UNIT 1 INTRODUCTION TO CIM

Structure

1.1 INTRODUCTION

Initially, machine tool automation started with the development of numerical control in 1950s. In less than 50 years, it is amazing that today's manufacturing plants are completely automated. However, establishment of these plants gave relatively a few varieties of product. At first we define what do we mean by a manufacturing plant? Here, we are considering a several categories of manufacturing (or production) for the various manufacturing plants. Manufacturing can be considered in three broad areas:

(i) continuous process production,

(ii) mass production, and

(iii) job-shop production.

Among these three, mass production and job-shop production can be categorized as *discrete- item production.*

Continuous Process Production

Such type of product flows continuously in the manufacturing system, e.g. petroleum, cement, steel rolling, petrochemical and paper production etc. Equipment used here are only applicable for small group of similar products.

Mass Production

It includes the production of discrete unit at very high rate of speed. Discrete item production is used for goods such as automobiles, refrigerators, televisions, electronic component and so on. Mass production contains the character of continuous process production for discrete products. That's why; mass production has realized enormous benefits from automation and mechanization.

Job Shop Production

A manufacturing facility that produces a large number of different discrete items and requires different sequences among the production equipments is called job shop. Scheduling and routine problems are the essential features of job shop. As a result automation has at best been restricted to individual component of job shop. But there have been few attempts in the field of total automation.

Physical components of an automated manufacturing system do not include continuous flow process as it only consists of a small percentage of manufacturing system. Mass production of discrete items is included in this category, where segments of production line are largely automated but not the entire line. Job shop facilities have used automated machines, but transfer of work among these machines is a difficult task. Apart from some physical equipment needed, a major component of the automated information that needs to be made available to the manufacturing operation must come from product design. This allows a plant to be automated and integrated. However, manufacturing is more concerned with process design rather than product design.

The characteristic of present world market include higher competition, short product life cycle, greater product diversity, fragmented market, variety and complexity, and smaller batch sizes to satisfy a variety of customer profile. Furthermore, non price factors such as quality of product design, innovation and delivery services are the preliminary determinant for the success of product. In today's global arena, to achieve these requirements manufacturing company needs to be flexible, adaptable and responsive to changes and be able to produce a variety of products in short time and at lower cost. These issues attract manufacturing industries to search for some advanced technology, which can overcome these difficulties. Computer integrated manufacturing (CIM), which emerged in 1970, was the outcome of this protracted search.

CIM involves a fundamental strategy of integrating manufacturing facilities and systems in an enterprise through the computer and its peripheral. CIM can be defined in different ways depending upon its application. CIM involves integration of advanced technologies in various functional units of an enterprise, in an effective manner to achieve the success of the manufacturing industries. A deep knowledge and understanding of all the technology is required for an effective integration. At first integration of advanced manufacturing technology (AMT) is required to get success in the application of CIM. Computers act as a subordinate to the technologies. Computers help, organize, and restore information in order to achieve high accuracy and speed. Their basic aim is to achieve the goals of the objectives within limited available capital. Traditionally, all the efforts were focused on achieving single goal to improve the effectiveness and competitiveness of the organization. But they failed because they didn't satisfy the overall objectives of the manufacturing companies. Hence, a multiple goal selection or mult- criteria optimization is proposed to make the CIM an effective tool to improve the economy of the company. The new approach should be developed for improving the existing multi-criteria optimization mechanism, so that CIM can be realized globally. In addition, global integration approach should be applied to make globally distributed company as a single entity. This concept is applied to make virtual CIM more effective and hence helps in meeting the present global economic circumstances using intelligent manufacturing. Therefore, manufacturing technology should be blended with intelligence. This will help manufacturing enterprise to produce better quality. It will also facilitate the manufacturing equipments to solve problems posed during normal course of the operations.

Computer technology is the necessary input to implement automation in manufacturing system. The term CIM denotes the widespread use of computer systems to design the product, to plan the production, control the operation, and perform the business related functions required in the manufacturing firm. True CIM includes integration of these functions in the system that operates throughout the enterprise. Other words are used to identify specific element of the CIM system. For example, computer aided design (CAD) denotes the use of computer system to support the product design system. *Computer aided manufacturing (CAM)* denotes the use of computer system to perform the functions related to manufacturing engineering, such as process planning and numerically controlled (NC) part programming. Some computer system performs the CAD and CAM, and so the term CAD/CAM is used to indicate the integration of the two systems into one. In addition to CAD/CAM, CIM also includes the firm business function that are related to manufacturing.

Benefits of CIM

CIM plays a vital role in the economy of the manufacturing system or enterprise. The benefits of CIM are indicated as follows:

(i) Products quality improvement.

(ii) Shorter time in launching new product in the market.

(iii) Flow time minimized.

(iv) Inventory level reduced.

(v) Competitiveness increases.

(vi) Improved scheduling performance.

(vii) Shorter vendor lead time.

(viii) Improved customer service.

(ix) Increase in flexibility and responsiveness.

(x) Total cost minimized.

(xi) Long term profitability increases.

(xii) Customers lead time minimized.

(xiii) Manufacturing productivity increases.

(xiv) Work in process inventory decreases.

Objectives

After studying this unit, you should be able to

- describe the fundamental concepts of CIM,
- explain enterprisewide integration of CIM and concept of CIM wheel,
- differentiate between CAM, CAD/CAM, and CIM,
- know the scope of CIM,
- discuss operations flow within CAD/CAM, and
- know the different approaches for integration of CAD/CAM.

1.2 ENTERPRISEWIDE INTEGRATION OF CIM

Dr. J. Harrington, Jr. introduces the concept of Computer Integrated Manufacturing (CIM) in the year 1973. He demonstrated the integration approach to an enterprise. Keeping in mind the current and future market trend for customized product and in order to stand in the competitive edge over long time, virtual organizations are used as an important weapon. Hence, in order to achieve corporate goal and objectives, integration approach is required for customer as well as suppliers. CIM, in general, may be defined as follows :

CIM is the integration of total manufacturing enterprise through the use of integrated system and data communication mixed with new managerial philosophies which results in the improvement of personnel or organizational efficiencies.

From the definition mentioned above, the ultimate goal of CIM is the integration of all the enterprise operation and activities around a common data collection. In this context, society of manufacturing engineers (SME) introduces the CIM wheel, which gives a clear cut picture of relationship among all parts of the enterprise. It shows three layered integration structure of an enterprise as given in Figure 1.1. Outer layer constitutes of general management which includes marketing, strategic planning, finance, manufacturing management and human resource management. The middle layer consists

of three process segments: product and process determination, manufacturing planning and control, and factory automation. These process segments represent all the activities in the design and manufacturing phase of a product life cycle taking the product from concept to assembly. The center of wheel represents the third layer which include information resources management and common database.

Figure 1.1 : The SME CIM Wheel
(© 1985, Society of Manfacturing Engineers, Dearborn, Mi 48121, Which Focuses on the Customer Rather than the Database

SAQ 1

(a) What are the different basis of classifying production system according to the quality and variety of product?

(b) What are the potential benefits of CIM?

(c) Discuss the concept of CIM wheel and explain the importance of integrating the enterprise included therein?

1.3 THE SCOPE OF COMPUTER-INTEGRATED MANUFACTURING

When all of the activities of the modern manufacturing plants are considered as a whole, it is impossible to think that a small portion might be automated, let alone trying to envisage automation of the whole. In systems approach, a large and complex system with interacting components are analyzed and improved. Anyone vested with the

responsibility of implementation of automation for complex system is advised to implement a technique similar to the traditional systems approach.

Following steps are involved in the systems approach :

(a) Objectives of the system are determined.

(b) Structuring the system and set definable system boundaries.

(c) Significant components for a system are determined.

(d) A detailed study of the components is carried out keeping in view the overall integration of the system.

(e) Analyzed components are synthesized into the system.

(f) On the basis of the performance criteria, predetermined system is evaluated.

(g) For continuous improvement, Step ‘b’ to Step ‘f’ are constantly repeated.

No task, however small, should be tackled without knowledge of the task objective. This is the key ingredient which, when lacking, causes members of the same team to pull in different directions. In considering factory automation, there could be many possible objectives. One might be to improve the performance of a specific process. Boundary conditions would then be limited to that process (as well as other processes that might be affected by increased output, such as material supply and assembly after production). Another objective might be to minimize cost in a segment of the operation, while a third might be profit maximization; obviously it is rare that such multiple objectives can all be optimized, even though politicians seem to think so when it comes close to election day. When considering moving to a computer integrated manufacturing operation, the objective would probably be related to being competitive, a problem that manufacturing plants are having at the micro level and a situation that is almost catastrophic for the nation at the macro level.

Setting system boundaries for a CIM project might at first appear to be concerned only with the engineering design and actual manufacture of the products. While the integration of these two components is a major task which is not satisfied in most of the facilities, CIM goes beyond these activities. Figure 1.2 shows graphically what is involved in computer integrated manufacturing.

As far as plant itself is concerned, there are five major components:

Computer Aided Engineering (CAE)

CAE encompasses CAD, NC programming, tool and fixture design, quality control (QC) planning, and process planning. This later areas that ties CAD and CAM together and when automated is called computer aided process planning (CAPP).

Operations Management

Operations management governs the acquisition of all materials needed for product manufacture; since a cost effective system is required, it is mandatory to include cost accounting. Production planning and control is required to ensure that parts are routed in an efficient manner to keep equipment busy as well as to ensure that customers needs are satisfied. Shop floor controls are needed to ensure that production data is available to production planning and control as well as to allow planned sequencing to be effected on the shop floor.

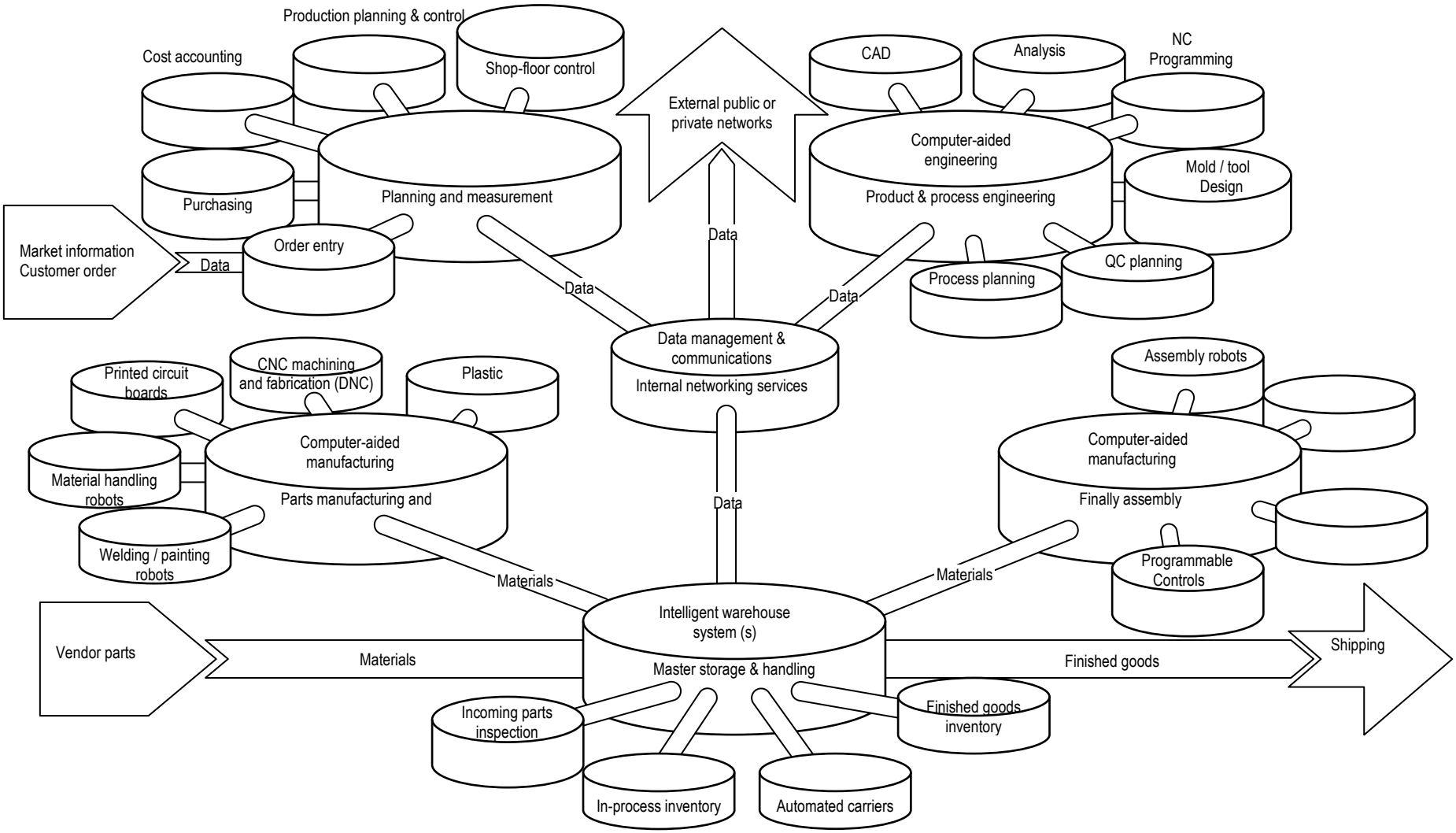

Figure 1.2 : Structure of CIM (from Ref.8, Courtesy of Production Engineering)

Computer Aided Manufacturing – Manufacturing and Test

Parts have to be manufactured and tested. A major point is made in Figure 1.2 that should be exemplified at this point. Many people think that computer aided manufacturing is for *chip-cutting* part only – those parts that are machined in same fashion. It is not true, as it cannot be stressed too forcefully. Several activities related to manufacturing of PCBs (Printed Circuit Board), controlling non-traditional machines (Electrical Discharge Machine, Electrochemical Machines etc.) and various precision operations have been using the salient features of CAM.

Computer Aided Manufacturing – Assembly and Test

Assembly, inspection and packing are the important features of CAM. They play a major role in the success of the implementation of CIM systems.

Intelligent Warehousing

The last component of the CIM encompasses automatic storage and retrieval of materials and components, and finished goods. It takes into consideration the incoming materials, products as well as the work-in-progress (WIP).

Finally to allow all the components to work as an integrated system, we have to integrate the five components with a network system as exemplified by the data management and communications modules shown in Figure 1.2. Standards have been evolved for this function, but the information flow in CIM is a major problem, which is yet to be handled in an effective manner.

In continuation to the systems approach, it is necessary to break the system into components for initial analysis. In fact the overall systems approach would be applied to the six major components as mentioned before, including the component of data management and communications. Analysis of the entire system is a difficult and tedious process as compared to the analysis of individual modules. This problem attains a complex magnitude, when one considers the integration of computer systems for design and manufacturing.

After the initial analysis of the components, the integration aspect is taken up. It is done through a networking scheme with a smart database able to handle design, manufacturing, and planning. To achieve this, a hierarchical computer structure must be employed. The manufacturing database remains at the top of the hierarchy followed by equipment controlling and data-gathering systems.

We have not yet branched out the CIM system. Table 1.1 depicts that fall under the broad purview of the components discussed so far. In the next section, we will consider the major functions that relate the areas of CAD, CAM and the production operating system.

SAQ 2

Discuss the scope of CIM in context of business, production and design.

	Business		Production				Design		
	Resource Management	**Economic Accounting**	**Production Planning**	**Part Planning**	**Production Control**	**Part Processing**	**Document Preparation**	**Test**	**Synthesis and Analysis**
Industry	Trend analysis Resource availability Economic Indicators		Capacity and delivery planning R&D	Machining technology database R&D		R & D Testing	Standards Design CAD Interface Parts database		Design standards
Corporation	Trend analysis Facility planning Strategic planning Merger/acquisition Synergistic product Production level Data management	Projection Simulations	Scheduling Facility planning Material requirement planning R&D	Machining technology database Group technology R&D	Data Management	R & D Testing	Parts database Bills of materials GT/ part classification Data management	Test database Field report database Computer - aided engineering	Computer - aided engineering Producibility analysis Design standards
Plant	Plant layout Inventory Scheduling Manpower utilization Make/buy decision Data management	Cost tracking Customer billing Customer order Normal accounting Make/ buy/ economic order quantity	Material requirment planning Bill of materials time standards Scheduling Make/buy decision Facility	Machining technology database GT/plan retrieve Computer assisted process planning R&D Part	Inventory Routine/scheduling Material handling QC/QA Maintenance Purchase/receive Data management Standard methods	R&D Testing	Parts database Computer aided design and drafting Bills of materials GT/part classification Tool/fixture Design and	Computer aided engineering Testing	Design analysis System modelling Producible Analysis GT/design retrieval Design standards

		Cost estimating Process justification	planning Capacity planning , Plant layout Manpower utilization GT/operation sequence	programme Cost estimating			cooling Data management		
Cell	Job sequencing Inventory Data management	Job tracking Economic data collection	Line balance Machine loading	Machining technology Database Computer assisted processing planning Part programme NC verification	Material handling Routing/scheduling QC/QA inspection Standards methods Inventory data management	Automatic assembly Adaptive control Robotics And data collection	Process instructions	Data acquisition	GT/design retrieval Design standards
Work stations		Economic data collection		Computer assisted process planning	Maintenance/diagnostic	NC. DNC CNC, adaptive control Automatic inspection, sensors diagnostic, data collection	Process instruction	Data acquisition	

(Various functions included under the umbrella of computer integrated manufacturing are indicated in this matrix presented by Edward J. Adlard, supervisor of manufacturing software system. Metcut Research Associates, inc., at SME"autofact 4 conference. The matrix represents the various functions involved in CIM and shows where these functions impact the manufacturing organization. The division along the left hand side of the matrix represents the various levels of overall manufacturing environment-industry, corporate, plan, cell, and workstation.) *Source* : Computer Integrated Manufacturing from Vision to Reality “Production Engineering, Nov-1983”.

1.4 OPERATIONAL FLOW WITHIN CAD/CAM

In this section, the operational flow of functions needed to process an item through a manufacturing facility has been briefly discussed. These operation flows within the CAD/CAM environment have been shown by a flow chart (Figure 1.3). The box number in figure refers the sequence number.

1, 2. All planning must be the function of known customer orders and sales forecasts. If expected demand are not known/or estimated, the enterprise will be working in a vacuum.

3. Management decisions depend on expected orders leading to long-term order requirement that must be satisfied by either production or by subcontracting to outside sources (vendors).

4. A relatively low term evaluation of facility requirement is needed to plan which parts can be manufactured. For example, enough machines of known capacity available, will material be available, can we perform our needs with the current workforce, and so on. The aggregate planning function determines what product quantities should be produced in what time periods to satisfy the long-term requirements. The result of this activity is called the *master production schedule or master schedule.* It is a schedule for *final product*, not for the components that go into the final product.

5. The master schedule is affected by current status conditions, so feedback loops come from many sources–including problems that might occur with deliveries from vendors, trouble in the shop floor, analysis that reveals demands cannot be satisfied due to capacity problems, lack of vendors, and so on.

6. The material requirements planning (MRP) function takes into consideration the current inventory levels for *all* components needed to make the final products (a plant might have 20,000 part numbers and perhaps 100 final products for which master schedules have been determined) as well as the components' bills-of-materials and lead time information (obtained from design and process planning data) and evolves component master schedules for all components according to the demand requirements agreed upon. MRP does not take into account whether manufacturing has sufficient capacity to handle the job releases, therefore capacity planning (6a) evaluates shop loading in terms of the requirements and feedback to the master schedule for corrective actions if any problems occur. A further function of MRP based on such analysis is determining whether components should be produced in-house (6b) or subcontracted to outside vendors (6c).

7. Computer aided design is the function that must be completed after a demand for a product has been determined. Thus, the sequence in which it is discussed in this section is not the same as that of sequence or cycle starting from customer to inception through design, manufacturing, assembly and testing, and back to the customer. The design engineer cannot talk in the same terms as the manufacturing engineer. For example, lines, splines, circles, and arcs come under geometrical design whereas pockets chamfers, holes and so on come under manufacturing design. Process planning function is to accomplish the language transition from design to manufacturing.

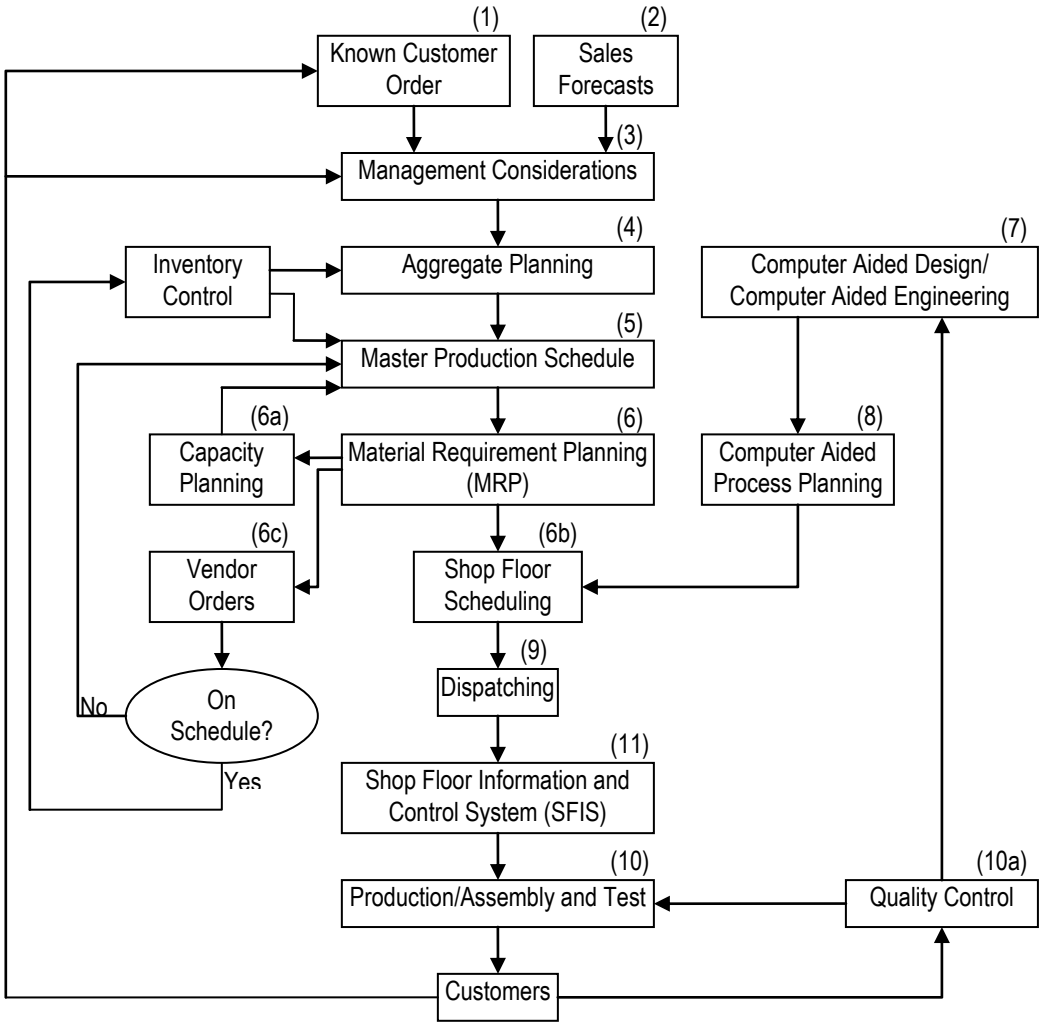

Figure 1.3 : Flow of Operations in CIM

8. Some of the functions carried out by process planning modules are as :

   (a) Sequence of operations required to manufacture a part

   (b) Assessing the time requirement to complete the operations.

   (c) Determining the type of machines and tooling required.

   (d) Enumerate tolerance stacking problems that are credited due to multiple cuts/multiple components related to a part type.

   The profitability and non-profitability of a part being manufactured can be ensured by the process planning function because it takes into account the several ways in which a part being manufactured. In order to achieve a detailed schedule, the information related to process planning is fed into MRP analysis and also in the shop floor scheduling (6b). This step may result in the production of a detailed schedule for machines, tooling, fixtures, people and material handling devices, etc. To avoid the damage, all these have to come together at the right time.

9. Dispatching is the function of releasing all required items needed to perform an operation on a part so that part production must be completed within the schedule time.

10. Production and assembly is accomplished through local control computers and /or programmable controllers.

11. At last, shop floor information system is responsible for getting the required information passed to the downstream entities such as processing

equipment, local controllers and sequencing controllers, etc. In this way, real time status records are captured from the various equipments, machines and parts to activate feedback tools so as to ensure the correction or normal continuation of operations in the desired manner.

SAQ 3

(a) Describe briefly about MRP (Material Requirement Planning).

(b) What do you mean by Master Production Schedule or Master Schedule?

1.5 CAM, CAD/CAM AND CIM

CAD/CAM and CIM were introduced in brief in previous sections. In this section, CAM, CAD/CAM and CIM are discussed in detail.

1.5.1 Computer Aided Manufacturing

The effective use of computer technology in manufacturing planning and control is known as computer aided manufacturing (CAM). Manufacturing engineering functions such as process planning and numeric control (NC) are included in CAM. The application of CAM is divided in two categories:

(i) manufacturing planning, and

(ii) manufacturing control.

Manufacturing Planning

The applications of CAM in manufacturing planning are those in which computers are used directly to support the production function, but there is no direct connection between the computer and the process. The computer is used “offline” to provide information for the effective planning and management of the production activities. The following list surveys the application of CAM in this category:

Computer Aided Process Planning (CAPP)

The route sheets listing the operation sequences and workstations required for manufacturing the products and its components are prepared in process planning. These route sheets are prepared now a days using CAPP.

Computer Assisted NC Part Programming

Computer assisted part programming represents a method to generate the control instructions for the machine tools for complex geometries rather than manual part programming. Part Programming for NC machines is step by step instructions according to which tool movements on the part for metal removal is carried out.

Computerized Machinability Data System

Determination of speed and feed in metal cutting for the given machine tools is a major problem. Computer program is written to propose the suitable condition to use for different materials. Estimation of tool life needs information about material of tools and workpiece, speed, feed and depth of cut etc. As per the cutting conditions, such calculations are to be

repeated. Therefore, application of computers for such purposes may assist process planner to a great extent.

Development of Work Standard

Responsibility for setting time standards on direct labour jobs performed in the factory is taken by time study department. It is a very tedious and time consuming task to establish standards by direct time study. There are several computer packages also available in market for setting up the work standards. These computer programs use standard time data that have been developed for basic work element that comprise any manual task. By summing the times for the individual elements required to perform a new job, the program calculates the standard time for the job.

Cost Estimating

In many industries, cost estimation of a new product is being simplified by computerizing several key steps needed to prepare the estimate. Suitable labour and overhead rates are applied with the help of the computer programs to the sequence of planned operations involved in the components of new products. Individual components cost which range from the engineering bill of the materials to determine the overall product cost is summed up by the program.

Production and Inventory Planning

Extensive application in many of the functions in inventory planning and production control is being executed by the computer. The aforementioned functions are maintenance of inventory records, automatic recording of stock items in the case when inventory is depleted, production scheduling, maintaining current priorities for the different production orders material requirements planning, and capacity planning etc.

Computer Aided Line Balancing

It is a very tough job to find the best allocation of work elements among stations on an assembly line if the line is of significant size. The problems are solved with the help of computer program.

Manufacturing Control

Another category of CAM application is development of computer supported system for implementing the manufacturing control functions. These control functions manage and control the physical operation in the factory. These functions are as follows:

- Process Monitoring and Control
  Process monitoring and control concerned with observing and regulating the production equipment of manufacturing processes in the plant. The applications of the process control are absorbed in automated production system. Which includes the example cases like transfer line assembly system, NC, robotics, material handling and flexible manufacturing systems. All these will be discussed later on. Process monitoring and the control functions are deployed to regulate the actions of various production equipments. Some of the well known control systems used in the industry are as follows.

Quality Control

There are varieties of approaches that insure highest possible quality level in the manufacturing system and products and these are included in quality control.

Shop Floor Control

Production management techniques for collecting data from factory operations and using these data to help control production and inventory in the factory comes under shop floor control. Shop floor control and computerized factory data collection systems are discussed in detail later on.

Inventory Control

The important thing about inventory control is that it maintains the most appropriate level of inventory in the face of two opposing objectives: minimizing the investment and storage cost of holding inventory and maximizing service to customer.

Just in Time Production System

A production system that is planned to deliver exactly the right number of each component to downstream workstations in the manufacturing sequence just at the time when that component is needed is known as just in time production system. This term is applicable to production operation and supplier delivery operation.

1.5.2 CAD/CAM

All the engineering functions in design and manufacturing are included in CAD/CAM. During 1970s and early 1980s, CAD/CAM came into the picture. Engineering activities in design include product design, engineering analysis and drafting whereas the process planning and NC part programming come in the manufacturing functions. The literal meaning of CAM is the manufacturing of the products with the aid of computers. Manufacturing is defined as a chain of interrelated activities that comprises designing, material selection, planning, production, quality assurance, management and marketing of discrete consumer and durable goods. CAM includes these aforementioned manufacturing functions.

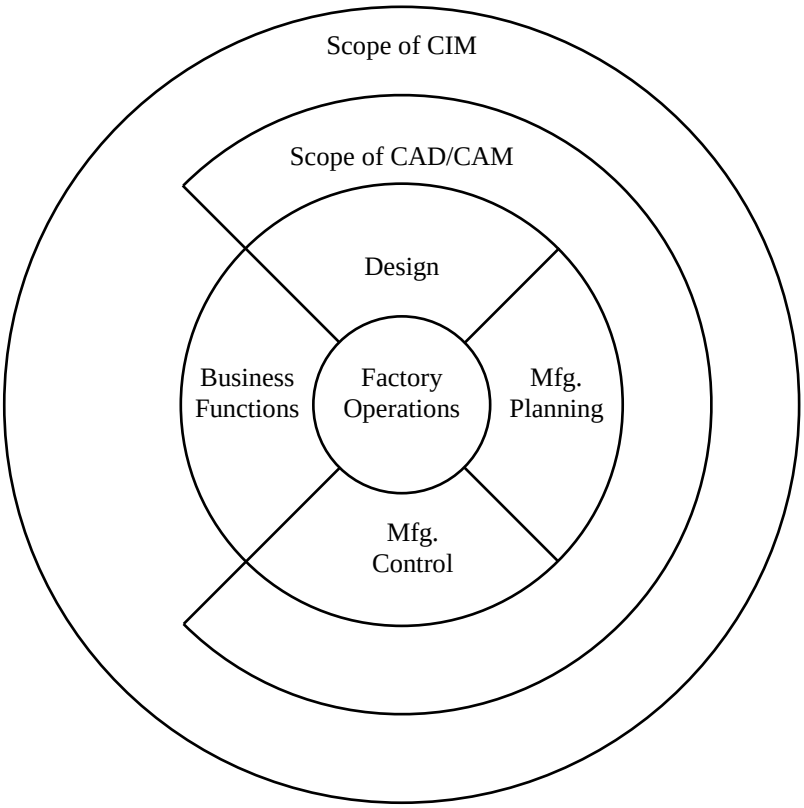

Figure 1.4 : The Scope of CAD/CAM and CIM

CAD/CAM signifies an integration of design and manufacturing activities with the aid of computers. The conventional method of manufacturing a product which involves two separate procedures – designing the product and process planning – is a time consuming one and also involved duplication of effort by design and manufacturing personnel. These conventional methods are replaced by CAD/CAM. The direct link between product design and manufacturing is established with the help of CAD/CAM. While considering ideal CAD/CAM system, it takes the specific design of the product because it remains in the database and is converted into a process plan for manufacturing a product. CAD/CAM system automatically converts design of a product into a process plan. On a numerically controlled machine tool, a large portion of the processing can be completed. CAD/CAM automatically generates NC part programming. Using telecommunication network, NC program is directly downloaded to the machine tool in CAD/CAM system. Thus under CAD/CAM system, computer implements all the functions such as Product design, NC programming and Physical Production.

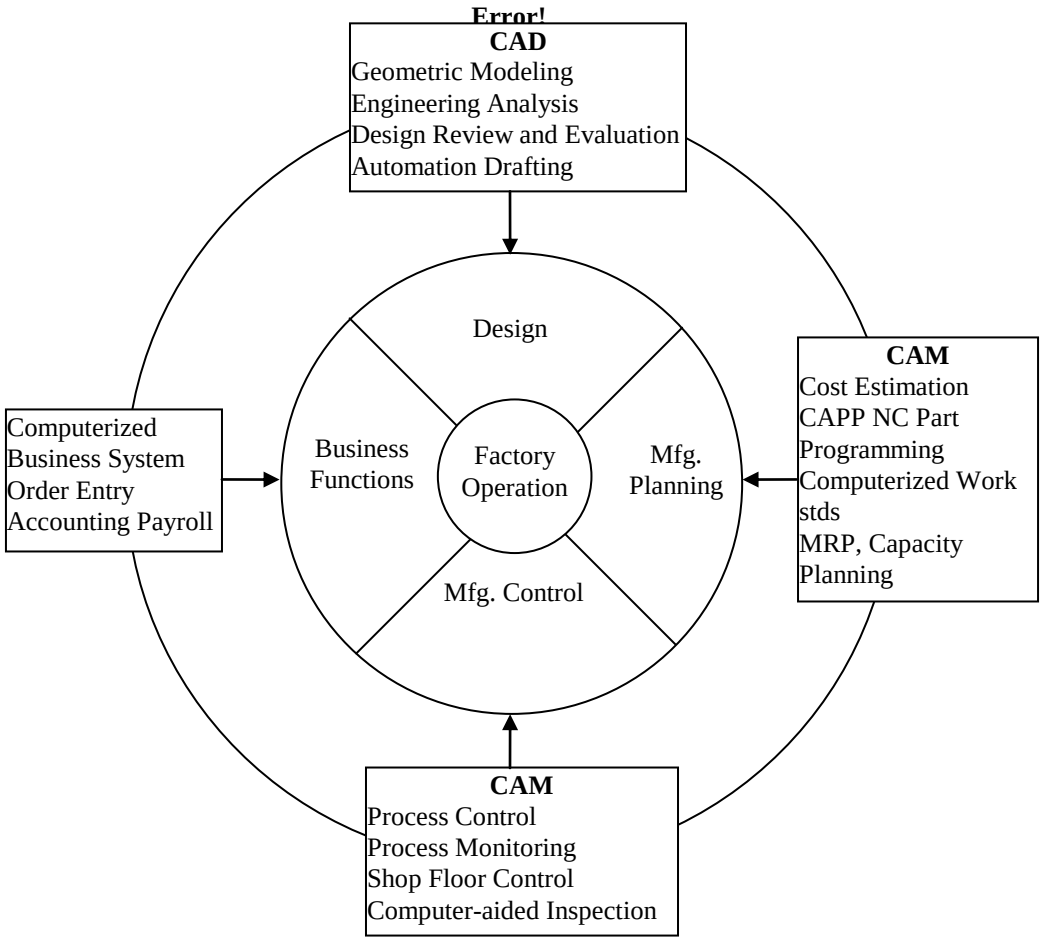

Figure 1.5 : Computerized Element of CIM System

1.5.3 Computer Integrated Manufacturing

CIM sums up all of the manufacturing functions of CAD/CAM along with firm's business functions which are related to manufacturing. CIM system includes the application of computer and communication technologies to all of the operational functions and information processing functions starting from the order receipt through design and production to product delivery. Figure 1.4 depicts the scope of CIM and its comparison with the limited scope of CAD/CAM.

The main aim of the CIM is to incorporate the firm's operations related to production in an integrated computer system to assist, augment, and automate the operations. Computer system touches all the activities throughout the firm that support manufacturing. In CIM, the output of one's activities act as input to the other activity and it starts with the sales order and finishes with its delivery. The components of the

integrated computer system are illustrated in Figure 1.5. Initially, customer's orders that contain the specifications describing the product are entered by either the company's sales force or directly by the customer into a computerized order entry system. Product design department takes these specifications as the input. Manufacturing engineering takes its input from the output of the design department where process planning, tool design, and similar activities are supported by the CIM system. CAPP performs process planning. On a CAD system, using the product model which is generated during product design, tool and fixture design is done. Manufacturing engineering provides its output into production planning and control, where material requirements planning and scheduling are performed using the computer system.

SAQ 4

(a) What do you mean by CAM, CAD/CAM and CIM? Differentiate them.

(b) What are the different types of CAM application? Discuss each type in detail.

1.6 INTEGRATION APPROACHES OF CAD/CAM PRELIMINARY STATUS

Majority of the manufacturer prefer to specify the rough design of their component. This information is sent to the potential supplier for further studies. Then, supplier evaluates the tooling, fixturing and other requirements of the given drawing and asses its manufacturing suitability keeping in view its production and other technological features. The completed designs having such details are sent again to the manufacturer by the supplier. Adopting the simulation and other optimization tool, manufacturer transfers the drawing to the dedicated CAD system. One more cycle of drawing are reverted back to the supplier, where moderation incorporated by the manufacturer is included. At this stage, supplier also includes some of the changes according to the suggestion furnished by the manufacturer. Detail control cycle of the design transferred to illustrate the mechanism of CAD system is described in Figure 1.6.

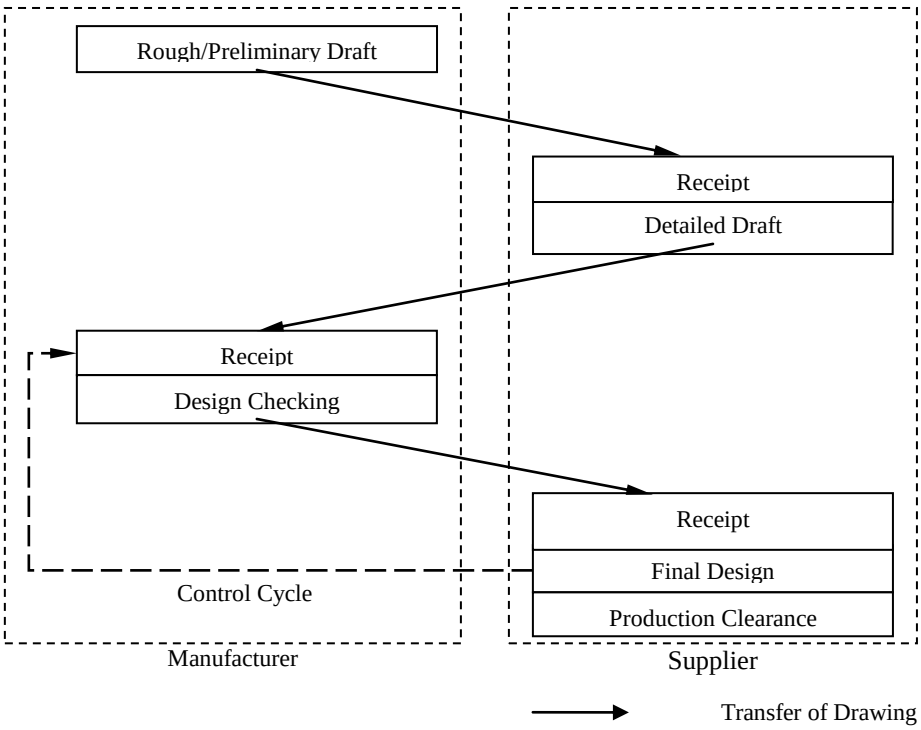

Figure 1.6 : Unconnected CAD Systems

Format Showing Data Exchange

Software incompatibility is the major hurdle that restricts the easy data sharing between two or more system. It happens due to the fact that supplier of the computer application may develop the design configuration for different priory format to store the data required and its display. In order to ensure the compatibility for smooth data sharing, there is a need of neutral data exchange format. Here the term neutral refers to a format that can be easily exploited by various systems. Reasonably good data exchange format or standard or neutral file should satisfy a minimum set of requirement. These requirements are concerned with the common entities needed in different modeling system such as wire frame entity and surface entity etc. It is expected from a standard format that it should become compact and help in achieving faster data storage and retrieval. Some of the popular standards reported in the various books are IGES (Initial Graphics Exchange Specification), and PDES (Product Data Exchange Standards).

In the 1980s, the features of IGES were published and in subsequent years the same has been thoroughly updated. Among the dissimilar CAD/CAM system, the first well known data exchange format was reported by IGES only. The same format has also been adopted to communicate the data among the manufacturer and the suppliers. Therefore, it can be inferred that IGES helps to develop a communication interface among the different system.

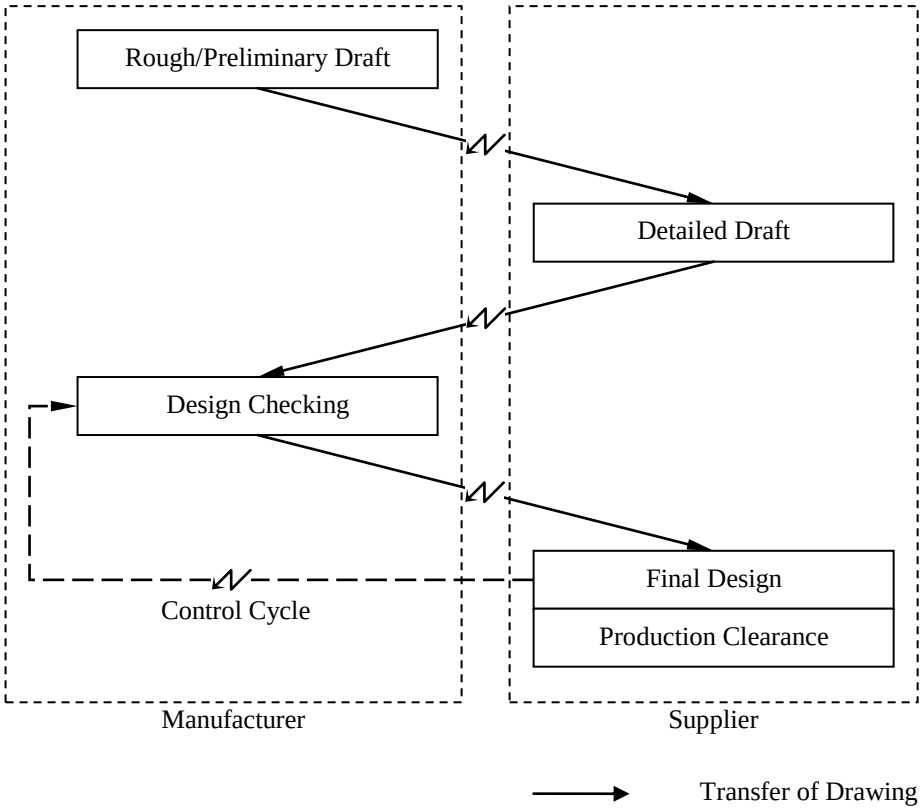

Figure 1.7 : CAD Systems with Electronic Data Transfer

Under the aegis of International Organization for Standardization (ISO), massive efforts have been pursued to develop an international standard known as STEP (Standard for Transfer and Exchange of Product Model Data). It refers to global standardization of exchange of information pertaining to the computer application in manufacturing. Features of STEP have been utilized to evolve another data exchange standard known as product data exchange,which has found wide ranging application for different type of work in the industry. The major difference between IGES and PDES is that IGES utilizes entities (different type of geometric entities, structure entities etc.) as basic element, whereas PDES data exchange is carried out in terms of application.

Operating mechanism of PDES is described by three layers. These are :

(1) application layer,

(2) logical layer, and

(3) physical layer.

The user and PDES are interfaced by the application layer, where application model is clearly defined and different types of information is expressed using information modeling techniques. The main task of logical layer is to support faultless, consistent and computer independent description so that sufficient information is available to encapsulate the wide range of applications. In order to maintain the structure and format of exchange file, the role of physical layer comes into picture to efficiently manage the magnitude of the file sizes.

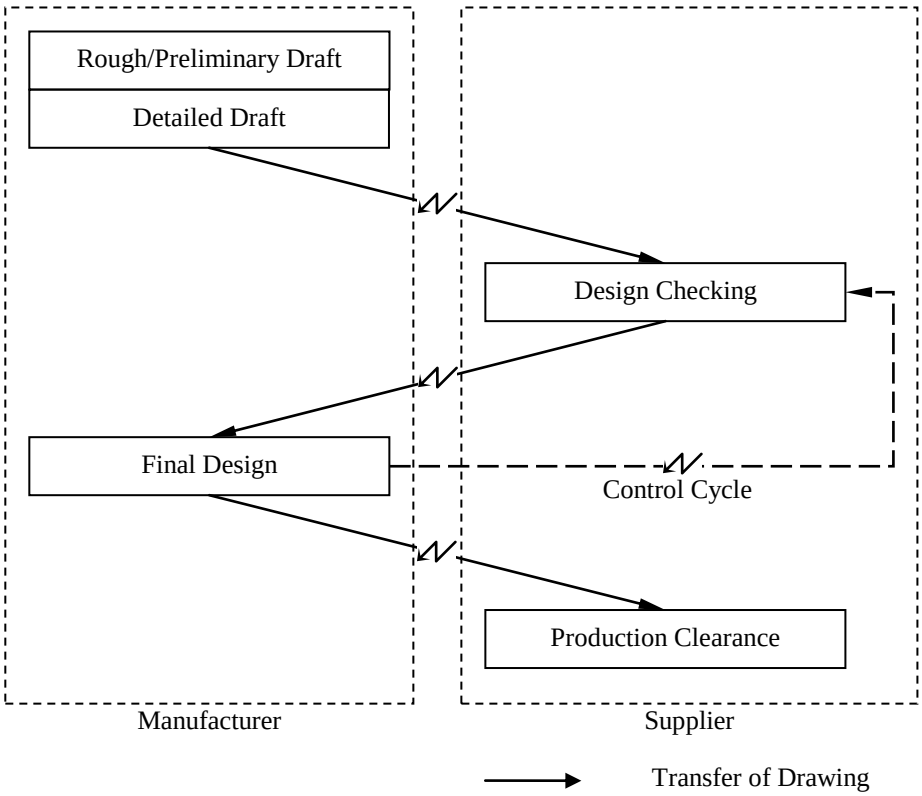

Figure 1.8 : CAD Systems with Context to Inter-Application Communication

Another format for data exchange has gained ground in recent years to assist in the interchange of drawings between AutoCAD and other program. It is known as DXF, which stands for Drawing Exchange File Format. This format is capable of implementing features of AutoCAD and also converts them into file representation. Majority of the software packages supports the DXF format and the ASCII test files also includes DXF files.

Irrespective of data exchange systems, the common way through which drawing details are transferred electronically among the different CAD system are explained in Figures 1.7 and 1.8.

SAQ 5

(a) Describe the role of IGES and PDES as a data exchange format between CAD/CAM. Enlist the reason for preferring PDES over IGES.

(b) Describe the steps through which electronic data transfer takes place from manufacturer to supplier.

1.7 SUMMARY

This unit highlights various components of CIM and also explains the interface among them. Scope and integration of CAD/CAM and CIM have been clearly remarketed. Adequate attention has been focused in this unit about various component related to CIM. Where it is explained that CIM is a process of using computers and communications network to transform island of enabling technologies into a highly interconnected manufacturing system. Details pertaining to enterprise wide integrating and CIM wheel are included in this unit to provide glimpses about the wider capacity of underlined subject. CAD/CAM integration approaches include initial position, data exchange, application integration, and their general effects. After going through the content of this unit, one can easily comprehend the importance of CIM in enhancing the productivity for different types of production system.

1.8 KEY WORDS

Computer Integrated Manufacturing	:	CIM is a process of using computers and communication networks to transform islands of enabling technologies into a highly interconnected manufacturing system.
Computer Aided Design	:	Computer aided design denotes the use of the computer systems to support the product design system.
Computer Aided Manufacturing	:	The term denotes the pervasive use of computer system to design the product, to plan the production, control the operation and perform the business related functions needed in the manufacturing firm.
CAD/CAM	:	Some computer system performs both the CAD and CAM, and so the term *CAD/CAM* is used to indicate the integration of the two into one system.
CIM Wheel	:	The society of manufacturing engineers (SME) CIM wheel provides a clear portrayal of relationships among all parts of an enterprise.
Process Planning	:	Process planning evolves the sequence of operations required for manufacturing a part, the times required to accomplish the operations, the machines and tooling required, and evaluates tolerance stacking problems that accrue from multiple cuts and/or multiple components that comprise a part.

COMPUTER INTEGRATED MANUFACTURING

Computer Integrated Manufacturing (CIM) is the automated version of the manufacturing process, where the three major manufacturing functions, product and process design, planning and control, and the manufacturing process itself are replaced by the computer automated technologies. All these technologies are tied together using a network and integrated database. Thus in a fully integrated system, the areas of design, testing, fabrication, assembly, inspection and material handling are not only automated but also integrated with each other and with the manufacturing planning and scheduling function.

In Block 1, various aspects of CIM fundamentals are covered. The integration approach of CAD/CAM have been discussed. It also covers automated materials handling systems, AGVS, AS/RS and design aspects of AS/RS.

Block 2 covers the role of CNC machines in CIM environment, recent trends and advances, tool handling system. It also discusses more about the FMS, CMS and group technology applications in CIM.

Block 3 includes CIM modeling and operations, computer simulations of FMS and benefits of CIM. Computer aided process planning will be discussed in detail with examples for simple shapes and also covers advances in CAPP. This block also covers various planning systems like MRP, MRP-II, ERP and their integrations with CIM.

Block 4 covers various simulation languages, illustrative examples and case studies in CIM. Various communication and control systems have been discussed. Some important network tools like LAN standards, protocols, manufacturing sensors, Bar Codes, and manufacturing data base management systems have been discussed. Lastly it covers future trends in manufacturing, future automated factory and social impact of automation of factories.

FUNDAMENTALS OF CIM

Technology has played the dominant role in the productivity growth of most nations and has provided the competitive edge to firms that have adopted in early and implemented it successfully. While each of the manufacturing and information technologies is a powerful tool by itself and can be adopted separately, their benefits grow exponentially when they are integrated with each other. This is particularly the case with CIM technologies.

In this block, we shall discuss the basics and fundamentals of Computer Integrated Manufacturing.

Unit 1 discusses more about the introduction part of the CIM. Further it explains the interrelationship between CAD, CAM and CIM, and benefits of CIM. The CIM wheel provides a clear portrayal of relationship among all parts of an enterprise.

Unit 2 elaborates the various types of inspection systems, inspection procedures, inspection vs testing, Coordinate Measuring Machine (CMM). The CMM is an electromechanical system designed to perform coordinate metrology.

Unit 3 explains the types of AGVS and their control systems. In this unit, we have dealt with the automated guided vehicles and robots used in the industry.

In Unit 4, we discuss the various types of AS/RS and various factors of design of an AS/RS. Here we also dealt with the AS/RS used in industries to handle, store and retrieve materials with precision, accuracy and speed under defined degree of automation.