can rest on the recent laurel of improved graphical user interfaces or an infusion of parametric or variational user input technology, which has made software easier to learn.

Having access to software that includes data management and that provides good service support is the second and third issues for Japanese end users. Both of these issues have a large importance/satisfaction gap of negative 1.9, indicating that there is much room for improvement on both of these fronts.

Overall, Japanese end users seem to be more dissatisfied with software features and functionality than U.S. or European users, as evidenced by the larger importance/satisfaction gaps for these issues. In general, though, all software issues were rated fairly high in importance (ratings of 3.8 or greater) among all respondents, regardless of the region of the world that they represent.

Point Solutions

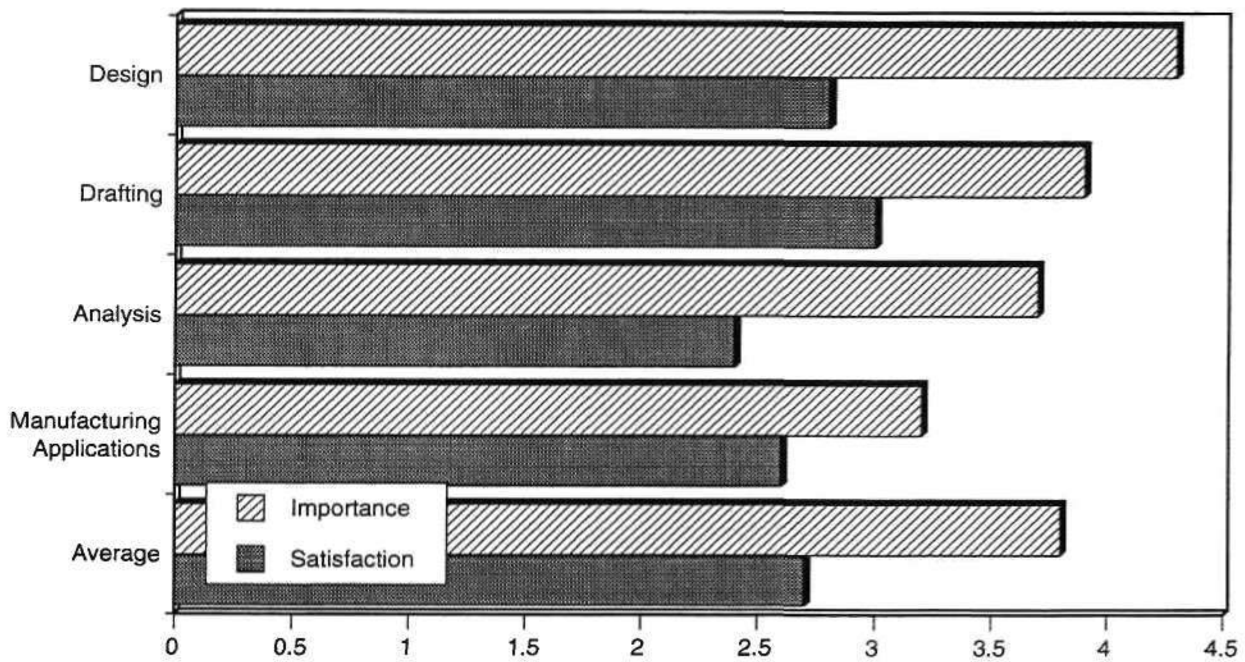
Considering the overall productivity at each site, the importance and level of satisfaction for each of the following high-performance CAD/CAM/CAE point solutions were rated: design, drafting, analysis, and manufacturing—ranked in that order for importance. While in our previous survey, the range in values was quite narrow, suggesting a similar level of importance, this time, the values are more spread out, with design (the highest-ranked application) having a rating of 4.3 and manufacturing (the lowest ranked application) having an importance rating of 3.2. The low level of importance given to manufacturing seems contradictory to the common belief that Japanese companies are aggressive in this area. Perhaps the impact of CAD/CAM tools is not a driving factor in the manufacturing process. The level of satisfaction ranges from 2.4 for analysis to 3.0 for drafting. See Figure 6-3 and Table 6-4 for detailed evaluation.

Integrated Solutions

Integrated solutions were rated about the same in importance as point solutions. Figure 6-4 and Table 6-5 show the user ratings. A fully combined design, analysis, drafting, and manufacturing package was desirable (importance rating of 3.9) but had the lowest satisfaction rating (2.2) and the largest gap (negative 1.7).

Overall, the Japanese end users rated integrated solutions slightly lower in importance than the U.S. and European respondents and also ranked these items much lower with respect to satisfaction. As a result, the importance/satisfaction gap, averaged over all integrated solution ratings, is much larger with the Japanese respondents (negative 1.4) than with the U.S./European respondents (negative 0.9).

Figure 6-3
Importance and Satisfaction Evaluation of Point Solutions



Note: On the scale of 1 to 5, 1 is not important or satisfied; 5 is very important or satisfied.

Source: Dataquest (September 1994)

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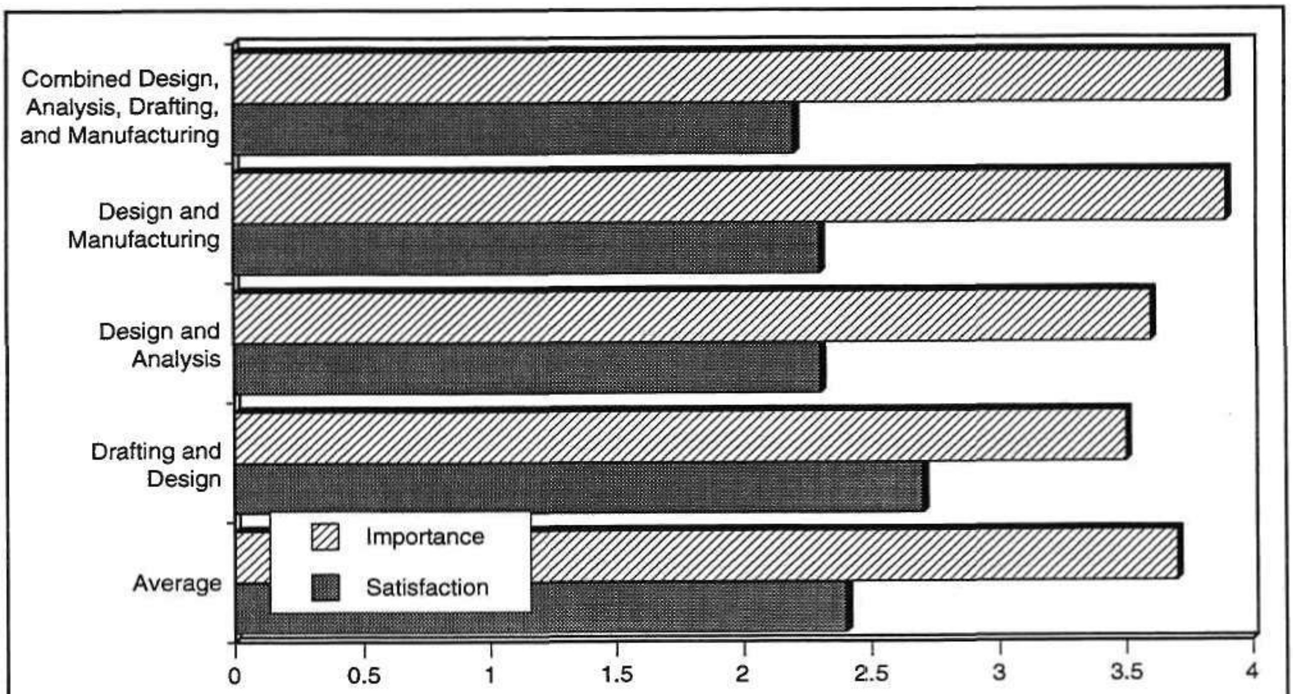
Table 6-4
Importance and Satisfaction Evaluation of Point Solutions

	User-Rated Importance	User-Rated Satisfaction	Gap
Design	4.3	2.8	-1.5
Drafting	3.9	3.0	-0.9
Analysis	3.7	2.4	-1.3
Manufacturing Applications	3.2	2.6	-0.6
Average	3.8	2.7	-1.1

Note: On a scale of 1 to 5, 1 is not Important or satisfied; 5 is very important or satisfied.

Source: Dataquest (September 1994)

Figure 6-4
Importance and Satisfaction Evaluation of Integrated Solutions



Note: On the scale of 1 to 5, 1 is not important or satisfied; 5 is very important or satisfied.
Source: Dataquest (September 1994)
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Table 6-5
Importance and Satisfaction Evaluation of Integrated Solutions

	User-Rated Importance	User-Rated Satisfaction	Gap
Combined Design, Analysis, Drafting, and Manufacturing	3.9	2.2	-1.7
Design Manufacturing	3.9	2.3	-1.6
Design Analysis	3.6	2.3	-1.3
Drafting Design	3.5	2.7	-0.8
Average	3.7	2.4	-1.4

Note: On a scale of 1 to 5, 1 is not important or satisfied; 5 is very important or satisfied.
Source: Dataquest (September 1994)

The integrated system and the design/manufacturing combination obtained the highest rating of importance, while the use of CAD in a standalone mode in manufacturing received a lower rating. This suggests that the importance of the link to manufacturing is highly regarded. A closer look finds the issues reversed in the earlier survey. An integrated solution for design and drafting was rated the most important in the U.S./European study. The design and manufacturing combination was rated the lowest. In the Japanese study, the rating is the other way around. So, the Japanese manufacturing companies are, in fact, more interested in a well-integrated system with strong links to the manufacturing processes.

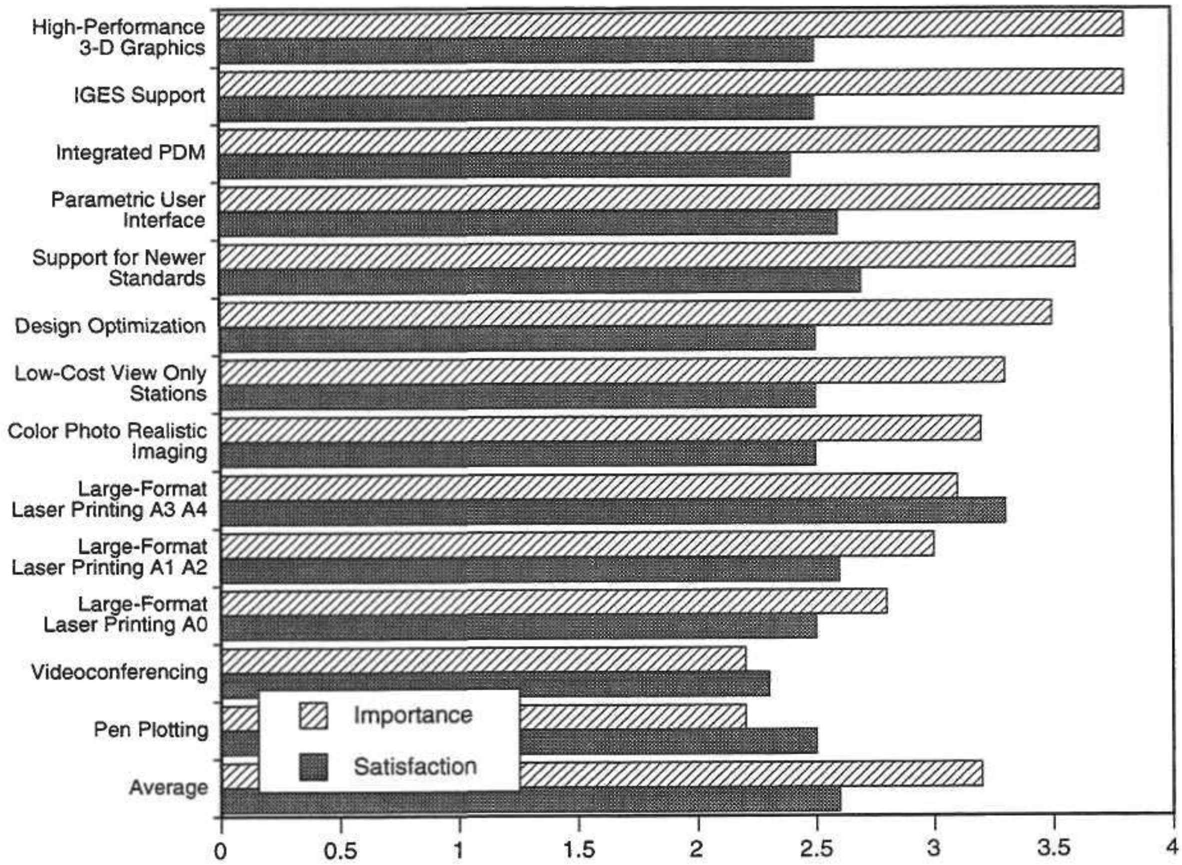
Future Acquisition Issues

We asked end users what is important when making future system and software acquisition plans in order to develop an idea of some of the critical decision-making issues at work in the minds of today's purchasers. The first five or six issues listed in Figure 6-5 will undoubtedly be considered in the future acquisition decision-making process. Table 6-6 shows this data in more detail. The general trend in importance was very similar in the two studies. For the U.S./European study, integrated product data management, design optimization, and support for new industry standards, such as PDES and STEP, were the top three issues. This year, IGES support, high-performance 3-D graphics, and integrated data management (tied with parametric user interface) are the issues of most importance. These same issues had some of the greater levels of dissatisfaction and the largest importance/satisfaction gaps.

As we have seen earlier, Japanese respondents ranked these future acquisition issues about the same in importance as U.S./European respondents, but much lower in satisfaction. Interest in pen plotting and videoconferencing are well below the indifference level.

It is worth noting that high-performance 3-D graphics was rated several items more important in the Japanese study. U.S. and European users were expecting design optimization tools to be more important in future acquisitions. We would expect the interest level for design optimization to increase in Japan as the benefits of this technology are more well known. This points to an interesting trend that will tend to reduce the need for high-performance graphics and increase the need for high-performance computing to support the massive amounts of analysis iteration under program control in future optimization activity.

Figure 6-5
Importance and Satisfaction of Future Acquisition Issues



Note: On the scale of 1 to 5, 1 is not important or satisfied; 5 is very important or satisfied.

Source: Dataquest (September 1994)

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Table 6-6
Importance and Satisfaction Evaluation of Future Acquisition Issues

	User-Rated Importance	User-Rated Satisfaction	Gap
IGES Support	3.8	2.5	-1.3
High-Performance 3-D Graphics	3.8	2.5	-1.3
Parametric User Interface	3.7	2.6	-1.1
Integrated PDM	3.7	2.4	-1.3
Support for Newer Standards	3.6	2.7	-0.9
Design Optimization	3.5	2.5	-1.0
Low-Cost View-Only Stations	3.3	2.5	-0.8
Color Photo Realistic Imaging	3.2	2.5	-0.7
Large Format Laser Printing A3 A4	3.1	3.3	0.2
Large Format Laser Printing A1 A2	3.0	2.6	-0.4
Large Format Laser Printing A0	2.8	2.5	-0.3
Pen Plotting	2.2	2.5	0.3
Videoconferencing	2.2	2.3	0.1
Average	3.2	2.6	-0.6

Note: On a scale of 1 to 5, 1 is not important or satisfied; 5 is very important or satisfied.
Source: Dataquest (September 1994)

Chapter 7
Findings and Recommendations

Vendor Recommendations

Many opportunities exist in the Japanese CAD/CAM/CAE market to develop a better solution based on newer technology and PC-based or workstation-based platforms. The users want easy-to-use software with improved integration among the modules, better data management, and strong service support. The recommendation in this case is to design easy-to-use software with these qualities for the installed base and for new customers.

Even with the poor economic trend in Japan, do not ignore this important market. Many companies are considering how to upgrade to the next-generation hardware platform and software combination. Japanese end users, as a whole, plan to learn twice the number of new products than the U.S. or European users during the next two years. Additionally, no one vendor dominates all of the subapplications in Japan. There is a huge void between the interest in product data management and the penetration of such products among end users.

Expect some fundamental changes in the organization and structure of many of the manufacturing companies in Japan. Strategic changes are being made to improve the competitiveness of these operations.

The idealized viewpoint of some of the future-looking questions in the survey indicate, at best, a strong interest in moving the latest design optimization tools into the hands of specialists. A less optimistic evaluation finds a reduced interest level in advanced technology. An advanced function for detail drafting was voted the highest for potential user growth.

User Recommendations

Develop a technology enrichment plan that systematically removes old systems from use and replace them with the best of the best. If the available talent in one's product design and manufacturing environment can fully utilize the best technology, take full advantage of the offerings from the leaders. If a less robust solution can fit the need, price shopping can be effective to a point. We do not believe the world-class manufacturing companies will be ordering their primary automation tools from a mail-order catalog.

Be aggressive in using this technology. The automation of a group effort is exponentially better than the incremental improvement of the individual. However, the specialists need support with unique tools optimized for their responsibilities. Implement a technology refreshment strategy that ensures access and experience with the best of today's technology.

For More Information...

Michael Seely, Director .... (408) 437-8178
Internet address .... mseely@dataquest.com
Via fax .... (408) 437-0292

Dataquest
a company of
The Dun & Bradstreet Corporation

Dataquest

a company of
The Dun & Bradstreet Corporation

Corporate Headquarters
Dataquest Incorporated
1290 Ridder Park Drive
San Jose, California 95131-2398
United States
Phone: 1-408-437-8000
Facsimile: 1-408-437-0292

Dataquest Incorporated
550 Cochituate Road
Framingham, Massachusetts 01701-9324
United States
Phone: 1-508-370-5555
Facsimile: 1-508-370-6262

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

Dataquest Korea
Trade Tower, Suite 3806
159 Samsung-dong
Kangnam-gu, Seoul 135-729
Korea
Phone: 82-2-551-1331
Facsimile: 82-2-551-1330

Dataquest Taiwan
3/F, No. 87 Sung Chiang Road
Taipei
Taiwan, R.O.C.
Phone: 886-2-509-5390
Facsimile: 886-2-509-5660

European Headquarters
Dataquest Europe Limited
Holmers Farm Way
High Wycombe, Buckinghamshire
HP12 4UL
England
Phone: 44-494-422722
Facsimile: 44-494-422742

Dataquest GmbH
Kronstadter Strasse 9
81677 München
Germany
Phone: 49-89-930-9090
Facsimile: 49-89-930-3277

Dataquest Europe SA
Tour Franklin
Cedex 11
92042 Paris-La-Défense
France
Phone: 33-1-41-25-18-00
Facsimile: 33-1-41-25-18-18

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

Representative Agencies in
Bangkok, Hong Kong,
Kronberg, North Sydney,
Singapore, and Tel Aviv