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(University Established under section 3 of UGC Act, 1956)

DEPARTMENT OF MECHANICAL ENGINEERING

Name of the Course : CAD/CAM

Name of the unit : Computer Aided Design

Topic – Title : Computers in Industrial Design Processes

I. Aim:

The main aim of the above topic is to provide better understanding of the importance of computers in engineering design processes.

II. Objectives:

The main objective of computers in engineering design is the following,

- increase in the need for design in manufacturing
- short lead times
- reducing complexity in design and analysis of a new product.

III. Pre-requisites:

To have a basic knowledge of applications of computers in mechanical engineering.

IV. Pre-test MCQ:

1. Following is not an operating system software
    a. Windows
    b. UNIX
    c. VAX/VMS
    d. IDEAS
2. Which of the following is the input device of computer?
    a. Printer
    b. Display
    c. Keyboard
    d. Plotter
3. LAN means
    a. Local Area Network
    b. Logical Aid Network
    c. Local Administrator Network

d. Logics And Networks

4. Which of the following is the output device of CAD?
    a. Scanner
    b. Mice
    c. keyboard
    d. Printer
5. ALU stands for
    a. Arithmetic and local unit
    b. Arithmetic and logic unit
    c. Android local unit
    d. American logical unit
6. Which of the following is NOT a cad software?
    a. Auto CAD
    b. Proe
    c. Catia
    d. MS-word
7. A computer is a fast ___ data processing machine.
    a. Electronic
    b. Machine
    c. Analog
    d. None of the above
8. Computers read a lot of data, do small number of calculators and output a large amount of data as result in ___ application.
    a. Electronic processing
    b. Data processing
    c. Network processing
    d. None of the above
9. An analog computer is
    a. Usually a special purpose computer
    b. Usually less accurate than a digital computer
    c. Often used to simulate a physical phenomenon
    d. All the above
10. Choice of manufacturing technology is based on
    a. Unit cost of production

b. Quantity and uniformity of product
c. Quantity of manufacturing envisaged
d. All of the above

V. Background of engineering design processes:

Microelectronics in the recent past have made higher computational ability available at a low cost. Thus, it becomes imperative that manufacturing has to take advantage of the availability of low-cost yet more powerful computers. Hence, the use of Computer Aided Engineering, particularly for mechanical industries, should now be a realisable goal. The role of computers in manufacturing may be broadly classified into two groups:

1. **Computer monitoring** and **control** of the manufacturing process
2. **Manufacturing support applications**, which deal essentially with the preparations for actual manufacturing and post-manufacture operations. The support functions that computers can provide for the successful completion of manufacturing operations. The types of support that can be envisaged are the following:

- **CAD — Computer Aided Design:** The use of computer methods to develop the geometric model of the product in three-dimensional form, such that the geometric and manufacturing requirements can be examined.
- **CADD — Computer Aided Design and Drafting:** Combining the CAD function with drafting to generate the production drawings of the part for the purpose of downstream processing.
- **CAE — Computer Aided Engineering:** The use of computer methods to support basic error checking, analysis, optimisation, manufacturability, etc., of a product design.
- **CAM — Computer Aided Manufacturing:** Generally, refers to the computer software used to develop the Computer Numerical Control part programs for machining and other processing applications.
- **CAPP — Computer Aided Process Planning:** The use of computers to generate the process plans for the complete manufacture of products and parts.
- **CATD — Computer Aided Tool Design:** Computer assistance to be used for developing the tools for manufacture such as jigs and fixtures, dies, and moulds.

- **CAP — Computer Aided Planning:** The use of computers for many of the planning functions such as material requirement planning, computer aided scheduling, etc.
- **CAQ — Computer Aided Quality Assurance:** The use of computers and computer-controlled equipment for assessing the inspection methods and developing the quality control and assurance functions.
- **CAT — Computer Aided Testing:** Refers to the software tools that can take a system through its various phases of operations and examine the response against the expected results.

The use of computers in manufacturing is a methodological approach to the enterprise in order to improve industrial performance. The total components that can be assumed to consist of a number of interlinked domains are shown in Figure 1. Design is an activity that needs to be well organised and should take into account all influences that are likely to be responsible for the success of the product under development.

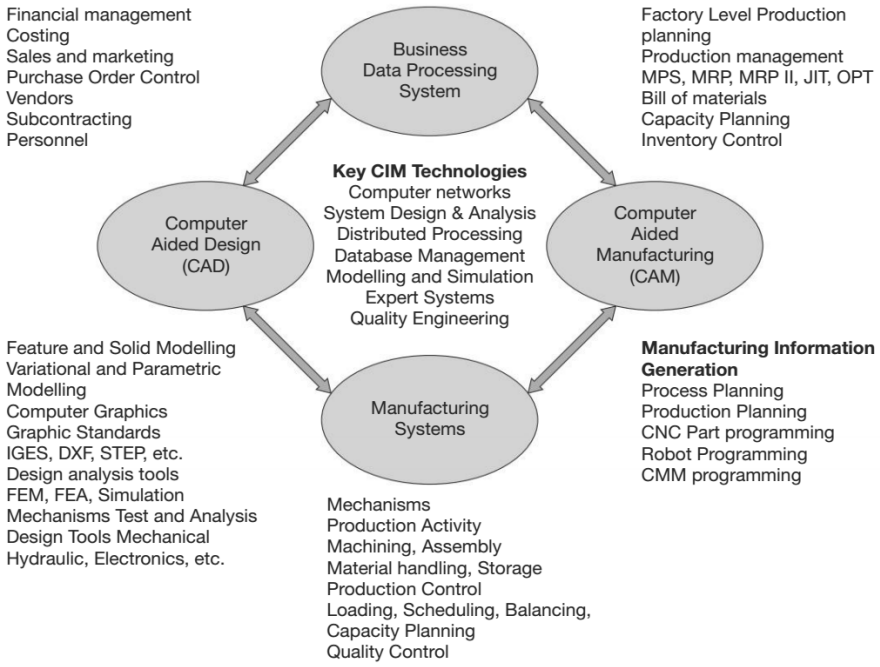

Figure 1: The influence of computers used in manufacturing environment

A product can range from a single component, which is functional in itself like a wrench to the assembly of a large number of components all of which will contribute to the functioning of the part, such as an automobile engine. The complexity of the design process increases with the number and diversity of components present in

the final part. Since there are such a large number of influencing factors, it is impossible to specify a design procedure for each component. The various faculties that are responsible for a successful product can be classified under two headings as follows:

Product Engineering	Manufacturing Engineering
Product functions Product specifications Conceptual design Ergonomics and Aesthetics Standards Detailed design Prototype development Testing Simulation Analysis Drafting	Process sheets Route sheets Tooling - Cutting tools, Jigs and fixtures, Dies and moulds Manufacturing Information Generation CNC part programs, Robot programs, Inspection (CMM) programs Production Organisation - Bill of materials, Material requirement planning, Production planning, etc. Marketing and Distribution – Packaging, Distribution, Marketing.

Ideally, the designer should consider all these factors while finalising the design. It is impossible for a single individual to carry out all these functions, except in the case of simple parts. For complex systems, the product design function needs to be carried out by a team of specialists who have specified knowledge and experience in the individual areas as mentioned above. As identified earlier, the design process goes through well-structured stages to reach the stage of actual part production as mentioned in Figure 2.

a. **Problem Identification** - it is possible to identify some of the basic questions related to the product such as who, what, where, when, why and how many should be answered with fair accuracy.
b. **Problem Definition** - The next stage in the design process is the clear definition of the problem and coming up with all possible ideas for solutions.

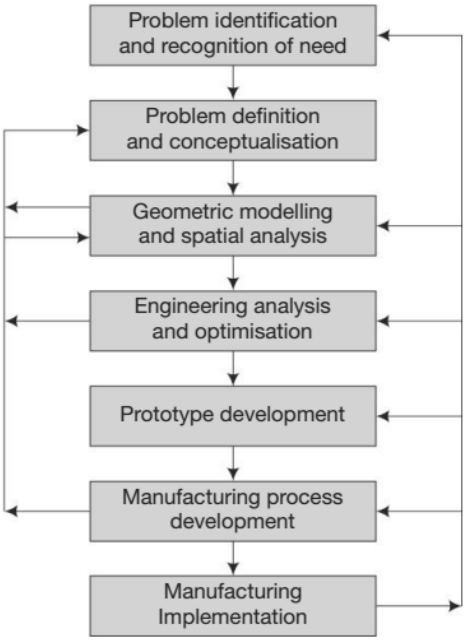

Figure 2: Stages in design process

c. **Geometric Modelling** - the identified solutions are further explored for the final design solution. At this stage, it is necessary to employ computers at the various phases.

d. **Engineering Analysis** - In this stage of design process, a thorough analysis of the product is carried out to get as much of information as possible before committing to final manufacturing. The analysis stage is basically an iterative one with modification to the geometric model being carried out until the desired end result is achieved.

e. **Prototype Development** - Before committing the design to manufacture, it is also essential to carry out some physical tests on the part. This will be in addition to the computerised analysis carried out using various facilities as outlined in the earlier stages.

f. **Manufacturing Process Development** - After finalizing the product design, it is important to move the product to the manufacturing stage. Already the geometric models of the individual components as well as the assemblies are available both in electronic form as well as hard-copy form from the earlier stages. They are utilised for developing the necessary manufacturing processes again utilising computers to their fullest extent.

VI. Applications of computers in design process:

The major benefit of computers in design process are given below.

1. It minimizes the manufacturing lead time.
2. It helps to identify exact ideal time of machines on the manufacturing lines during the real time manufacturing.
3. CAD reduces the human component of manufacturing and thereby relieves the process of its slow, expensive and error-prone component.
4. A systematic methodological approach is applied to all activities from the design of the product to customer support in an integrated way, using various methods, means and techniques in order to achieve production improvement, cost reduction, fulfillment of scheduled delivery dates, quality improvement and total flexibility in the manufacturing system.

VII. MCQ - Post Test:

1. CAD means,
    - **a. Computer Aided Design**
    - b. Computer Aim Design
    - c. Computer Assembled Design
    - d. Computer Aviation Design
2. MLT means
    - a. Material loading time
    - b. Manual loading time
    - **c. Manufacturing lead time**
    - d. Material liquefy time
3. CADD means,
    - **a. Computer Aided Design & Drafting**
    - b. Computer Aided Detailing of Designs
    - c. Computer Aided Demonstration for Design
    - d. None of the above
4. The basic geometric building blocks provided in a CAD/CAM package are
    - a. Points
    - b. Lines
    - c. Circles
    - **d. All of the mentioned**

5. CAE stands for
    a. Computer Aided Energy
    b. Computer Aided Engineering
    c. Computer Aided Engraving
    d. Computer Aided Engine
6. Basic process in process planning determines the basic ____ of the work part
    a. Size
    b. Geometry
    c. Color
    d. Material
7. CAPP stand for
    a. Computer aided process planning
    b. Computer aided project planning
    c. Computer aided primary planning
    d. Computer aided permanent planning
8. Which of the faculties that is responsible for a successful product under manufacturing engineering?
    a. Conceptual design
    b. Detailed design
    c. CNC part programs
    d. Drafting
9. Which of the faculties that is responsible for a successful product under product
   engineering?
    a. Process sheets
    b. Route sheets
    c. Marketing and Distribution
    d. Conceptual design
10. Which of the statement is CORRECT?
    a. The complexity of the design process increases with the number and diversity of components present in the final part.
    b. Manufacturing lead time is the total time required to remove all the rejected part in a CNC machining.
    c. CAD stands for Computer Aided Development.

d. Basic process in process planning determines the basic size of the work part.

VIII. Conclusion:

Based on the above topic, the conclusions can be drawn,

- The application of computers in manufacturing has been to direct, monitor and control the processes as well as support the various functions of the operations.
- Computers are being applied in all aspects of manufacturing such as design and drafting, engineering, manufacturing, process planning, tool design, material requirement planning, scheduling, etc. The conventional design process involves a large number of activities where a variety of processes need to interact while arriving at the best and economic design.
- Computer aided design deals with all the operations that deal with the development of the product. These could include such operations as design, analysis, testing, manufacturing information generation, etc.
- A number of advantages are gained by the use of computers in the design process. Using CAD reduces a number of unwanted repetitive operations, at the same time improving the accuracy, reducing the developmental time and cost.
- Computer Aided Design Integrated Manufacturing tries to link all the operations that are used in manufacturing such that the information is shared between all the operations. This would mean the reduction of waste leading to lean manufacturing.

IX. References

a. Zimmers, E. W., Groover, M. P. (1984). CAD/CAM: computer-aided design and manufacturing. Taiwan: Prentice-Hall.

b. Cad/Cam Theory & Practice 2E. (2009). India: McGraw-Hill Education (India) Pvt Limited.

c. Radhakrishnan, P., Subramanyan, S., Raju, V. (2008). CAD/CAM/CIM. India: New Age International (P) Limited, Publishers.

d. Rao, P. N. (2010). Cad/Cam: Prin & Appl 3E. India: McGraw-Hill Education (India) Pvt Limited.

X. Audio / Video

https://www.youtube.com/watch?v=MAhpfFt_mWM

https://www.youtube.com/watch?v=ZQF8iU7ygoM&t=107s

XI. Assignments

a. Specify the various stages present in a conventional design process.
b. Explain the importance of engineering analysis in the design cycle.
c. Briefly describe the role of engineering analysis process in the product design cycle.

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