CAIRO UNIVERSITY
FACULTY OF ENGINEERING
MECHANICAL DESIGN & PRODUCTION DEPT.

CAD / CAM AN OVERVIEW

DR. HESHAM A. HEGAZI
ASSISTANT PROFESSOR OF MACHINE DESIGN

Home Page: www.geocities.com/hahegazi

Email: hahegazi@yahoo.com

1ST YEAR DIPLOMA IN MACHINE DESIGN
2002/2003

1- INTRODUCTION

CAD/CAM is a term which means computer-Aided Design and Computer-Aided Manufacturing. Computer-Aided Design (CAD) can be defined as the use of computer systems to assist in the creation, modification, analysis, or optimization of a design. The computer systems consist of the hardware and software to perform the specialized design functions required by particular user firm. Computer-Aided Manufacturing (CAM) can be defined as the use of computer system to plan, manage, and control the operations of a manufacturing plant through either direct or indirect computer interface with the plant's production resources [1].

In engineering practice, CAD/CAM has been utilized in different ways by different people. Some utilize it to produce drawings and document designs. Others may employ it as a visual tool by generating shaded images and animated displays. A third group may perform engineering analysis of some sort on geometric models such as Finite Element Analysis (FEA) [2].

2- THE CAD PROCESS AND TOOLS

The CAD process (Fig. 1) is a subset of the design process. The definition a geometric model is the first step in CAD process. It is similar to the mathematical model in engineering analysis. It depends directly on the type of analysis to be performed. A valid geometric model is created by the CAD/CAM system through its definition translator which converts the designer input into the proper database format. In order to apply engineering analysis to the geometric model, interface algorithms are provided by the system to extract the required data from the model database to perform the analysis. In the case of finite element analysis (FEA) these algorithms form the finite element modeling of the system. Design testing and evaluation may require changing the geometric model before finalizing it. When the final design is achieved the drafting and detailing of the model starts, followed by documentation and production of final drawings is obtained. The design conceptualization, modeling, and simulation, requires geometric modeling techniques, graphics aids, manipulation, visualization, animation, assemblies and special modeling packages. The design analysis and optimization, requires customized programs and packages. Design evaluation requires dimensioning, tolerances, and bill of materials, while design documentation requires drafting and detailing.

The core of the CAD tools is geometric modeling and graphics applications. Even though CAD tools for design evaluations are hard to identify, they may include the proper sizing of the model after the analysis is performed to ensure engineering practices such as gradual change in dimensioning and avoidance of stress concentrations. Adding tolerances, performing tolerance analysis, generating a bill of materials, and investigating the effect of manufacturing on the design by utilizing Numerical Control (NC) packages are also valuable tools that are available to designers. The implementation of CAD tools in the design environments can be defined as the design tools and computers (Software and Hardware).

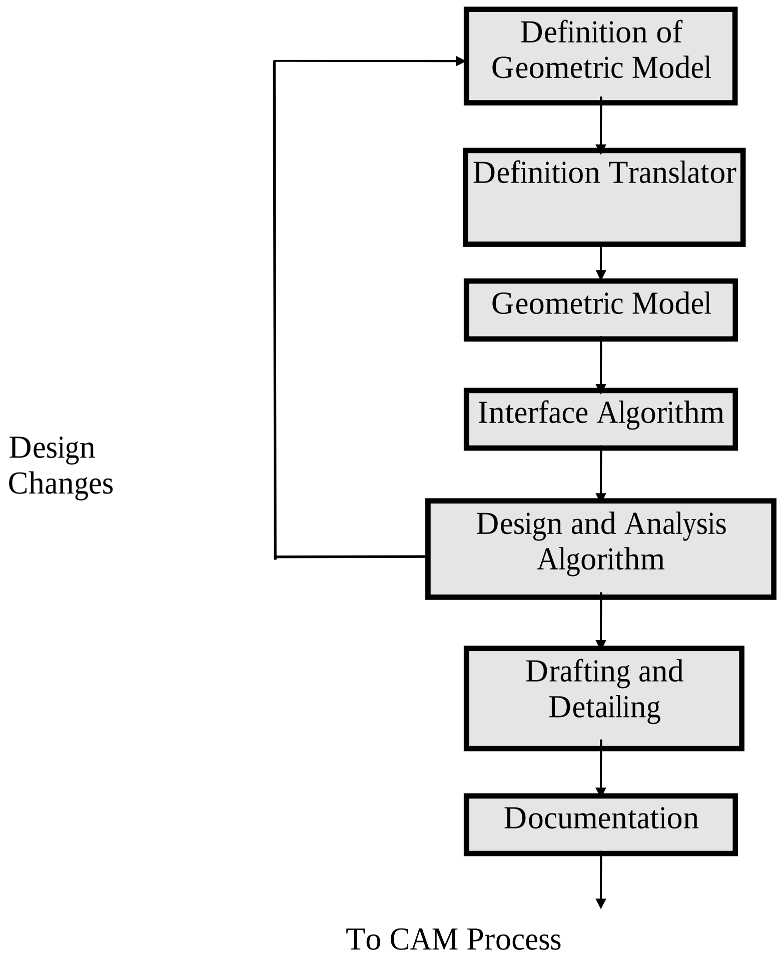


Fig. 1[2] (*Implementation of a CAD process on a CAD/CAM system*)

CAD hardware would include one or more design workstations. Each workstation would consist of:

- A graphics terminal
- Operator input devices
- One ore more plotter and other output devices
- Central processing unit (CPU)
- Secondary storage

The graphics software can be divided into three modules according to a conceptual model as follows:

- The graphics package or (graphics system)
- The application program
- The application database

The typical configuration of hardware components and graphics software in a stand-alone CAD system is shown in Fig.2

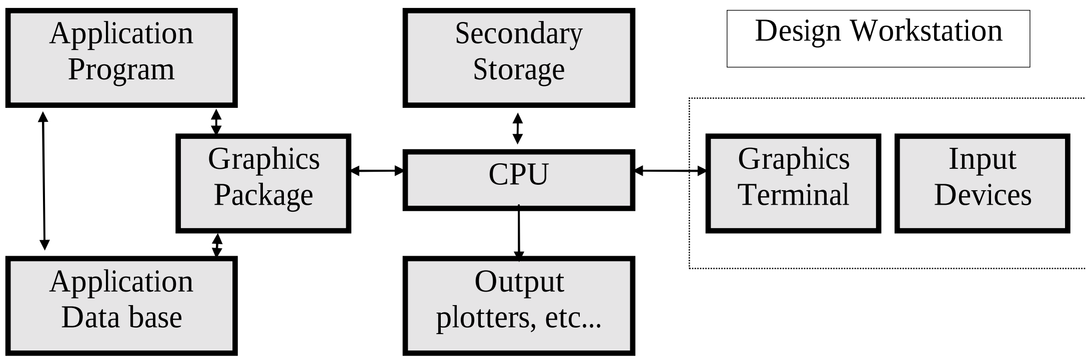


Fig. 2 (*Configuration of Graphics software and Hardware components in a CAD system*)

3- THE CAM PROCESS AND TOOLS

The CAM process (Fig. 3) starts from the geometric model developed during the CAD process. Interface algorithms are usually utilized to extract such information from CAD databases. In the case of process planning, features that are utilized in manufacturing (eg., hole, slots, etc.) must be recognized to enable efficient planning of manufacturing. NC programs, along with ordering tools and fixtures, result from process planning. Once parts are produced, CAD software can be used to inspect them. This is achieved by superposing an image of the real part with a master image stored in its model database. After passing inspection, CAM software can be utilized to instruct robot systems to assemble the parts to produce the final product.

CAM tools can be defined as the intersection of three sets: CAD tools, networking concepts, and the manufacturing tools. The manufacturing tools and computers (Hardware, Software, Networking) can describe a CAM tools.

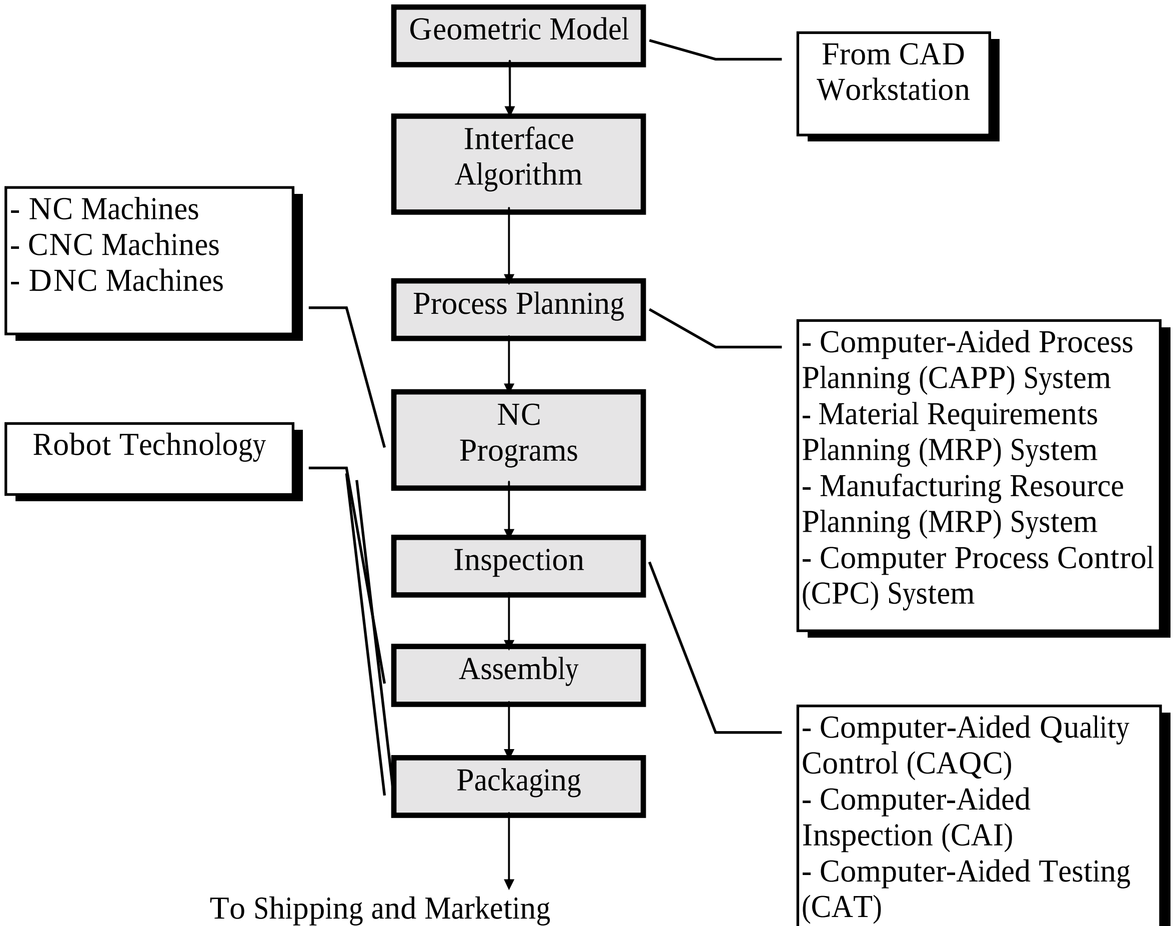
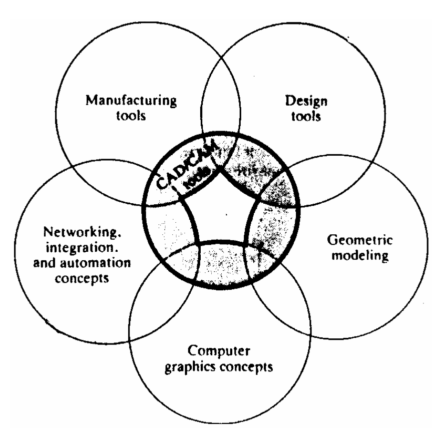


Fig. 3[2] (*Implementation of a CAM process on a CAD/CAM system*)

3- THE CAD/CAM PROCESS AND TOOLS

The definition of CAD/CAM can be represented in Fig. 4 as the intersection of five sets: The design tools, the manufacturing tools, geometric modeling, computer graphics concept, and networking concepts.

Fig. 4 [2] (*Definition of CAD/CAM tools based on their constituents*)



The impact of CAD/CAM is manifest in all of the different activities in the product cycle as indicated in Fig. 5. CAD/CAM is overlaid on virtually all of the activities and functions of the product cycle.

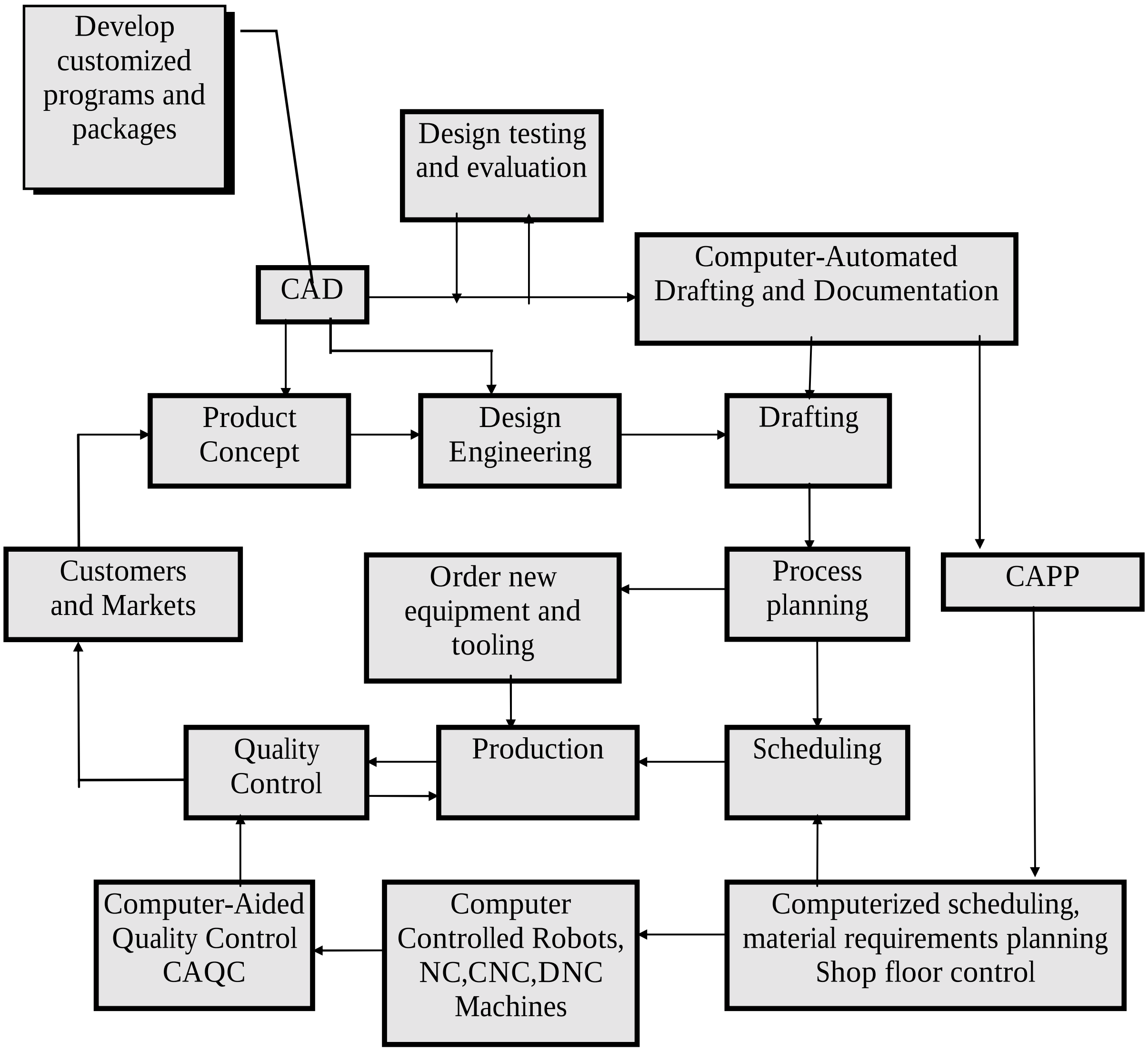


Fig. 5 (*CAD/CAM Product Cycle*)

The problem of the selection of the CAD/CAM solution may take 1,2 or even 3 years. Another 3 or 4 years may then go by before it becomes clear that the investment has paid off. The activities that took place between the moment that a company first decides to invest in CAD/CAM and the decision on a specific solution.

4- APPLICATIONS OF CAD/CAM

Aerospace, automotive, and shipbuilding industries have influenced, to a great extend, the development of lofted and sculptured surfaces. The future of CAD/CAM is bright. The price of hardware is continually decreasing while its speed and performance is increasing. CAD/CAM became a key factor of the future envelopment of versatile tools for design and manufacturing applications. The concept of the “factory of the future” hinges on the successful integration and automation of various CAD/CAM functions. The CAD/CAM market by application type in the United States is show in Fig. 6. The application in the mechanical engineering takes the largest portion.

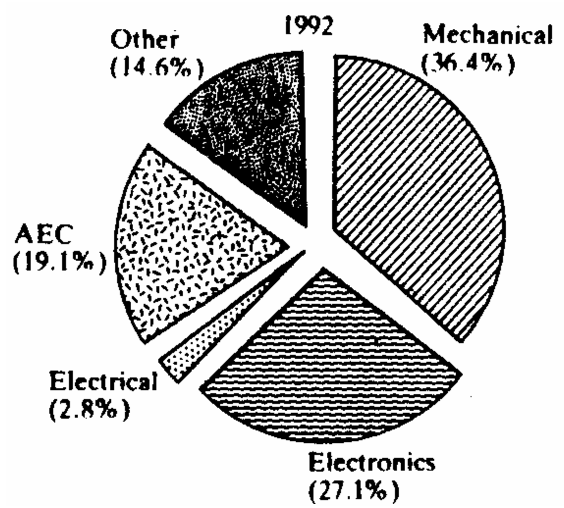


Fig. 6 [2] (*CAD/CAM market by application type*)

5- THE CIM ENVIRONMENT

Computer Integrated Manufacturing (CIM) integrates all the computers and stored data are tied together. The data base or data-management system may be at one central location or, more likely, spread around at several locations. With CIM we use computers and a data base to help us to design, order, and control the raw material, operate the machines for fabrication, keep track of all aspects of production control, do scheduling, order and warehouse parts, make inspections and do many other important tasks. The computer also keeps track of costs of finished goods and work in process. Fig. 7 shows a model of CIM configuration, and how the various operations such as assembly, manufacturing, and CAD are tied together by computer communication networks to the data base.

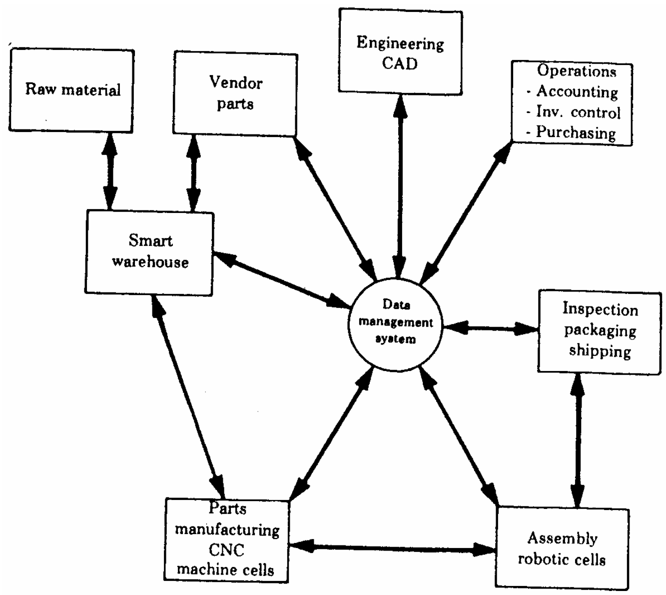


Fig. 7 [4] (*Computer Integrated Manufacturing*)

6- CONCLUSION AND FUTURE WORK

The implementation of CAD/CAM systems in any company takes a long time, for taking the decision to use it. It is very important to determine the cost of CAM/CAM system to the task required in the company, to have the gain of using the CAD/CAM system economically. A company may utilize a CAD/CAM system by purchasing the system from one CAD/CAM vendor, extend an existing corporate computer system, or to develop a CAD/CAM capability from scratch within the user company.

While the CAD/CAM field has come a long way in four decades thus far, its future certainly holds many challenges. Extrapolating this existing history reveals that the decade of the 1990s and beyond will represent the age where the fruits of the current research efforts in integrating and automating design and manufacturing applications will mature. It is anticipated that new design and manufacturing algorithms and capabilities will become available. These applications will be supported by better and faster computing hardware, and efficient networking and communication software. It was seen that the large applications of CAD/CAM is in the field of mechanical engineering. In the next few years, it is expected that purchases of large numbers of personal computers and workstations will be made.

REFERENCES

1] Grosser, M.P., Zimmers, E.W., "**CAD/CAM Computer-Aided Design and Manufacturing**", Prentice-Hall, 1989.

2] Zeid, I., "**CAD/CAM Theory and Practice**", McGraw-Hill, Inc., 1991.

3] Bedworth, D.D., Henderson, M.R., Wolfe, P.M., "**Computer Integrated Design and Manufacturing**", McGraw-Hill, Inc., 1991.

4] Vail, P.S., "**Computer Integrated Manufacturing**", PWS-KENT Pub. Co., 1988.

5] Corbett, J., Dooner, M., Meleka, J., Pym, C., "**Design For Manufacture, Strategies, Principles and Techniques**", Addison-Willey Pub. Co., 1991.

6] Stark, J., "**Managing CAD/CAM, Implementation, Organization, and Integration**", McGraw-Hill, Inc., 1989.

7] Callen, J.N., "**The Case For CAM**", Manufacturing Engineering, Vol. 113, No. 5, Nov. 94.