

9/1/87

REPORT PRINTER READY CHECK LIST

DATE: 2/4/88

PROJ. CODE: MSVA-ES

REPORT NAME: ENGINEERING AND SCIENTIFIC

AUTHOR: \_\_\_\_\_

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# INFORMATION SERVICES INDUSTRY-SPECIFIC AND CROSS-INDUSTRY MARKETS

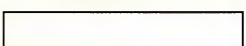
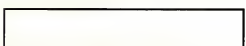
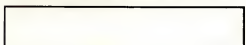
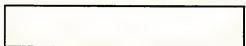
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Market  
Analysis and  
Planning  
Services  
(MAPS)



**U.S. Information  
Services  
Cross-Industry  
Markets  
1987-1992**

**Engineering and  
Scientific Sector**

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U.S. INFORMATION SERVICES  
CROSS-INDUSTRY MARKETS  
1987-1992

ENGINEERING AND  
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Published by  
INPUT  
1280 Villa Street  
Mountain View, CA 94041-1194  
U.S.A.

**Market Analysis and Planning Services  
(MAPS)**

***U.S. Information Services, Cross-Industry  
Markets, 1987-1992  
Engineering and Scientific Sector***

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the 1990s, the number of people in the world who are undernourished has increased from 600 million to 800 million (FAO 2001).

There are a number of reasons for this increase. First, the world population has increased from 5 billion in 1987 to 6 billion in 2000, and is projected to reach 8 billion by 2025 (UN 2000). Second, the world population is becoming increasingly urbanized, and this has led to a greater demand for food. Third, the world population is becoming increasingly aged, and this has led to a greater demand for food.

There are a number of ways in which we can address the problem of food security. First, we can increase the production of food. This can be done by increasing the area of land under cultivation, by increasing the yield of crops, and by increasing the number of harvests per year. Second, we can reduce the loss of food. This can be done by reducing the amount of food that is wasted, and by reducing the amount of food that is lost to pests and diseases.

Third, we can improve the distribution of food. This can be done by reducing the amount of food that is lost to transport, and by reducing the amount of food that is lost to corruption. Fourth, we can improve the nutrition of the population. This can be done by increasing the amount of food that is consumed, and by increasing the quality of the food that is consumed.

There are a number of challenges that we face in addressing the problem of food security. First, we need to increase the production of food. This is a challenge because we need to increase the area of land under cultivation, and we need to increase the yield of crops. Second, we need to reduce the loss of food. This is a challenge because we need to reduce the amount of food that is wasted, and we need to reduce the amount of food that is lost to pests and diseases.

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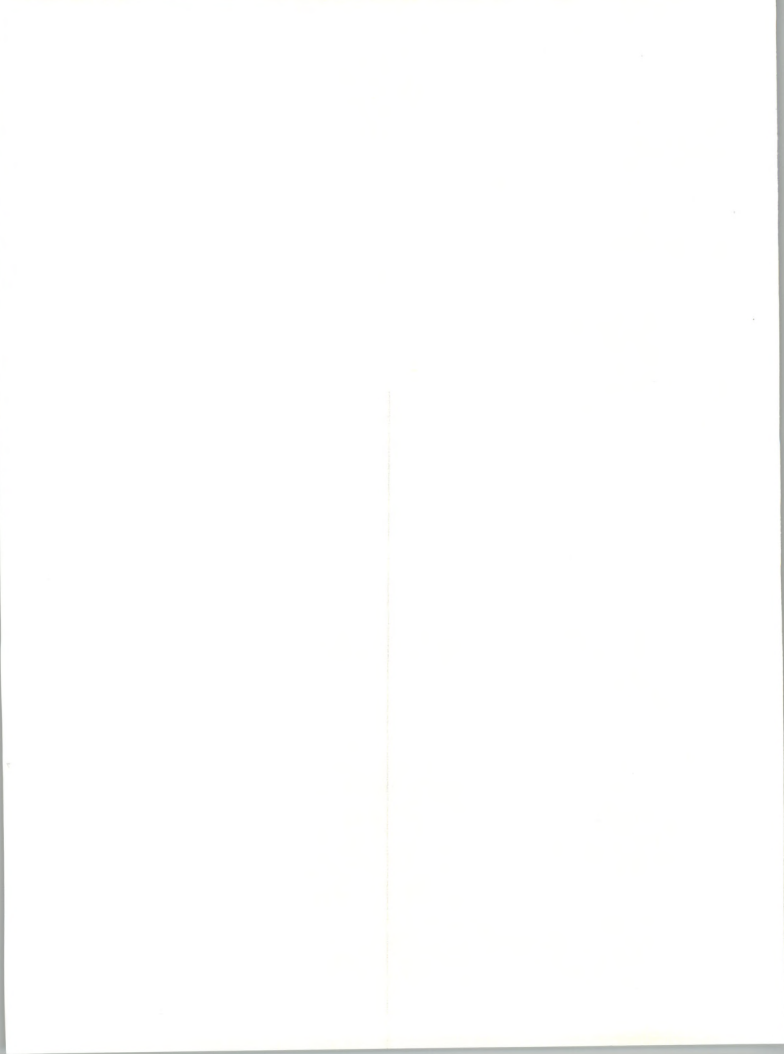
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the same, the rate of change of the total number of individuals in the population is given by the sum of the rates of change of the number of individuals in each age class. This is given by

$$\frac{dN}{dt} = \sum_{i=1}^n \frac{dN_i}{dt} \quad (1)$$

where  $N$  is the total number of individuals in the population,  $N_i$  is the number of individuals in the  $i$ th age class, and  $\frac{dN_i}{dt}$  is the rate of change of the number of individuals in the  $i$ th age class. The rate of change of the number of individuals in the  $i$ th age class is given by

$$\frac{dN_i}{dt} = \sum_{j=1}^n \lambda_{ij} N_j - \mu_i N_i \quad (2)$$

where  $\lambda_{ij}$  is the rate of transition from age class  $j$  to age class  $i$ , and  $\mu_i$  is the rate of mortality in age class  $i$ .

The matrix  $\mathbf{L}$  is called the Leslie matrix. The eigenvalues and eigenvectors of  $\mathbf{L}$  are used to determine the long-term growth rate of the population and the stable age distribution.

The characteristic equation of  $\mathbf{L}$  is given by

$$\det(\mathbf{L} - \lambda \mathbf{I}) = 0 \quad (3)$$

where  $\lambda$  is the eigenvalue and  $\mathbf{I}$  is the identity matrix. The roots of this equation are the eigenvalues of  $\mathbf{L}$ .

The dominant eigenvalue of  $\mathbf{L}$  is the long-term growth rate of the population, denoted by  $\lambda_1$ . The corresponding eigenvector is the stable age distribution, denoted by  $\mathbf{v}_1$ .

The dominant eigenvalue  $\lambda_1$  is the real part of the eigenvalue with the largest magnitude. The stable age distribution  $\mathbf{v}_1$  is the eigenvector corresponding to  $\lambda_1$ .

The long-term growth rate of the population is given by

$$\lambda_1 = \lim_{t \rightarrow \infty} \left( \frac{N(t)}{N(0)} \right)^{1/t} \quad (4)$$

where  $N(t)$  is the total number of individuals in the population at time  $t$ , and  $N(0)$  is the total number of individuals in the population at time  $0$ .

The stable age distribution is given by

$$\mathbf{v}_1 = \lim_{t \rightarrow \infty} \frac{N_i(t)}{N(t)} \quad (5)$$

where  $N_i(t)$  is the number of individuals in the  $i$ th age class at time  $t$ , and  $N(t)$  is the total number of individuals in the population at time  $t$ .

The stable age distribution  $\mathbf{v}_1$  is the eigenvector of  $\mathbf{L}$  corresponding to the dominant eigenvalue  $\lambda_1$ .

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## Issues, Trends, and Events







## Issues, Trends, and Events

### A

#### Introduction

Computer-aided engineering, computer-aided design, and computer-aided manufacturing (CAE/CAD/CAM) is the major component of the applications that are covered in the engineering and scientific market. While the report focuses on the CAE/CAD/CAM segment of the market because it is the largest and the most dynamic, the forecasts also include scientific applications for such uses as biological research, statistical analysis, and linear programming.

CAD/CAM includes design and drafting applications and also applications such as structural analysis and structural engineering. However, for the purpose of analysis, structural analysis applications are covered in a separate section.

CAD/CAM includes a wide range of applications:

- Mechanical design and drafting that includes finite element modeling and analysis, wireframe analysis, surface design, and solids modeling.
- Electronic design that includes circuit analysis, schematic capture, schematic design-rule checking, and integrated circuit layout.
- Architecture, engineering, and construction (AEC) that includes plant design, piping design and analysis, building design and management, mapping, and site engineering.
- Computer-aided manufacturing includes robot program design and simulation, and numerical control programming.

CAD can stand for either computer-aided design or computer-aided drafting.

the 1990s, the number of people in the world who are under 15 years of age has increased from 1.1 billion to 1.3 billion, and the number of people aged 65 and over has increased from 0.2 billion to 0.4 billion (United Nations 2002).

There are a number of reasons why the world population is increasing. One of the main reasons is that the number of children born to each woman has increased. This is due to a number of factors, including the fact that women are now having children at a younger age, and that there is a higher birth rate in developing countries. Another reason is that the number of people who are surviving to old age has increased. This is due to a number of factors, including the fact that people are now living longer, and that there is a higher life expectancy in developed countries.

The increase in the world population has a number of implications. One of the main implications is that there is a greater demand for resources, such as food, water, and energy. This is because there are more people who need these resources. Another implication is that there is a greater demand for housing and infrastructure. This is because there are more people who need these things. The increase in the world population also has a number of social implications, such as the fact that there are more people who are poor, and that there is a greater need for social services.

There are a number of ways in which the world population can be managed. One way is to reduce the birth rate. This can be done by providing women with access to family planning services, and by educating women about the benefits of having fewer children. Another way is to reduce the number of people who are surviving to old age. This can be done by providing people with access to health care, and by encouraging people to live healthier lifestyles.

The world population is increasing, and this has a number of implications. There are a number of ways in which the world population can be managed, and it is important that we take action now to manage the world population in a sustainable way. This is because the world population is expected to continue to increase, and this will have a number of negative impacts on the world if we do not take action now.

## 2. THE CHANGING DEMOGRAPHIC PROFILE OF THE WORLD POPULATION

The world population is increasing, and this has a number of implications. One of the main implications is that there is a greater demand for resources, such as food, water, and energy.

Another implication is that there is a greater demand for housing and infrastructure. This is because there are more people who need these things. The increase in the world population also has a number of social implications, such as the fact that there are more people who are poor, and that there is a greater need for social services. There are a number of ways in which the world population can be managed, and it is important that we take action now to manage the world population in a sustainable way.

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The world population is increasing, and this has a number of implications. One of the main implications is that there is a greater demand for resources, such as food, water, and energy.

- Computer-aided design involves design rule checks on drawings that have been entered. The design rule checks performed include checking for typographical errors, simple design mistakes, and for incomplete drawings. Examples include checking for spacing for parts, electrical overloads, and unspecified sizes of parts.

In addition to designing products, engineers also analyze the designs to make sure the products perform as required. Computer-aided engineering (CAE) programs fulfill this role.

Sometimes the terms CAD and CAE are used interchangeably because they are both design automation tools. However, there are important differences between the two:

- CAE systems are used at the "front-end," where products are conceived. They are used by engineers to automate the analysis and simulation of the design. In analysis and simulation, a mathematical or software model of the design is created and tested under various conditions. The results of these tests show what a physical model would do under the same conditions.
- On the other hand, CAD systems are used to draw and analyze physical structures. They are typically employed at the "tail end" of the product development process where they are used to convert engineers' designs into production drawings. The engineering and scientific market is typified by work that spans many industry segments, yet is concentrated in manufacturing, both discrete and process.

Approximately 17% the total CAE/CAD/CAM turnkey systems is included in the engineering and scientific segment forecasts. The remainder is included in the discrete manufacturing, process manufacturing, utilities, transportation, federal government, and other sectors.

- Likewise, the CAM portion is excluded from the analysis and forecasts in the engineering and scientific section. User expenditures for CAM sales are included in the discrete manufacturing industry sector.
- Expenditures by architectural and engineering firms for applications that are designed specifically for that type of firm, as opposed to an application designed for engineers or architects in any type of firm, are included in the industry-specific services sector under architectural and engineering services.

## B

### CAD/CAM

There are three major groups of CAD/CAM turnkey systems:

- The first is a low-cost system that sells for less than \$20,000. These systems are typically dedicated to a single task such as semiconductor





design. The IBM PC AT is the primary hardware for these products. These systems are typically limited to drafting and two-dimensional (2D) design capability.

- The second group of systems have more than one graphics workstation linked together in a cluster. Such systems begin at around \$100,000 and are suited to the needs of medium-sized firms with complex design needs.
- The third group of CAD/CAM systems comprises of the largest and most expensive equipment. These systems allow many designers to work on different portions of one project by using separate workstations that are connected to the central computer that updates and coordinates the whole design process. The high end of the market is growing at a slower rate than the other two groups.

The CAD/CAM market is characterized by the influx of microcomputer-based products into what had previously been a minicomputer and mainframe dominated market. PC CAD software has become a commodity product. PC-based systems have hurt sales of the high-end systems.

In addition to the move toward PC-based systems, the major trends in the CAD/CAM industry are the following:

- Move toward open architecture or industry-standard platforms.
- Emergence of systems to integrate mechanical design, engineering, and shop floor manufacturing systems.
- Integration of data management and computing systems. An effective data base management environment is necessary for the integration of a multi-vendor information system.
- Communications across disparate workstations and computer systems from multiple vendors. In order to address these communication problems, CAE/CAD/CAM vendors are making major shifts in their workstation offerings toward systems based on emerging industry standards.
- Distribution solutions in a hierarchical setting. The promise of a hierarchy of computing systems is that data management and archiving functions are performed at the host level and the interactive data management and design applications at the workstation level.
- Back-end processors at the departmental level.
- Move toward solids modeling and three-dimensional (3D) capabilities.



- Introduction of more intelligence through the incorporation of expert systems.
- Greater involvement of senior management in the decision to buy a system. CAD/CAM systems have become capital-expenditure items, thus requiring the approval of senior management. This lengthens the sales cycle.
- Move toward component CAD/CAM systems. Companies that already have computers installed are reluctant to buy integrated CAD/CAM systems that may duplicate what they already own. Instead, they are likely to want separate CAD/CAM components such as software and graphics workstations that they can connect to their existing hardware.

Vendors of CAD/CAM systems are focusing on front-end and back-end design applications since the drafting function of CAD has become a commodity product. As a result, vendors are placing increased emphasis upon integrating formerly disparate applications.

Turnkey CAD vendors are facing increasing pressure to unbundle software giving users even more choices in assembling their systems. Traditional companies will find it difficult to keep up their revenue streams.

A recent development has been the appearance of consulting centers designed to help CAD users do their own integration. These centers provide users with the guidance, training, and consulting needed to get their systems up and running.

## C

### CAE in Electronics Industry

The need for CAE tools in electronic design resulted from the increasing complexity of large-scale integrated circuits and the electronic systems incorporating such components. This increasing design complexity has significantly lengthened the product development cycle while, at the same time, more competition in the electronics industry has shortened product life cycles.

- The primary user benefits of CAD/CAM/CAE systems are in producing products less expensively and, more importantly, developing them faster to take advantage of market windows.
- CAE is used to improve the quality of design by simulating operational performance and by reducing the turnaround time for various phases of electronics engineering, including defining overall system architecture, logic circuit layout, design-rule checking, and timing simulation.
- This implies that there will have to be significant links between the design function and the production function, and post-production issues such as product testing and field service. Engineers want the design to

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go smoothly from CAD to CAE and then to CAM in a fully integrated system.

There are about 3,000 chip designers in the world compared with about 400,000 systems designers. The integrated circuit designers were the initial purchasers of CAE tools. The trend is toward system design rather than chip design. CAE tools will be more gradually adopted by systems designers which will be accompanied by evolutionary changes in the characteristics of CAE tools and suppliers. Systems designers will require tools that are easier to learn and use and which address a broader range of electronic design applications. It takes a long time, even for a sophisticated IC designer, to learn how to use the current systems.

A key issue facing CAE vendors now is data management, that is, the ability to move data through a particular vendor's system as well as the ability to transfer data from one vendor's system to another. However, because of the sheer volume of data and the assortment of formats used, data management presents a formidable challenge to the industry.

Currently, three companies dominate the CAE tools marketplace: Mentor Graphics, Daisy Systems, and Valid Logic Systems. The market forces facing these three leading CAE vendors are:

- Customers are demanding easier-to-use systems that cost less.
- Start-up companies are offering PC-based systems.
- Established instrument, CAD/CAM, and computer companies are suddenly attracted to the CAE market.

Vendors that have either entered or have announced their intention of entering the CAE market include:

- Tektronix, a leading instrumentation company, who acquired CAE Systems, Inc. of Sunnyvale, California.
- Hewlett-Packard, which has floundered in its attempts to develop CAE software, purchased a CAE software company—Cerico Inc. of Salt Lake City, Utah.
- The CAD/CAM companies, led by Computervision, Intergraph, General Electric's Calma subsidiary, and Schlumberger's Applicon division, have already begun encroaching on the CAE market.
- AT&T and IBM, with their own advanced internal CAE tools, could each be a major force in the market.

the 1990s, the number of people aged 65 and over in the United States is projected to increase from 20 million to 35 million (U.S. Census Bureau 1996).

As the number of people aged 65 and over increases, the number of people aged 75 and over is also expected to increase. The number of people aged 75 and over in the United States is projected to increase from 10 million in 1990 to 15 million in 2000 (U.S. Census Bureau 1996).

As the number of people aged 75 and over increases, the number of people aged 85 and over is also expected to increase.

The number of people aged 85 and over in the United States is projected to increase from 3 million in 1990 to 5 million in 2000 (U.S. Census Bureau 1996).

As the number of people aged 85 and over increases, the number of people aged 95 and over is also expected to increase.

The number of people aged 95 and over in the United States is projected to increase from 1 million in 1990 to 2 million in 2000 (U.S. Census Bureau 1996).

As the number of people aged 95 and over increases, the number of people aged 100 and over is also expected to increase.

The number of people aged 100 and over in the United States is projected to increase from 0.5 million in 1990 to 1 million in 2000 (U.S. Census Bureau 1996).

As the number of people aged 100 and over increases, the number of people aged 105 and over is also expected to increase.

The number of people aged 105 and over in the United States is projected to increase from 0.2 million in 1990 to 0.5 million in 2000 (U.S. Census Bureau 1996).

As the number of people aged 105 and over increases, the number of people aged 110 and over is also expected to increase.

The number of people aged 110 and over in the United States is projected to increase from 0.1 million in 1990 to 0.2 million in 2000 (U.S. Census Bureau 1996).

As the number of people aged 110 and over increases, the number of people aged 115 and over is also expected to increase.

The number of people aged 115 and over in the United States is projected to increase from 0.05 million in 1990 to 0.1 million in 2000 (U.S. Census Bureau 1996).

As the number of people aged 115 and over increases, the number of people aged 120 and over is also expected to increase.

The number of people aged 120 and over in the United States is projected to increase from 0.02 million in 1990 to 0.05 million in 2000 (U.S. Census Bureau 1996).

As the number of people aged 120 and over increases, the number of people aged 125 and over is also expected to increase.

The number of people aged 125 and over in the United States is projected to increase from 0.01 million in 1990 to 0.02 million in 2000 (U.S. Census Bureau 1996).

As the number of people aged 125 and over increases, the number of people aged 130 and over is also expected to increase.

The number of people aged 130 and over in the United States is projected to increase from 0.005 million in 1990 to 0.01 million in 2000 (U.S. Census Bureau 1996).

As the number of people aged 130 and over increases, the number of people aged 135 and over is also expected to increase.

The number of people aged 135 and over in the United States is projected to increase from 0.002 million in 1990 to 0.005 million in 2000 (U.S. Census Bureau 1996).

As the number of people aged 135 and over increases, the number of people aged 140 and over is also expected to increase.

The number of people aged 140 and over in the United States is projected to increase from 0.001 million in 1990 to 0.002 million in 2000 (U.S. Census Bureau 1996).

As the number of people aged 140 and over increases, the number of people aged 145 and over is also expected to increase.

The number of people aged 145 and over in the United States is projected to increase from 0.0005 million in 1990 to 0.001 million in 2000 (U.S. Census Bureau 1996).

As the number of people aged 145 and over increases, the number of people aged 150 and over is also expected to increase.

The number of people aged 150 and over in the United States is projected to increase from 0.0002 million in 1990 to 0.0005 million in 2000 (U.S. Census Bureau 1996).

As the number of people aged 150 and over increases, the number of people aged 155 and over is also expected to increase.

The number of people aged 155 and over in the United States is projected to increase from 0.0001 million in 1990 to 0.0002 million in 2000 (U.S. Census Bureau 1996).

However, all has not gone well for these new entrants.

- Companies like Hewlett-Packard and Tektronix have barely gained a toehold in CAE.
- The established CAD vendors have had trouble moving into CAE as well. Both Computervision and Calma bought small CAE startups to help them move into chip design systems, but marketing and technical problems have hampered their product introductions.

It takes a major investment of both time and resources to successfully penetrate this market. The software involved is very complex and, as H-P and Tektronix have discovered, more difficult and time consuming than anticipated. One cannot rush into the market with a CAE application.

- In addition, an ever increasing number of product features are required to enter this market. Additional features that have been added recently to CAE systems include PCB layout, ATE (automatic test equipment) interfaces, silicon compilation, and standard cell layout.
- The newer CAE products integrate the once independent functions of design, design verification, layout, and test generation, thereby easing the bottlenecks in the design-to-production process.

## D

### Structural Analysis

Structural analysis and modeling is of interest to a diverse range of customer segments, including the aerospace, automotive, and civil engineering industries. In general, engineering analysis involves the detailed simulation of structural behavior under a variety of operating conditions.

Typically, such analysis involves the use of "finite element modeling" (FEM) techniques for solutions. Finite element analysis, the most widely used of the structural engineering techniques, divides the structural unit being modeled into a discrete number of well-defined elements—the finite elements. These elements are assumed to be connected to each other in simple geometric shapes that individually lend themselves to analysis. The geometric shapes are then added together to form the essential structure of the object. Using this technique, the behavior of complex shapes, such as an airplane wing or an automobile fender, can be studied.

The commonality and generic appeal of FEM techniques applied to diverse applications had led to the development of industry standard software packages, such as ANSYS, NASTRAN, PATRAN, and STRUDL.





- The most popular FEM software is MacNeal-Schwendler Corporation's MSC/NASTRAN, a continuously enhanced version of the original NASA structural analysis program currently licensed for a monthly fee to over 300 customers in aerospace, defense, energy, construction, and consumer products industries. The full-scale program is available from most RCS vendors that support engineering and can be leased by a corporation for use on its own mainframe or minicomputer.
- Dozens of other structural simulation packages are available either in the public domain or for a fee from third parties, generally designed to aid in problem solving applicable to specific disciplines of engineering analysis.

The STRUctural Design Language (STRUDL) is an outgrowth of work done on computerized engineering techniques at MIT in the 1950s and 1960s. The early programs were in the public domain. Several software and RCS vendors have used this code as the basis of their own proprietary offerings. Proprietary STRUDLs offer greatly enhanced capability for analyzing complex structures under a wide variety of conditions. These packages feature automatic model generation, graphics model verification, automatic load generation, complete building code compliance, and member (element) redesign.

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## E

### Workstations

Today's workstation environment is marked by high-speed color graphics and the ability to run complex programs, making intense use of local CPU resources, while tapping shared resources via networking.

1987 marks a turning point with prices of workstations declining to affordable levels for many users. The low-cost workstations will dominate the market in terms of units sold.

Agreement among vendors, in the form of widely accepted standards, particularly in the area of window management, has spurred applications development by independent software vendors. A standard provides a stable framework within which new products can be developed with some assurance of being transportable to other environments.

There will be four major CAE/CAD/CAM workstation platforms accepted over the next few years:

- Unix workstation (Apollo, Sun, etc.)
- DEC MicroVAX family
- IBM PC family (PC AT compatible, PS/2 series)
- IBM workstation family (RT PC)



## F

## Silicon Compilers

One new technology with a great deal of promise that has so far failed to take off in the market is silicon compilers. A silicon compiler is a computer program that automatically designs a chip based on engineering descriptions of what the circuit should do. These compilers go beyond the capabilities offered by present CAE systems by actually doing the design of the chip. Despite much promise, the market for silicon compilers has not grown as quickly as expected.

Silicon compilers began appearing in late 1984. Today, they are sold mainly by three small, private companies: Silicon Compilers Inc. (San Jose, CA); Seattle Silicon Technology (Bellevue, WA); and Silicon Design Labs (Liberty Corner, NJ).

One established semiconductor company, LSI Logic, has recently entered the market with a silicon compiler based on a different concept. Rather than accepting the compromises in design that current products trying to automate the design of all types of chips are forced to make, LSI is developing a different compiler for each of the dozen or so major types of chips.

The reasons this market has failed to take off at this point are:

- The electronics companies, their primary customers, have just begun to recover from a two year slump.
- While silicon compilers can do the design job faster than an engineer, they still do not do as good a job. Computer-designed chips waste more space on the silicon, making such chips more expensive to manufacture.
- However, silicon compilers have a bright future. Because chips are becoming so complex, engineers can no longer do the design without the aid of a computer. There must be a way for a designer to deal with all of the intricacies of a complex integrated circuit, and silicon compilers offer one the few, if not only, available solutions.





## Market Forecasts







## Market Forecasts

The four largest markets for CAD systems are:

- Mechanical design—this is the largest area, encompassing the aerospace and automobile industries.
- Integrated and printed circuit board design—this primarily includes the electronics companies.
- Civil engineering—this includes the construction industry. The primary use is for piping design and layout. Key users are oil and chemical companies and construction contractors that design and build refineries and chemical plants.
- Mapping—this is used primarily by local and federal government agencies for municipal planning and public utility mapping. Natural resource firms are using CAD techniques for mapping seismic data on mineral deposits.

The largest market for CAE is for electronics design, particularly for integrated circuit design.

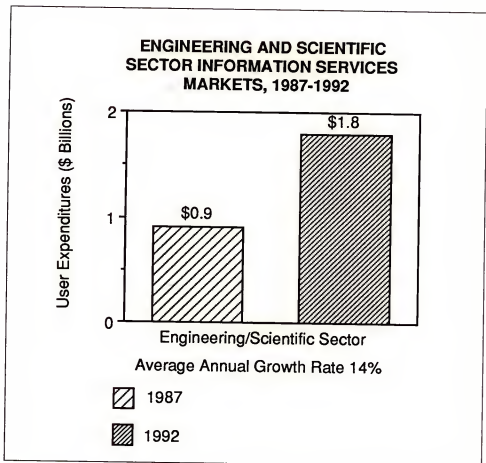
User expenditures for cross-industry engineering and scientific applications will grow 14% annually through 1992, increasing from \$911 million in 1987 to \$1.8 billion in 1992, as shown in Exhibit II-1.

One promising area is remote computing services based on a supercomputer. Supercomputer processing services, such as Control Data Corporation's Cybernet service, provide the processing capabilities necessary for a number of applications such as wind tunnel simulation.





EXHIBIT II-1



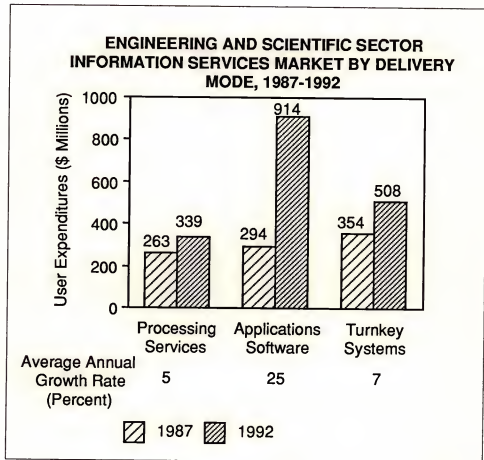
Forecasts for user expenditures by delivery mode are shown in Exhibit II-2. Application software user expenditures will grow most rapidly at a rate of 25% as firms buy engineering/scientific software for their in-house computer systems. Appendix ES-A contains the forecast data base for each year, 1986-1992, by delivery mode.

The CAE/CAD/CAM industry is in a transition from the rapid growth of the early eighties to a period of slower expansion. The reasons for the slowdown in growth include the following:

- The initial period of rapid growth has slowed as the "early adopter" phase has run its course and vendors face a more difficult task of selling to a new level of customers. Unlike the early days of CAD/CAM, companies want their systems to fit into their overall corporate plans for automation.
- CAE/CAD/CAM systems are now considered as capital expenditure items. Purchases require senior management approval and as a result long purchase cycles. The capital spending slowdown in recent years depresses the market for CAE/CAD/CAM systems.



EXHIBIT II-2



- There has been a huge price erosion in the marketplace. Consequently, the dollar values do not provide an accurate picture of the industry. While industry growth is not significant in dollar terms, unit volumes have soared.
- The intense competition in the industry, particularly among the workstation manufacturers has led to "lower-than-anticipated" prices.

More rapid growth in the CAE/CAD/CAM industry will come from low-end systems where PC-based systems are proving to be an increasingly popular choice. PC-based CAD software such as two-dimensional drafting software are becoming commodity products. The CAE segment is a promising market due to the advent of low-cost entry level CAE workstations and the low penetration of the overall market.

the 1990s, the number of people in the world who are under 15 years of age has increased from 1.1 billion to 1.3 billion. The number of people aged 65 and over has increased from 200 million to 350 million. The number of people aged 75 and over has increased from 50 million to 100 million.

There are a number of reasons for the increase in the number of people aged 65 and over. One reason is that the number of people who are surviving to old age has increased. This is due to a number of factors, including improved medical care, better nutrition, and a more active lifestyle.

Another reason for the increase in the number of people aged 65 and over is that the number of people who are retiring has increased. This is due to a number of factors, including a longer life expectancy and a higher retirement age.

The increase in the number of people aged 65 and over has a number of implications for society. One implication is that there is a need for more social services for the elderly. This includes services such as housing, food, and transportation.

Another implication is that there is a need for more financial resources for the elderly. This is because many elderly people have a lower income than when they were younger. This is due to a number of factors, including a longer life expectancy and a higher retirement age.

The increase in the number of people aged 65 and over is a global trend. This is true for all developed countries and many developing countries. This is due to a number of factors, including improved medical care, better nutrition, and a more active lifestyle.

The increase in the number of people aged 65 and over is a challenge for society. It is a challenge because it requires more resources and services than in the past. It is a challenge because it requires more financial resources than in the past.

There are a number of ways to address the challenge of the increasing number of people aged 65 and over. One way is to improve social services for the elderly. This includes services such as housing, food, and transportation.

Another way to address the challenge is to improve financial resources for the elderly. This can be done by increasing the retirement age and by providing more financial support for the elderly.

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the 1990s, the number of people in the world who are undernourished has increased from 600 million to 800 million (FAO 2001).

There are a number of reasons for this increase. One of the main reasons is the increase in the world population. The world population has increased from 5 billion in 1987 to 6 billion in 2000, and is projected to reach 9 billion by 2050 (FAO 2001). This increase in population has led to an increase in the demand for food, which has led to an increase in the number of people who are undernourished.

Another reason for the increase in the number of people who are undernourished is the increase in the number of people who are living in poverty. The number of people who are living in poverty has increased from 1 billion in 1987 to 1.5 billion in 2000, and is projected to reach 2 billion by 2050 (FAO 2001). This increase in poverty has led to an increase in the number of people who are undernourished.

A third reason for the increase in the number of people who are undernourished is the increase in the number of people who are living in rural areas. The number of people who are living in rural areas has increased from 2 billion in 1987 to 3 billion in 2000, and is projected to reach 4 billion by 2050 (FAO 2001). This increase in rural population has led to an increase in the number of people who are undernourished.

There are a number of ways in which the number of people who are undernourished can be reduced. One way is to increase the production of food. This can be done by increasing the number of people who are working in agriculture, by increasing the number of people who are working in food processing, and by increasing the number of people who are working in food distribution.

Another way to reduce the number of people who are undernourished is to increase the number of people who are living in poverty. This can be done by increasing the number of people who are working in the private sector, by increasing the number of people who are working in the public sector, and by increasing the number of people who are working in the non-profit sector.

A third way to reduce the number of people who are undernourished is to increase the number of people who are living in rural areas. This can be done by increasing the number of people who are working in agriculture, by increasing the number of people who are working in food processing, and by increasing the number of people who are working in food distribution.

There are a number of challenges that must be overcome in order to reduce the number of people who are undernourished. One of the main challenges is the increase in the world population. This increase in population has led to an increase in the demand for food, which has led to an increase in the number of people who are undernourished.

Another challenge is the increase in the number of people who are living in poverty. This increase in poverty has led to an increase in the number of people who are undernourished. In order to reduce the number of people who are undernourished, it is necessary to increase the number of people who are living in poverty.

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There are a number of ways in which these challenges can be overcome. One way is to increase the production of food. This can be done by increasing the number of people who are working in agriculture, by increasing the number of people who are working in food processing, and by increasing the number of people who are working in food distribution.

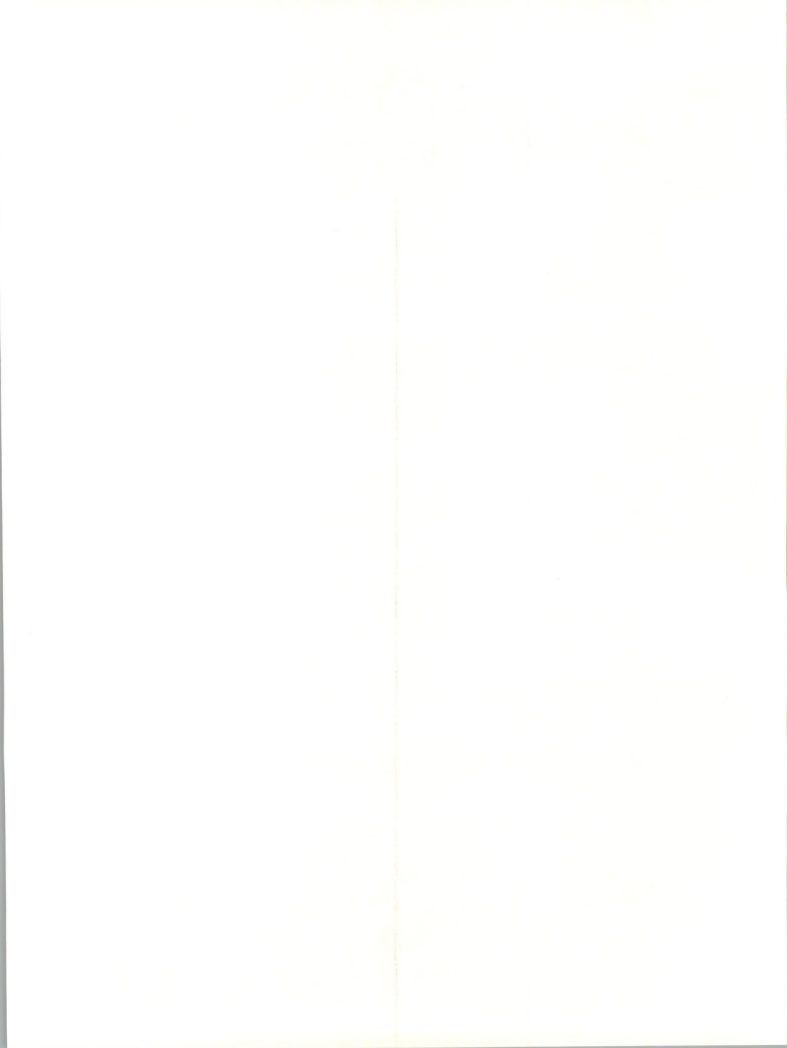
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## Competitive Developments









## Competitive Developments

### A

#### Introduction

The engineering and scientific marketplace is characterized by new product introductions and extreme price competition to the benefit of end users.

With the introduction of the Macintosh II, Apple has the opportunity to capture a share of the low-end market.

IBM's introduction of the Personal System/2 series of personal computers has signified the emergence of a new front in the workstation arena. These computers offer good graphics, considerable processing power, and large memories.

1987 marks a turning point with workstations available at affordable prices. With prices dropping into the \$5,000 range, workstations appear to be on a collision course with PC-based systems. Further price-cutting and MIPS one-upmanship between Sun, Apollo, and DEC promises to put affordable systems within the reach of more users. While Apollo and Sun are the leaders in the workstation market, they will have to contend with increasing competition from the major computer companies, DEC, Hewlett-Packard, and IBM. As customers look for integrated systems and vendor stability, the major computer companies are likely to be the beneficiaries.

DEC has changed its pricing policies to the disadvantage of its OEMs, including turnkey vendors. The company has revised its discount rates and made them the same for OEMs and volume end users. This makes it easier for some users to buy the hardware from DEC and "unbundled" software from a CAE/CAD/CAM vendor.

Table 1. Mean (SD) scores on the 10-item subscale of the 36-item Health Action Process Approach (HAPA) questionnaire. The questionnaire is based on the HAPA model of Bandura (2002)

Item	Mean (SD)
1. I have decided to do this	3.75 (1.07)
2. I have thought about this	3.75 (1.07)
3. I have thought about the benefits of this	3.75 (1.07)
4. I have thought about the costs of this	3.75 (1.07)
5. I have thought about how to do this	3.75 (1.07)
6. I have thought about how long it will take to do this	3.75 (1.07)
7. I have thought about how often I will do this	3.75 (1.07)
8. I have thought about how to overcome obstacles to doing this	3.75 (1.07)
9. I have thought about how to overcome my fears about doing this	3.75 (1.07)
10. I have thought about how to overcome my doubts about doing this	3.75 (1.07)

to be a good idea. The questionnaire was based on the HAPA model of Bandura (2002).

The questionnaire was used to assess the extent to which participants had thought about the benefits and costs of the intervention, and how they planned to overcome any obstacles to taking part.

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**B**

## Vendor Profiles

**1. APPLICON (4251 Plymouth Road, Ann Arbor, Michigan 48106)****a. Products/Services**

Applicon, an operating unit of Schlumberger Limited, offers turnkey systems for CAE/CAD/CAM/CIM applications. The company's major product offering Bravo3 is based on a broad range of integrated applications with a common user interface.

**b. Markets Served**

Applicon offers computer-aided tools to industries whose products are mechanical, electronic or a combination of both. These industries include semiconductors, consumer products, defense, automotive, aerospace, and metals.

**c. Company Strategy**

Rather than compete head-on with IBM, Intergraph, and Computervision at large accounts, Applicon has repositioned itself to focus on small and medium companies.

**d. Recent Activities**

In March 1987, Applicon announced several new products:

- Bravo3 Facilities software package for the graphic layout of facilities, equipment, and utilities for manufacturing plants.
- Bravo3 Tech Doc technical documentation software integrates graphics and text and produces camera-ready typeset quality documents.
- Design Review software, an easy-to-use application for viewing graphics data.
- Graphics Workstation GW4790, a high performance graphics workstation.
- Applicon also announced lower prices and unbundling of all Bravo3 software.

**e. Future Directions**

Applicon anticipates that electronics customers will account for 25% of its sales by 1988; they now represent less than 15% of revenues.

the 1990s, the number of children in the population has increased, and the number of children in the population aged 15 years and under has increased from 19.8 million in 1990 to 21.9 million in 2000 (UNEP 2001).

There are a number of reasons why the number of children in the population has increased. One of the main reasons is that the number of children in the population has increased because of the increase in the number of children in the population aged 15 years and under. This is due to the fact that the number of children in the population aged 15 years and under has increased from 19.8 million in 1990 to 21.9 million in 2000 (UNEP 2001).

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**2. AUTO-TROL TECHNOLOGY CORPORATION (12500 North Washington Street, Denver, Colorado 80233)  
Revenue (FYE 12/31/86): \$62.4 million**

**a. Products/Services**

Auto-trol manufactures and markets turnkey CAD/CAM systems. Auto-trol's systems integrate hardware, proprietary graphics software, and applications software. The hardware components of Auto-trol systems include the Advanced Graphics Workstation (AGW), the Advanced Raster Workstation (ARW), and the Advanced Personal Workstation (APW).

Graphics and applications software include Auto-trol Series 5000 Advanced Graphics software and Auto-trol Series 7000 Advanced Graphics software.

**b. Markets Served**

Auto-trol's primary markets are the architecture, engineering and construction, mechanical design and manufacturing, and technical publication industries.

**c. Recent Activities**

In April 1987, Auto-trol announced the availability of a publishing system interface based on PostScript, a page description language from Adobe Systems. The interface will offer technical illustrators the ability to address PostScript compatible imaging devices for proofing and final production of illustrations and presentation graphics.

In November 1986, Auto-trol announced a number of new products:

- Engineering Information Management System (EIMS), a project-oriented job accounting and file management system for the control and maintenance of CAD-based engineering data.
- Interactive Nesting System to enhance the automation of a manufacturing process.
- Empress/32, a general-purpose relational data base management system for use within engineering environments.
- Facility Layout, an addition to its family of products for Industrial Plant Design.

In addition to the above-mentioned new products, Auto-trol announced a joint marketing agreement with CIMCO/AIS (Austin, TX) for the sale of



the latter's hardware and software for Direct Numerical Control (DNC) systems. Auto-trol also entered into an OEM agreement with Interleaf, Inc. (Cambridge, MA) acquiring the distribution rights for the Interleaf Workstation Publishing Software.

**3. Computervision Corporation (100 Crosby Drive, Bedford, Massachusetts 01730)**

**Revenue (FYE 12/31/86): \$494.7 million**

**a. Products/Services**

Computervision offers turnkey CAD/CAM/CAE systems based on proprietary hardware as well as systems based on hardware from IBM, DEC, Prime and Sun Microsystems. The company has developed several integrated lines of CAD/CAM systems marketed under the names CADDStation, CDS 4000, Designer, Medusa, and Personal Systems. Computervision's best-selling product line is its CADDStation. CADDStation has emerged as the company's bread-and-butter product replacing the CDS 4000 series.

**b. Markets Served**

The company primarily serves five major industry groups: automotive, aerospace, mechanical machinery, electrical/electronic, and architecture/engineering/construction.

**c. Company Strategy**

In 1986 Computervision began a financial turnaround. The company became profitable after incurring losses for six quarters. Although the year ended with a loss, the last two quarters of 1986 were profitable. This trend continued into the first half of 1987.

Computervision's difficulties reflected difficulties in its product line that was based on proprietary hardware. With the introduction of CADDStation, Computervision has successfully ported its software to industry-standard hardware. Introduced in April 1986, CADDStation is a workstation based on 32-bit hardware technology from Sun Microsystems, the Unix operating system and the Ethernet local area network.

**d. Recent Activities**

In June 1987 Computervision announced that it had ported its Medusa CAD software to the Sun Microsystems platform.

In July 1987 Computervision announced the CADDStation 34, a graphics workstation featuring Sun's version of the Unix operating system.

the 1990s, the number of people in the UK who are aged 65 and over has increased from 10.5 million to 13.5 million (15.5% of the population).

There is a growing awareness of the need to address the needs of older people, and the Government has set out a strategy for doing this in the White Paper on *Ageing Better: The Government's Strategy for Older People* (Department of Health 2000). The White Paper sets out a number of key objectives for the Government, including: 'to ensure that older people are able to live independently, safely and comfortably in their own homes, and to continue to play an active role in their communities'.

The White Paper also sets out a number of key areas for action, including: 'to ensure that older people have access to the services and support they need to live independently, safely and comfortably in their own homes, and to continue to play an active role in their communities'. This includes a number of key areas for action, including: 'to ensure that older people have access to the services and support they need to live independently, safely and comfortably in their own homes, and to continue to play an active role in their communities'.

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In August 1987, Computervision introduced TechPubs II, software packages designed to help users of its CADDStation family of 32-bit engineering workstations document their work.

**e. Future Directions**

The company plans to shift its emphasis from hardware to software.

Computervision plans to focus its research and development efforts in the areas of mechanical CAE, artificial intelligence, solid modeling, precise surface modeling, numerical control and computer-aided manufacturing applications, and advanced electronics design.

**4. CONTROL DATA CORPORATION (8100 34th Avenue South, Minneapolis, Minnesota 55440)**

**a. Products/Services**

Control Data's Computer Systems and Services Division designs, manufactures, and markets Control Data's CYBER line of computer systems. In the area of CAE/CAD/CAM Control Data specializes in CIM (computer-integrated manufacturing), that forms part of the Computer Systems and Services division. The company's principal CIM product line is its ICEM, Integrated Computer-Aided Engineering and Manufacturing. ICEM products integrate CAD/CAM activities under a single computerized design management and control system. The ICEM software runs on Control Data's CYBER 910 series of Unix-based integrated workstations.

**b. Markets Served**

Control Data's customers are primarily in the scientific and engineering computing environments, such as CAE and integrated manufacturing, utility, education, and petroleum industries.

**c. Company Strategy**

The company focuses on integrated solutions as it believes that its integration capabilities is its major strength.

**d. Recent Activities**

In July 1987, Control Data introduced the ICEM plus that provided major enhancements to its graphics workstations and software.

Also in July 1987, Control Data expanded the CYBER 190 family by introducing four high-performance 3-D graphics workstations.

the 1990s, the number of people in the world who are under 15 years of age has increased from 1.1 billion to 1.5 billion. This increase is due to the fact that the number of children under 15 years of age has increased in every country in the world, and the rate of increase is particularly high in developing countries.

The increase in the number of children under 15 years of age has led to a corresponding increase in the number of children who are in need of education. In 1990, there were 1.1 billion children under 15 years of age in the world, and of these, 1.1 billion were in need of education. In 2000, there were 1.5 billion children under 15 years of age in the world, and of these, 1.5 billion were in need of education.

The increase in the number of children in need of education has led to a corresponding increase in the number of children who are out of school. In 1990, there were 1.1 billion children in need of education in the world, and of these, 1.1 billion were out of school. In 2000, there were 1.5 billion children in need of education in the world, and of these, 1.5 billion were out of school.

The increase in the number of children out of school has led to a corresponding increase in the number of children who are in need of vocational training. In 1990, there were 1.1 billion children out of school in the world, and of these, 1.1 billion were in need of vocational training. In 2000, there were 1.5 billion children out of school in the world, and of these, 1.5 billion were in need of vocational training.

The increase in the number of children in need of vocational training has led to a corresponding increase in the number of children who are in need of technical education. In 1990, there were 1.1 billion children in need of vocational training in the world, and of these, 1.1 billion were in need of technical education. In 2000, there were 1.5 billion children in need of vocational training in the world, and of these, 1.5 billion were in need of technical education.

The increase in the number of children in need of technical education has led to a corresponding increase in the number of children who are in need of higher education. In 1990, there were 1.1 billion children in need of technical education in the world, and of these, 1.1 billion were in need of higher education. In 2000, there were 1.5 billion children in need of technical education in the world, and of these, 1.5 billion were in need of higher education.

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The increase in the number of children in need of post-secondary education has led to a corresponding increase in the number of children who are in need of tertiary education. In 1990, there were 1.1 billion children in need of post-secondary education in the world, and of these, 1.1 billion were in need of tertiary education. In 2000, there were 1.5 billion children in need of post-secondary education in the world, and of these, 1.5 billion were in need of tertiary education.

#### **e. Future Directions**

Control Data is moving from engineering applications into combining engineering and manufacturing for an integrated manufacturing approach.

#### **5. DAISY SYSTEMS CORP. (700 Middlefield Road, Mountain View, California 94039)**

**Revenue (FYE 9/30/87): \$100.9 million**

##### **a. Product/Services**

Daisy Systems designs, manufactures, and markets turnkey CAE systems to automate the electronic design engineering process. Its tools are used for the design and layout of application-specific integrated circuits (ASICs), printed circuit boards (PCBs), and integrated circuits (ICs).

##### **b. Markets Served**

Daisy's products are primarily used by the military/aerospace, semiconductor, telecommunications, and computer industries.

##### **c. Company Strategy**

In 1986 Daisy created the Customer Support Division combining the training, technical publications, field service, and customer hot-line operations into one division. The creation of this division is part of Daisy's efforts in improving its customer service.

Once considered a star performer and a pioneer in the CAE workstation market Daisy has fallen far and fast. The company's problems resulted from its decision to use a proprietary system. The company has since embarked on a strategy of developing systems based on industry-standard hardware.

##### **d. Recent Activities**

The company is continuing its efforts to implement the transition to industry-standard platforms. In March 1987, Daisy introduced a line of CAE workstations based on Intel's microprocessors (80286 and 80386) and EGA graphics standards. The workstations are called the Personal Logician 286, Personal Logician 386, and Logician 386. In the mid-range Daisy is considering the Sun Microsystems Sun-3 and Sun-4 as platforms.

the 1990s, the number of people in the world who are under 15 years of age is expected to increase from 1.1 billion to 1.5 billion (United Nations 1994).

There are a number of reasons why the number of children in the world is increasing. One of the main reasons is that the number of children who are surviving to adulthood is increasing. This is due to a number of factors, including improved medical care, better nutrition, and a decrease in child mortality.

Another reason why the number of children in the world is increasing is that the number of children who are being born is increasing. This is due to a number of factors, including a decrease in the age at which women are having children, and an increase in the number of children who are being born to women who are already having children.

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#### e. Future Directions

It will take about a year for Daisy to offer CAE systems based on a broad line of industry-standard hardware including IBM, DEC, and Sun. Daisy has the resources (cash reserves: \$75 million in August '87) to achieve its objectives.

The company plans to increase its emphasis on improving and formalizing procedures, particularly in the manufacturing, quality control, and project management areas.

### 6. INTERGRAPH CORPORATION (One Madison Industrial Park, Huntsville, Alabama 35807)

Revenue (FYE 12/31/86): \$605.7 million

#### a. Products/Services

Intergraph designs, develops, and markets turnkey CAD/CAM/CAE interactive graphics and data base management systems. The company's systems are based on the DEC VAX line of minicomputers and on a proprietary series of engineering workstations.

#### b. Markets Served

Intergraph's systems are used in mechanical and electronics CAD/CAM; architecture, engineering, and construction (AEC); mapping and earth sciences; energy exploration, utilities, and electronic publishing industries.

#### c. Company Strategy

Faced with declining demand for large turnkey systems Intergraph has implemented bold changes during the past few years. The company has placed increased emphasis on workstation products and has shifted its focus to its hardware capabilities. In 1986 Intergraph made a strategic decision in developing its own workstation. The company's decision to develop its own hardware was based on its being a large DEC OEM and the inevitable tension resulting from the two companies becoming competitors in the marketplace. (DEC's corporate direction has changed as the company moves into the end-user market, while reducing its dependence on OEM sales.)

#### d. Recent Activities

In 1986 Intergraph announced the InterPro 32C, a workstation based on the Clipper Microprocessor (developed by Fairchild Semiconductor) and the Unix operating system. With this hardware, Intergraph entered the

the 1990s, the number of people in the UK who are aged 65 and over has increased from 10.5 million to 13.5 million, and the number of people aged 75 and over has increased from 4.5 million to 6.5 million (Office for National Statistics 2000).

There is a growing awareness of the need to address the needs of older people, and the need to ensure that the health care system is able to meet the needs of older people. The Department of Health (2000) has set out a strategy for the health care system to meet the needs of older people, and the Health Service Research Unit (2000) has set out a strategy for the health care system to meet the needs of older people.

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generic stand-alone workstation market and thus competing with Apollo, Sun, and DEC. The company hopes to see the system accepted as a general-purpose workstation and plans to pursue OEMs.

In January 1987, Intergraph acquired a 50% interest in Bentley Systems (Lionville, PA), a computer graphics software development company.

In September 1987, Intergraph purchased Fairchild Semiconductor's clipper operations (Advanced Processor Division) from National Semiconductor. (National Semiconductor had acquired Fairchild Semiconductor.) Intergraph plans to continue to sell the clipper on the open market.

#### **e. Future Directions**

Intergraph is promoting the concept of distributed processing for design applications.

### **7. THE MACNEAL-SCHWENDLER CORPORATION (815 Colorado Boulevard, Los Angeles, California 90041) Revenue (FYE 1/31/87): \$27.1 million**

#### **a. Products/Services**

MacNeal-Schwendler markets computer software products for mechanical CAE applications. The company's principal product is MSC/NASTRAN, a computer program used by designers and engineers to analyze the strength characteristics of structures or products prior to construction or manufacture. MacNeal-Schwendler also offers a complete line of mechanical CAE products for personal computers. According to the company, MSC/NASTRAN is the most widely used finite element analysis program in the world.

#### **b. Markets Served**

The company's products are used in the aerospace industry and other industries including automotive, ship building, industrial and office equipment, nuclear, petrochemical, and architecture and engineering.

#### **c. Company Strategy**

MacNeal-Schwendler plans to build on its success as a leader in finite element analysis.

#### **d. Recent Activities**

In January 1987, MacNeal-Schwendler began shipping MSC/pal, a finite element analysis software product for the Macintosh.

the 1990s, the number of people in the world who are illiterate has increased from 1.1 billion to 1.2 billion. The number of illiterate people in the world is expected to reach 1.5 billion by the year 2015 (UNESCO, 2003).

There are many reasons for the increase in illiteracy. One of the reasons is that the population growth rate is higher than the literacy rate. Another reason is that the quality of education is low. In many countries, the quality of education is so low that students who have completed primary school are unable to read and write. This is especially true in rural areas where the quality of education is even lower.

There are many ways to reduce illiteracy. One way is to improve the quality of education. This can be done by providing better training for teachers and by providing better facilities for schools. Another way is to provide more opportunities for people to learn to read and write. This can be done by providing more literacy classes and by providing more opportunities for people to learn to read and write in their own languages.

There are many reasons why people do not learn to read and write. One reason is that they do not see the need to learn to read and write. Another reason is that they do not have the time to learn to read and write. A third reason is that they do not have the money to learn to read and write. These are all reasons that can be addressed by providing more opportunities for people to learn to read and write.

There are many ways to provide more opportunities for people to learn to read and write. One way is to provide more literacy classes. Another way is to provide more opportunities for people to learn to read and write in their own languages. A third way is to provide more opportunities for people to learn to read and write in their own communities.

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In March 1987, MacNeal-Schwendler announced that it had agreed to develop a new version of its MSC/NASTRAN program for Alliant Computer Systems' FX/Series of minicomputers. (Alliant Computer Systems is based in Littleton, MA.)

Also, in March 1987, MacNeal-Schwendler introduced ADCAD2 Version 2, software that enables users of popular PC-based CAD programs to easily transfer drawing files to and from MSC/pal 2, the company's finite element analysis program for minicomputers.

In June 1987, the company introduced a version of its MSC/pal 2 software for the IBM PS/2 series of personal computers.

#### **e. Future Directions**

The company plans to expand its software product line for personal computers.

### **8. MENTOR GRAPHICS CORPORATION (8500 Southwest Creekside Place, Beaverton, Oregon 97005) Revenue (FYE 12/31/86): \$173.5 million**

#### **a. Products/Services**

Mentor Graphics designs, develops, manufactures, and markets turnkey CAE systems for use in the design, analysis, physical layout, and testing of integrated circuits and electronic systems. Mentor markets its data base and applications software on engineering workstations supplied by Apollo. The company's principal product line is the IDEA Series of engineering workstations. Mentor also offers CAE software products for personal computers.

#### **b. Markets Served**

Mentor markets its products to customers in the aerospace, computer, telecommunications, semiconductor, and consumer electronics industries.

#### **c. Company Strategy**

Mentor has emerged as the leading vendor in the CAE field. Mentor's strategy in developing systems based on industry-standard hardware seems to have paid off. The company has no immediate plans of developing applications for multiple platforms. Mentor claims that "its customers are concerned not as much with the underlying computer platform as they are with the depth and breadth of the software applications that run on it."



#### **d. Recent Activities**

In June 1987, Mentor introduced the Domain Series 4000 Workstation, a series of products for electronic computer aided design. The systems based on Apollo workstations are available under the names Idea Station for schematic capture and local simulation, Chip Station for custom VLSI (very large-scale integration) circuit design and layout, and Board Station for printed circuit board design.

#### **e. Future Directions**

Mentor hopes to stay ahead by moving beyond CAE to diversify into related fields that are part of the automated design market. These areas include CAD, publishing, packaging and software engineering. One niche that Mentor is focusing on is design for printed circuit boards.

### **9. TEKTRONIX, INC. (P.O. Box 500, Beaverton, Oregon 97077) Revenue (FYE 5/31/87): \$1,395.9 million**

#### **a. Products/Services**

Tektronix offers test and measurement instruments, display products, and communications products. The company's Design Automation Group focuses primarily on the design, simulation, verification, and analysis of digital integrated circuits systems and subsystems generally associated with computer technology. The products include CAE, computer-aided software engineering (CASE) products, microcomputer development products, logic analyzers, and semiconductor test systems. Tektronix CAE systems facilitate transfer of design data from schematic capture and design verification through layout, fabrication, and final testing for printed circuit board (PCB) and application-specific integrated circuit (ASIC) design.

#### **b. Markets Served**

Tektronix's customers are in the electronics, communication, computer, government, and education industries.

#### **c. Company Strategy**

Tektronix's approach to CAE is to provide integrated design, evaluation, and testing for electronic systems development.

#### **d. Recent Activities**

In fiscal 1987, Tektronix introduced over 60 new products including oscilloscopes and a new series of graphics terminals.

the 1990s, the number of people in the world who are undernourished has increased from 600 million to 800 million (FAO 2001).

There are many reasons for this increase. One of the main reasons is that the population of the world has increased from 5 billion in 1987 to 6 billion in 2000. Another reason is that the number of people who are undernourished has increased in many developing countries. This is due to a number of factors, including population growth, a decline in agricultural production, and a decrease in the number of people who are employed in agriculture (FAO 2001).

The FAO (2001) has identified a number of key factors that contribute to undernutrition. These include: (1) a decline in agricultural production, (2) a decrease in the number of people who are employed in agriculture, (3) a decline in the number of people who are employed in other sectors of the economy, (4) a decline in the number of people who are employed in the public sector, and (5) a decline in the number of people who are employed in the private sector (FAO 2001).

The FAO (2001) has also identified a number of key factors that contribute to malnutrition. These include: (1) a decline in the number of people who are employed in agriculture, (2) a decline in the number of people who are employed in other sectors of the economy, (3) a decline in the number of people who are employed in the public sector, and (4) a decline in the number of people who are employed in the private sector (FAO 2001).

The FAO (2001) has also identified a number of key factors that contribute to micronutrient deficiency. These include: (1) a decline in the number of people who are employed in agriculture, (2) a decline in the number of people who are employed in other sectors of the economy, (3) a decline in the number of people who are employed in the public sector, and (4) a decline in the number of people who are employed in the private sector (FAO 2001).

The FAO (2001) has also identified a number of key factors that contribute to iron deficiency. These include: (1) a decline in the number of people who are employed in agriculture, (2) a decline in the number of people who are employed in other sectors of the economy, (3) a decline in the number of people who are employed in the public sector, and (4) a decline in the number of people who are employed in the private sector (FAO 2001).

The FAO (2001) has also identified a number of key factors that contribute to zinc deficiency. These include: (1) a decline in the number of people who are employed in agriculture, (2) a decline in the number of people who are employed in other sectors of the economy, (3) a decline in the number of people who are employed in the public sector, and (4) a decline in the number of people who are employed in the private sector (FAO 2001).

#### **e. Future Directions**

Tektronix will continue to take advantage of its four-decade experience in test equipments. The major challenge facing Tektronix is tying together its instrument-type products into the CAE area.

### **10. VALID LOGIC SOLUTIONS INC. (2820 Orchard Parkway, San Jose, California 95134) Revenue (FYE 12/31/86): \$60.9 million**

#### **a. Products/Services**

Valid Logic designs, manufactures, and markets turnkey CAE applications for electronic systems design and integrated circuits design.

#### **b. Markets Served**

The market for Valid's products includes two groups of electrical engineers; systems engineers and integrated circuit designers. Valid has sold its systems to customers in the computer, semiconductor, telecommunications, instrumentation, and aerospace and military industries.

#### **c. Company Strategy**

Valid's strategy lies in integrating the operations of Valid and Telesis to realize the maximum synergies possible (Valid acquired Telesis - See "Recent Activities.") Valid plans to develop applications for Sun workstations while Telesis plans to develop applications for the DEC MicroVAX. Historically Valid has used DEC hardware and Telesis has run on Sun workstations.

#### **d. Recent Activities**

In February 1987, Valid acquired Telesis Systems Corp. (Chelmsford, MA), another player in the CAE industry. Telesis develops and markets electronic design automation workstations used for printed circuit board design.

In June 1987 Valid introduced two new products, ValidCOMPOSE and Allegro. ValidCOMPOSE is an integrated circuit design tool for developing chip architectures. Allegro is a rules-driven printed circuit board design system.

Also in June 1987, Valid ported its electronic design automation tools to Sun's Unix-based workstations.



**e. Future Directions**

In the interview with Electronic Business (June 15, 1987) Douglas Hajar, president and CEO of Valid (formerly president and CEO of Telesis) stated, "There's no doubt that in the near future a company that has a Unix-based Sun platform and a MicroVAX-based platform with IBM PCs in the front end, all running full CAE and PCB capability with software links into manufacturing and testing - there is nobody in the marketplace today that can touch that kind of company. And that's exactly what we will have in a very short period of time."

the 1990s, the number of people with diabetes has increased in all industrialized countries.

Diabetes is a chronic disease with a high prevalence. In the Netherlands, the prevalence of diabetes is 6.5% in the population aged 15 years and over. The prevalence of diabetes is higher in men than in women, and increases with age. The prevalence of diabetes is also higher in people with a family history of diabetes.

Diabetes is a complex disease with a multifactorial aetiology. The main risk factors for the development of diabetes are obesity, physical inactivity, and a diet high in fat and sugar. Genetic factors also play a role in the development of diabetes.

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## New Opportunities



the 1980s, the 1990s, and the 2000s. The 1980s were characterized by a high level of activity, with a large number of projects being completed. The 1990s saw a decline in activity, with fewer projects being completed. The 2000s saw a resurgence in activity, with a large number of projects being completed. This trend is likely to continue in the future, as the industry continues to grow and evolve.

The 1980s were a period of high activity, with a large number of projects being completed. This was due to a combination of factors, including a strong economy, a high level of investment in infrastructure, and a focus on large-scale projects. The 1990s saw a decline in activity, with fewer projects being completed. This was due to a combination of factors, including a weaker economy, a lower level of investment in infrastructure, and a focus on smaller-scale projects.

The 2000s saw a resurgence in activity, with a large number of projects being completed. This was due to a combination of factors, including a strong economy, a high level of investment in infrastructure, and a focus on large-scale projects. The 2010s saw a decline in activity, with fewer projects being completed. This was due to a combination of factors, including a weaker economy, a lower level of investment in infrastructure, and a focus on smaller-scale projects.

The 2020s saw a resurgence in activity, with a large number of projects being completed. This was due to a combination of factors, including a strong economy, a high level of investment in infrastructure, and a focus on large-scale projects. The 2030s saw a decline in activity, with fewer projects being completed. This was due to a combination of factors, including a weaker economy, a lower level of investment in infrastructure, and a focus on smaller-scale projects.

The 2040s saw a resurgence in activity, with a large number of projects being completed. This was due to a combination of factors, including a strong economy, a high level of investment in infrastructure, and a focus on large-scale projects. The 2050s saw a decline in activity, with fewer projects being completed. This was due to a combination of factors, including a weaker economy, a lower level of investment in infrastructure, and a focus on smaller-scale projects.

The 2060s saw a resurgence in activity, with a large number of projects being completed. This was due to a combination of factors, including a strong economy, a high level of investment in infrastructure, and a focus on large-scale projects. The 2070s saw a decline in activity, with fewer projects being completed. This was due to a combination of factors, including a weaker economy, a lower level of investment in infrastructure, and a focus on smaller-scale projects.

The 2080s saw a resurgence in activity, with a large number of projects being completed. This was due to a combination of factors, including a strong economy, a high level of investment in infrastructure, and a focus on large-scale projects. The 2090s saw a decline in activity, with fewer projects being completed. This was due to a combination of factors, including a weaker economy, a lower level of investment in infrastructure, and a focus on smaller-scale projects.



## New Opportunities

### A CAD/CAM

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There are three major areas of opportunity in the CAD/CAM market: three-dimensional capabilities, integration, and solids modeling.

Three-dimensional modeling and design represents a significant opportunity. These capabilities are needed in the mechanical, electrical, and chemical fields. Applications include: three-dimensional mechanical design, fluid and air flow, and modeling of molecules in three dimensions.

The next major opportunity in the market is the emergence of genuine integration of CAD and CAM, and in linkages between CAE and computer-aided testing, developments that promise to compress the process of design, testing, and manufacture.

- Integration is important because it streamlines the product development cycle. A circuit board, for examples, evolves from a schematic design into a layout of physical parts and is then rendered as an assembly drawing and transferred to manufacturing. At the same time, the board's mechanical housing must be designed and fitted. With an integrated data base, this activity becomes a single flow of information since all of these functions share a common data base. Thus, engineers at each step can work from the same model, speeding the communication of design progress and automatically ensuring parts accuracy and compatibility.
- Costly R&D efforts will be required to succeed in developing and bringing such products to market.

Solid modeling software is an emerging application that is expected to dominate design applications by the end of the decade. In the past, the computing power needed for solid modeling was often prohibitive, but as



hardware prices declined and processing power increased, this allowed the capabilities of solid modeling to be available to more engineers. Solid modeling software enables designers to describe the volume and mass of mechanical parts on the computer—a considerable improvement over the edges and corners provided by other kinds of CAD software.

**B****CAE**

The opportunities in the CAE market revolve around price, improved data management, and performance.

- A drawback to CAE systems is price. What is needed are systems in the \$10,000-20,000 price range with the same performance and functionality as the systems that average about \$50,000. This will bring the systems into a price range that many more engineers can afford. There appears to be a threshold at about \$20,000 where large companies to think of buying a workstation for every engineer. Currently, engineering workstations are typically shared by a number of engineers.
- One of the problems associated with CAE systems is the lack of sophisticated data management. Most CAE systems have only limited facilities for relating information files. Once a hierarchical DBMS can be integrated into a CAE workstation, the designer will be relieved of much routine work, with a key benefit being the ability to do modular design.
- Another need by chip designers is for faster circuit simulation.

**C****Workstations**

New opportunities in the workstation market lie in the commercial sector such as banking and finance. As an example, Sun has introduced a workstation for financial applications for stock brokerages and other investment banking companies.

**D****Other**

The following are emerging research areas that will need software packages:

- Biochemistry.
- Combined chemical and structural engineering.
- Cryogenic and space related research.
- Graphics for biology.
- Hydrology.
- Linkage between automated design and machine tool control.
- On-line simulation of biological and chemical processes.
- Parametric design for a family of products.
- Process synthesis.
- Strategic Defense Initiative ("Star Wars").
- Rock stability.



In addition, other applications that are needed include:

- Drilling simulation for underground modeling.
- Improved laboratory management systems.

Demand for computerized design and simulation tools will increase in biological and genetic engineering as new technical advances increase the complexity of these fields.

the 1990s, the number of people with a mental health problem has increased in the UK. The prevalence of mental health problems has risen from 10% in 1986 to 15% in 1999 (Mental Health Act 2003). The prevalence of mental health problems has also increased in the USA, from 10% in 1986 to 15% in 1999 (Mental Health Act 2003).

There is a growing awareness of the need to address the needs of people with mental health problems. The UK government has set out a strategy for mental health care in the 2003 Mental Health Act. The strategy is to provide a range of services to meet the needs of people with mental health problems, including community care, hospital care, and residential care. The strategy also aims to improve the quality of care and to reduce the stigma associated with mental health problems.

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the case of a random walk, the variance of the error term  $\epsilon_{i,t}$  is assumed to be constant over time, i.e.  $\text{var}(\epsilon_{i,t}) = \sigma^2$ .

Let  $\hat{\beta}_i$  denote the OLS estimator of  $\beta_i$  based on the observations on  $y_{i,t}$  for  $t = 1, \dots, T$ . Then

$$\hat{\beta}_i = (\mathbf{X}_i' \mathbf{X}_i)^{-1} \mathbf{X}_i' \mathbf{y}_i \quad (1)$$

where  $\mathbf{X}_i$  is the  $T \times 2$  matrix of regressors and  $\mathbf{y}_i$  is the  $T \times 1$  vector of observations on  $y_{i,t}$ . The variance-covariance matrix of  $\hat{\beta}_i$  is

$$\text{var}(\hat{\beta}_i) = (\mathbf{X}_i' \mathbf{X}_i)^{-1} \text{var}(\mathbf{X}_i' \boldsymbol{\epsilon}_i) \quad (2)$$

where  $\boldsymbol{\epsilon}_i$  is the  $T \times 1$  vector of error terms. Under the usual OLS assumptions, the variance-covariance matrix of  $\hat{\beta}_i$  can be written as

$$\text{var}(\hat{\beta}_i) = (\mathbf{X}_i' \mathbf{X}_i)^{-1} \sigma^2 \mathbf{I}_T \quad (3)$$

where  $\mathbf{I}_T$  is the  $T \times T$  identity matrix. The variance-covariance matrix of  $\hat{\beta}_i$  is a function of  $\sigma^2$ .

Let  $\hat{\beta}_i$  and  $\hat{\beta}_j$  denote the OLS estimators of  $\beta_i$  and  $\beta_j$  based on the observations on  $y_{i,t}$  and  $y_{j,t}$  for  $t = 1, \dots, T$ . Then

$$\hat{\beta}_i = (\mathbf{X}_i' \mathbf{X}_i)^{-1} \mathbf{X}_i' \mathbf{y}_i \quad (4)$$

$$\hat{\beta}_j = (\mathbf{X}_j' \mathbf{X}_j)^{-1} \mathbf{X}_j' \mathbf{y}_j \quad (5)$$

where  $\mathbf{X}_i$  is the  $T \times 2$  matrix of regressors and  $\mathbf{y}_i$  is the  $T \times 1$  vector of observations on  $y_{i,t}$ . The variance-covariance matrix of  $\hat{\beta}_i$  is

$$\text{var}(\hat{\beta}_i) = (\mathbf{X}_i' \mathbf{X}_i)^{-1} \sigma_i^2 \mathbf{I}_T \quad (6)$$

where  $\sigma_i^2$  is the variance of the error term  $\epsilon_{i,t}$ . The variance-covariance matrix of  $\hat{\beta}_j$  is

$$\text{var}(\hat{\beta}_j) = (\mathbf{X}_j' \mathbf{X}_j)^{-1} \sigma_j^2 \mathbf{I}_T \quad (7)$$

where  $\sigma_j^2$  is the variance of the error term  $\epsilon_{j,t}$ . The variance-covariance matrix of  $\hat{\beta}_i$  and  $\hat{\beta}_j$  is

$$\text{var}(\hat{\beta}_i, \hat{\beta}_j) = (\mathbf{X}_i' \mathbf{X}_i)^{-1} \sigma_i^2 \mathbf{I}_T \quad (8)$$

where  $\sigma_i^2$  is the variance of the error term  $\epsilon_{i,t}$ . The variance-covariance matrix of  $\hat{\beta}_i$  and  $\hat{\beta}_j$  is

$$\text{var}(\hat{\beta}_i, \hat{\beta}_j) = (\mathbf{X}_j' \mathbf{X}_j)^{-1} \sigma_j^2 \mathbf{I}_T \quad (9)$$

where  $\sigma_j^2$  is the variance of the error term  $\epsilon_{j,t}$ . The variance-covariance matrix of  $\hat{\beta}_i$  and  $\hat{\beta}_j$  is

$$\text{var}(\hat{\beta}_i, \hat{\beta}_j) = (\mathbf{X}_i' \mathbf{X}_i)^{-1} \sigma_i^2 \mathbf{I}_T \quad (10)$$

where  $\sigma_i^2$  is the variance of the error term  $\epsilon_{i,t}$ . The variance-covariance matrix of  $\hat{\beta}_i$  and  $\hat{\beta}_j$  is

$$\text{var}(\hat{\beta}_i, \hat{\beta}_j) = (\mathbf{X}_j' \mathbf{X}_j)^{-1} \sigma_j^2 \mathbf{I}_T \quad (11)$$

# V

## Conclusions and Recommendations

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the 1990s, the number of people with a mental health problem has increased in the UK (Mental Health Act 1983, 1990).

There is a growing awareness of the need to address the needs of people with mental health problems in the community. The 1990s have seen a move away from the institutional care of people with mental health problems towards a focus on community care. This has led to a number of initiatives aimed at improving the lives of people with mental health problems in the community.

One of the main initiatives has been the development of mental health services in the community. This has involved the establishment of mental health teams, which provide a range of services to people with mental health problems in the community. These services include assessment, diagnosis, treatment, and rehabilitation.

Another initiative has been the development of self-help groups for people with mental health problems. These groups provide a supportive environment for people to share their experiences and learn from each other. They also provide a range of practical advice and information on mental health problems.

There has also been a focus on improving the lives of people with mental health problems in the community through the development of housing and social services. This has involved the establishment of supported housing schemes, which provide a range of services to people with mental health problems in the community. These services include housing, social activities, and support with daily living.

Finally, there has been a focus on improving the lives of people with mental health problems in the community through the development of employment and training schemes. These schemes provide a range of services to people with mental health problems in the community. These services include employment, training, and support with daily living.

These initiatives have led to a number of improvements in the lives of people with mental health problems in the community. For example, the number of people with mental health problems in hospital has decreased, and the number of people with mental health problems in the community has increased. This has led to a number of improvements in the lives of people with mental health problems in the community.

However, there is still a need to improve the lives of people with mental health problems in the community. There are a number of challenges that need to be addressed in order to improve the lives of people with mental health problems in the community. These challenges include the need to improve the quality of mental health services, the need to improve the lives of people with mental health problems in the community, and the need to improve the lives of people with mental health problems in the community.

One of the main challenges is the need to improve the quality of mental health services. This involves the need to improve the training and skills of mental health professionals, the need to improve the quality of mental health services, and the need to improve the lives of people with mental health problems in the community.

Another challenge is the need to improve the lives of people with mental health problems in the community. This involves the need to improve the quality of housing and social services, the need to improve the lives of people with mental health problems in the community, and the need to improve the lives of people with mental health problems in the community.

Finally, there is a need to improve the lives of people with mental health problems in the community through the development of employment and training schemes. These schemes provide a range of services to people with mental health problems in the community. These services include employment, training, and support with daily living.



## Conclusions and Recommendations

Rapid technological advances will continue to characterize the CAD/CAM/CAE industry and competition will continue to be intense.

Communications are key to creating a productive system whether a company is trying to share data among its various types of workstations, pass data to a remote location, or tie into a corporate data base.

The winners in the turnkey market will be those vendors that offer products in the form of an open architecture with independent workstations ranging in power and capability that can all be hooked up to a common data base.

In the future, current capabilities offered on workstations will be available on PCs. The implications of this are lower prices, greater unit sales, and potentially declining revenues for some vendors. However, the offering of greater capabilities on lower priced systems will serve to overcome a threshold level in the market by opening up the market to new users and new applications.

To address the needs of the environment, a company should offer a hierarchy of solutions. A vendor should provide an entire spectrum of solutions that all work with a consistent user interface.

Offering an inexpensive two-dimensional product on a PC will provide the vendor with the opportunity to sell the customer a more expensive three-dimensional product when the customer outgrows two-dimensional.

The cost of entry into the market for sophisticated engineering programs such as NASTRAN is substantial and will limit the introduction of new competitive products.

The CAD/CAM market will eventually develop into a data base battle, giving IBM the advantage over other CAD/CAM vendors. This will

the 1990s, the number of publications on the topic has increased steadily (see Figure 1).

There are a number of reasons for this increase. First, the number of researchers in the field has increased. Second, the number of journals publishing research on the topic has increased. Third, the number of researchers publishing in the field has increased.

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occur when the CAD capabilities become a commodity and the data base consequently takes on greater importance.

the 1990s, the number of people in the world who are under 15 years of age is expected to increase from 1.1 billion to 1.5 billion.

There are a number of reasons why the world's population is growing so rapidly. One of the main reasons is that the number of children born to each woman has increased. This is due to a number of factors, including the fact that women are now having children at a younger age, and that there are more children surviving to adulthood.

Another reason why the world's population is growing so rapidly is that the number of people who are living longer is increasing. This is due to a number of factors, including the fact that people are now living longer, and that there are more people surviving to old age.

There are a number of other reasons why the world's population is growing so rapidly. One of the main reasons is that the number of people who are moving from rural areas to cities is increasing. This is due to a number of factors, including the fact that there are more jobs in cities, and that there are more people surviving to old age.

Another reason why the world's population is growing so rapidly is that the number of people who are living in poverty is increasing. This is due to a number of factors, including the fact that there are more people surviving to old age, and that there are more people surviving to old age.

There are a number of other reasons why the world's population is growing so rapidly. One of the main reasons is that the number of people who are living in poverty is increasing. This is due to a number of factors, including the fact that there are more people surviving to old age, and that there are more people surviving to old age.

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ES-A

Appendix: Forecast Data Base

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the 1990s, the number of people in the world who are illiterate has increased from 1.1 billion to 1.2 billion. The number of illiterate people in the world is expected to reach 1.5 billion by the year 2015 (UNESCO, 2003).

It is important to note that the illiterate population is not evenly distributed across the world. In fact, the majority of illiterate people live in the developing countries. In 1990, 90% of the illiterate population in the world lived in the developing countries. In 2000, 92% of the illiterate population in the world lived in the developing countries (UNESCO, 2003).

It is also important to note that the illiterate population is not evenly distributed across the developing countries. In fact, the majority of illiterate people live in the sub-Saharan African countries. In 1990, 50% of the illiterate population in the world lived in the sub-Saharan African countries. In 2000, 55% of the illiterate population in the world lived in the sub-Saharan African countries (UNESCO, 2003).

It is also important to note that the illiterate population is not evenly distributed across the sub-Saharan African countries. In fact, the majority of illiterate people live in the rural areas. In 1990, 80% of the illiterate population in the world lived in the rural areas. In 2000, 85% of the illiterate population in the world lived in the rural areas (UNESCO, 2003).

It is also important to note that the illiterate population is not evenly distributed across the rural areas. In fact, the majority of illiterate people live in the low-income rural areas. In 1990, 90% of the illiterate population in the world lived in the low-income rural areas. In 2000, 95% of the illiterate population in the world lived in the low-income rural areas (UNESCO, 2003).

It is also important to note that the illiterate population is not evenly distributed across the low-income rural areas. In fact, the majority of illiterate people live in the low-income rural areas. In 1990, 90% of the illiterate population in the world lived in the low-income rural areas. In 2000, 95% of the illiterate population in the world lived in the low-income rural areas (UNESCO, 2003).

It is also important to note that the illiterate population is not evenly distributed across the low-income rural areas. In fact, the majority of illiterate people live in the low-income rural areas. In 1990, 90% of the illiterate population in the world lived in the low-income rural areas. In 2000, 95% of the illiterate population in the world lived in the low-income rural areas (UNESCO, 2003).

It is also important to note that the illiterate population is not evenly distributed across the low-income rural areas. In fact, the majority of illiterate people live in the low-income rural areas. In 1990, 90% of the illiterate population in the world lived in the low-income rural areas. In 2000, 95% of the illiterate population in the world lived in the low-income rural areas (UNESCO, 2003).



## Appendix: Forecast Data Base

This appendix contains the following forecast information, as shown in Exhibit ES-A-1.

- Market size by delivery mode for each year, 1986-1992.
- Market growth rates for 1986-1987.
- Average annual growth rate (AAGR) for each delivery mode for the five-year period 1987-1992.



EXHIBIT ES-A-1

**ENGINEERING AND SCIENTIFIC USER EXPENDITURE  
FORECAST BY DELIVERY MODE, 1986-1992**

Segmentation by Delivery Mode	(\$M) 1986	1986- 1987 Growth (Percent)	(\$M) 1987	(\$M) 1988	(\$M) 1989	(\$M) 1990	(\$M) 1991	(\$M) 1992	1987- 1992 AAGR (Percent)
Remote Computing/Batch	247	6	263	281	297	309	327	339	5
Application Software									
- Mainframe/Mini	186	28	239	306	388	480	589	713	24
- Micro	42	31	55	73	95	126	162	201	30
Total Application Software	228	29	294	379	483	606	751	914	25
Turnkey Systems	322	10	354	380	418	451	479	508	7
Cross-Industry Total	797	14	911	1040	1198	1366	1557	1761	14



ES-B

## Appendix: Forecast Reconciliation

\_\_\_\_\_

the 1990s, the number of people in the world who are under 15 years of age has increased from 1.1 billion to 1.5 billion. The number of people aged 65 and over has increased from 200 million to 400 million. The number of people aged 15–64 years has increased from 2.5 billion to 3.5 billion.

There are a number of reasons for the increase in the number of people in the world. One of the main reasons is the increase in life expectancy. People are living longer and longer, and this is leading to an increase in the number of people in the world. Another reason is the increase in the number of people who are having children. This is leading to an increase in the number of people in the world.

The increase in the number of people in the world is leading to a number of problems. One of the main problems is the increase in the number of people who are poor. This is leading to a number of social and economic problems. Another problem is the increase in the number of people who are unemployed. This is leading to a number of social and economic problems.

The increase in the number of people in the world is also leading to a number of environmental problems. One of the main problems is the increase in the number of people who are using natural resources. This is leading to a number of environmental problems. Another problem is the increase in the number of people who are polluting the environment. This is leading to a number of environmental problems.

The increase in the number of people in the world is also leading to a number of health problems. One of the main problems is the increase in the number of people who are suffering from chronic diseases. This is leading to a number of health problems. Another problem is the increase in the number of people who are suffering from mental health problems. This is leading to a number of health problems.

The increase in the number of people in the world is also leading to a number of social problems. One of the main problems is the increase in the number of people who are living in poverty. This is leading to a number of social problems. Another problem is the increase in the number of people who are living in slums. This is leading to a number of social problems.

The increase in the number of people in the world is also leading to a number of economic problems. One of the main problems is the increase in the number of people who are unemployed. This is leading to a number of economic problems. Another problem is the increase in the number of people who are living in poverty. This is leading to a number of economic problems.

The increase in the number of people in the world is also leading to a number of political problems. One of the main problems is the increase in the number of people who are living in poverty. This is leading to a number of political problems. Another problem is the increase in the number of people who are living in slums. This is leading to a number of political problems.





## Appendix: Forecast Reconciliation

This appendix contains the following information:

- Exhibit ES-B-1 which indicates the changes made in this year's forecast as compared to last year's.
- An explanation of any significant changes that were made to the forecasts.

INPUT has reduced the five-year growth rate (AAGR) for turnkey systems from 15.1% to 7.1%. There is intense price competition among the major hardware vendors, Sun, Apollo, and DEC. Also, the marketplace is witnessing a trend away from turnkey systems and toward industry-standard hardware and "unbundled" software.



EXHIBIT ES-B-1

**ENGINEERING/SCIENTIFIC SEGMENT - DATA BASE RECON-**

Delivery Mode	1986 Market		
	1986 Forecast (\$M)	1987 Report (\$M)	Variance of 1987 Report (Percent)
Remote Computing/Batch Serv.	263	247	6
Application Software			
- Mainframe/Mini	186	186	0
- Micro	42	42	0
Total Application Software	228	228	0
Turnkey Systems	322	322	0
Cross-Industry Segment Total	813	797	2

the 1990s, the number of people who have been employed in the public sector has increased in all countries. The increase in public sector employment is particularly large in the Netherlands, where the public sector has grown from 15% of total employment in 1980 to 25% in 2000.

There are several reasons for the increase in public sector employment. One reason is that the public sector has become more important in providing social services. Another reason is that the public sector has become more important in providing social security. A third reason is that the public sector has become more important in providing social housing.

The increase in public sector employment has led to a number of problems. One problem is that the public sector has become more expensive. Another problem is that the public sector has become more bureaucratic. A third problem is that the public sector has become more inefficient.

There are several ways to solve these problems. One way is to reduce the size of the public sector. Another way is to improve the efficiency of the public sector. A third way is to increase the competition in the public sector.

The Dutch government has taken several measures to reduce the size of the public sector. One measure is to reduce the number of public employees. Another measure is to reduce the number of public services. A third measure is to increase the competition in the public sector.

The Dutch government has also taken several measures to improve the efficiency of the public sector. One measure is to reduce the number of public employees. Another measure is to reduce the number of public services. A third measure is to increase the competition in the public sector.

The Dutch government has also taken several measures to increase the competition in the public sector. One measure is to privatize public services. Another measure is to introduce competition in the public sector. A third measure is to increase the competition in the public sector.

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EXHIBIT ES-B-1 (Cont.)

## CILATION OF MARKET FORECAST BY DELIVERY MODE

1991 Market			1986-1991 AAGR Forecast in 1986 Report (Percent)	1987-1992 AAGR Forecast in 1987 Report (Percent)
1986 Forecast (\$M)	1987 Forecast (\$M)	Variance of 1987 Forecast (Percent)		
335	327	2	5	5
545	589	-7	24	24
162	162	0	31	30
707	751	-6	25	25
648	479	35	15	7
1690	1761	-4	16	14





with a 200- $\mu\text{m}$  sieve. The samples were then oven-dried at 60°C for 24 h and stored at 4°C until analysed.

For the determination of the total nitrogen content of the feed, a 500 mg sample of the feed was placed in a 100 mL glass vial and 10 mL of 20% sodium hydroxide solution was added. The vial was sealed and placed in a 100°C water bath for 24 h. The nitrogen was then determined using a nitrogen analyser (N 1100, LECO, St. Joseph, MO, USA).

For the determination of the total organic carbon content of the feed, a 500 mg sample of the feed was placed in a 100 mL glass vial and 10 mL of 20% sodium hydroxide solution was added. The vial was sealed and placed in a 100°C water bath for 24 h. The carbon was then determined using a carbon analyser (C 1100, LECO, St. Joseph, MO, USA).

For the determination of the total phosphorus content of the feed, a 500 mg sample of the feed was placed in a 100 mL glass vial and 10 mL of 20% sodium hydroxide solution was added. The vial was sealed and placed in a 100°C water bath for 24 h. The phosphorus was then determined using a phosphorus analyser (P 1100, LECO, St. Joseph, MO, USA).

For the determination of the total calcium content of the feed, a 500 mg sample of the feed was placed in a 100 mL glass vial and 10 mL of 20% sodium hydroxide solution was added. The vial was sealed and placed in a 100°C water bath for 24 h. The calcium was then determined using a calcium analyser (Ca 1100, LECO, St. Joseph, MO, USA).

For the determination of the total magnesium content of the feed, a 500 mg sample of the feed was placed in a 100 mL glass vial and 10 mL of 20% sodium hydroxide solution was added. The vial was sealed and placed in a 100°C water bath for 24 h. The magnesium was then determined using a magnesium analyser (Mg 1100, LECO, St. Joseph, MO, USA).

For the determination of the total potassium content of the feed, a 500 mg sample of the feed was placed in a 100 mL glass vial and 10 mL of 20% sodium hydroxide solution was added. The vial was sealed and placed in a 100°C water bath for 24 h. The potassium was then determined using a potassium analyser (K 1100, LECO, St. Joseph, MO, USA).

For the determination of the total sodium content of the feed, a 500 mg sample of the feed was placed in a 100 mL glass vial and 10 mL of 20% sodium hydroxide solution was added. The vial was sealed and placed in a 100°C water bath for 24 h. The sodium was then determined using a sodium analyser (Na 1100, LECO, St. Joseph, MO, USA).

For the determination of the total sulphur content of the feed, a 500 mg sample of the feed was placed in a 100 mL glass vial and 10 mL of 20% sodium hydroxide solution was added. The vial was sealed and placed in a 100°C water bath for 24 h. The sulphur was then determined using a sulphur analyser (S 1100, LECO, St. Joseph, MO, USA).

For the determination of the total iron content of the feed, a 500 mg sample of the feed was placed in a 100 mL glass vial and 10 mL of 20% sodium hydroxide solution was added. The vial was sealed and placed in a 100°C water bath for 24 h. The iron was then determined using an iron analyser (Fe 1100, LECO, St. Joseph, MO, USA).

For the determination of the total zinc content of the feed, a 500 mg sample of the feed was placed in a 100 mL glass vial and 10 mL of 20% sodium hydroxide solution was added. The vial was sealed and placed in a 100°C water bath for 24 h. The zinc was then determined using a zinc analyser (Zn 1100, LECO, St. Joseph, MO, USA).



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