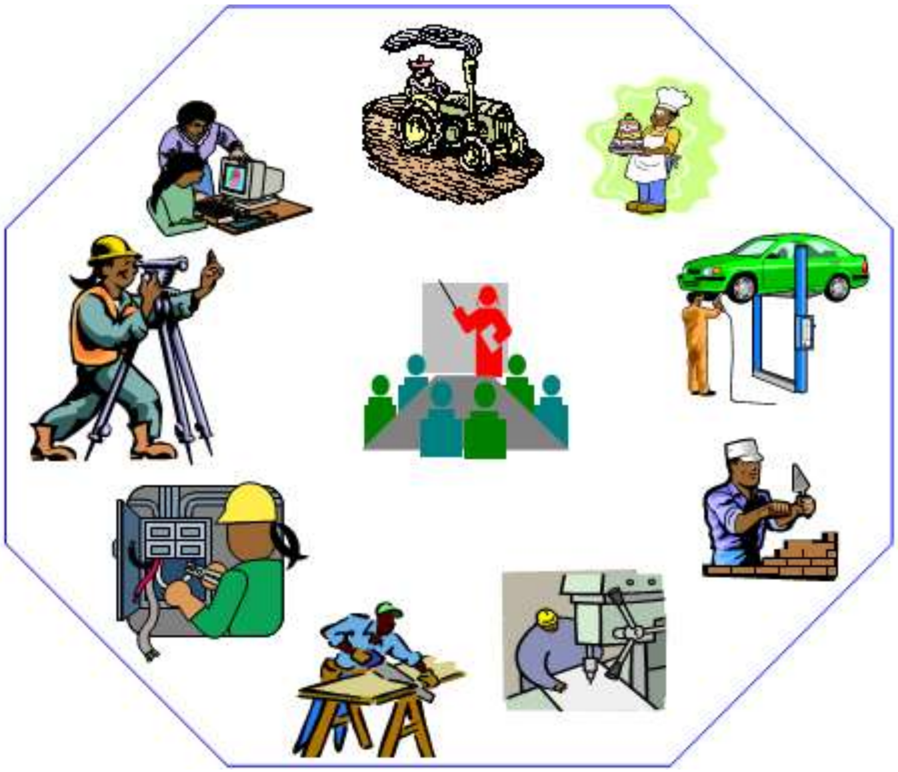
Welding
Level-IV

Based on May 2017, Version 1 Occupational standard



Module Title: - Supervise and guide CIM production operation

LG Code: IND WLD4 M14 (1-4) LG (28-31)
TTLM Code: WLD4 TTLM 0221v1

February , 2021
Adama/ Ethiopi

LG #28	LO1. Interpret the design brief or scope of production including CIM system.

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following content coverage and topics:

- Considering OHS, regulatory requirements.
- Eestablishing features and extent of integration of the CIM system.
- Establishing technical, commercial and environmental parameters .
- Consulting technical managers and senior design engineers.
- Collecting and presenting preliminary advice on feasibility of manual or CIM project .

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Consider OHS, regulatory requirements.
- Eestablish features and extent of integration of the CIM system.
- Establish technical, commercial and environmental parameters .
- Consult technical managers and senior design engineers.
- Collect and presenting preliminary advice on feasibility of manual or CIM project .

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the "Information Sheets". Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the "Self-checks" which are placed following all information sheets.
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answering the Self-checks).

6. If you earned a satisfactory evaluation proceed
7. Perform “the Learning activity performance test”
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Information Sheet 1- Considering OHS, regulatory requirements.

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.

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What is an occupational health and safety(OH&S) program ?

A health and safety program is a definite plan of action designed to prevent accidents and occupational diseases. Some form of a program is required under occupational health and safety legislation in most Canadian jurisdictions. A health and safety program must include the elements required by the health and safety legislation as a minimum.

Because organizations differ, a program developed for one organization cannot necessarily be expected to meet the needs of another. This document summarizes the general elements of a health and safety program. This approach should help smaller organizations to develop programs to deal with their specific needs.

What are examples of responsibilities of workers?

Examples of responsibilities of workers include:

- Using personal protection and safety equipment as required by the employer.
- Following safe work procedures.
- Knowing and complying with all regulations.
- Reporting any injury or illness immediately.
- Reporting unsafe acts and unsafe conditions.
- Participating in joint health and safety committees or as the representative

Safe: By automating the operation and transferring the operator from an active participation to a supervisory role, work is made safer. The safety and physical well-being of the worker has become a national objective with the enactment of the Occupational

Visual Problems

Where computer tasks reach beyond two hours per day, they are deemed to be visually demanding and thus impact the health and safety of a person. Visual health complications can include eyestrain, burning, sore and irritated eyes, blurred vision, changes in perception of colours, tiredness, headaches, migraines and nausea. However, though annoying, these symptoms are directly associated with the computer work and will not cause long term negative effects.

Musculo-Skeletal Difficulties

This is generally caused by keeping muscles in one position for too long. An example of this would be a person siting in one position for a prolonged period of time *(say at the computer),* and can lead to an abnormal muscle use and cause substantial pain and injury. Muscular issues normally occur in the back, neck and head area and known as Occupational Overuse Syndrome.

Stress

- 18% of workers experience occupational related stress most of the time
- 66.7% feel stress part of the time
- 1/4 workers take stress related leave each year
- Stress is induced by computer based work
- Programs that monitor employee performance and encourage percentage schemes are linked to creating high levels of stress

  Chemical Exposure
- While computer related environments generally have low chemical exposure rates, there is cause for concern around laser printers which have been found to omit ozone gas. Very low concentrations of ozone can irritate the eyes, nose and throat. Another similar compound is toner powder that can become airborne when cartridges are replaced. All employees should have access to Material Safety Data Sheets containing this information.

Controlling Occupational Health and Safety Hazards in the Workplace

The principles of control methods to reduce the risk of workplace injury and disease are quite simple. They consist of a hierarchy of controls:

Elimination: The first option for the control of health and safety hazards is the elimination of the hazard. In screen based work, elimination of a hazardous processes might occur by using non computer-based methods to complete tasks when practical.

Substitution: Where complete elimination is not possible, the next option for control is substitution with a safer alternative. For screen based work, an example of substitution might be upgrading software packages to more "user friendly" systems, providing easier and better control over the work with larger text and images.

Isolation: Where control is inadequate following the best efforts at elimination and substitution, the next option is isolation. An example of isolation might be the placing of noise, chemical or other hazards either at a distance from people performing screen based work, or in a separate room entirely.

Engineering Controls: Engineering controls provide a further level of control where a combination of elimination, substitution and isolation controls still do not provide adequate control. In relation to the screen based work environment, engineering controls might be applied to limit the level of 50 hertz electromagnetic fields in the working environment by re-phasing high-voltage transmission lines, or shielding some mains power cabling and electrical switch rooms.

Safe Work Practices: Safe work practices are administrative practices which require people to work in safer ways. Limiting the amount of time to be spent per day involved in screen based work could be considered to be a safe work practice.

What personal protective equipment might I need?

- Use the appropriate safety equipment for the job. Wear CSA-certified safety glasses with side shields or goggles. Prescription eye glasses are not substitutes for safety glasses.
- Wear appropriate safety footwear.
- Wear respiratory protection where required.
- Wear hearing protection when required. If you have trouble hearing someone speak from one metre (three feet) away, the noise level from the machine is too high. Damage to hearing may occur.

Self-Check -6	Written Test

Instruction: choose the best answer for the following question

1. Which one of followings are Not The Cost Estimate process provides:
   A. The activity quantities that make up the scope of work;
   B. The estimated resource hours and non-labor values that make up the work;
   C. The cost element data (labor and non-labor) needed to complete the products/deliverables;
   D. Standard: hard castors for soft floors, example carpeted, floors.
2. ___________________is one of the most important steps to writing an SOW
   A. Goal
   B. Scope of work
   C. Project work
   D. Design
3. Most cost estimates have common characteristics, regardless of whether the technical scope
   A. .traditional (capital funded,
   B. construction,
   C. .equipment
   D..all

Note: **Satisfactory rating - 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Score = ____________

Rating: _____________

Name: ___________________________ Date: _______________

Information Sheet - 2 . Eestablishing features and extent of integration of the CIM system

2. 1. integration of the CIM

Computer-integrated manufacturing (CIM) is the manufacturing approach of using computers to control entire production process. This integration allows individual processes to exchange information with each other and initiate actions.

Computer Integrated Manufacturing (CIM) encompasses the entire range of product development and manufacturing activities with all the functions being carried out with the help of dedicated software packages. The data required for various functions are passed from one application software to another in a seamless manner. For example, the product data is created during design. This data has to be transferred from the modeling software to manufacturing software without any loss of data. CIM uses a common database wherever feasible and communication technologies to integrate design, manufacturing and associated business functions that combine the automated segments of a factory or a manufacturing facility. CIM reduces the human component of manufacturing and thereby relieves the process of its slow, expensive and error-prone component. CIM stands for a holistic and methodological approach to the activities of the manufacturing enterprise in order to achieve vast improvement in its performance.

The first major innovation in machine control is the Numerical Control (NC), demonstrated at MIT in 1952. Early Numerical Control Systems were all basically hardwired systems, since these were built with discrete systems or with later first generation integrated chips. Early NC machines used paper tape as an input medium. Every NC machine was fitted with a tape reader to read paper tape and transfer the program to the memory of the machine tool block by block. Mainframe computers were used to control a group of NC machines by mid 60's. This arrangement was then called Direct Numerical Control (DNC) as the computer bypassed the tape reader to transfer the program data to the machine controller. By late 60's mini computers were being commonly used to control NC machines. At this stage NC became truly soft wired with the facilities of mass program storage, offline editing and software logic control and processing. This development is called Computer Numerical Control (CNC). Since 70's, numerical controllers are being designed around microprocessors, resulting in compact CNC systems. A further development to this technology is the distributed numerical control (also called DNC) in which processing of NC program is carried out in different computers operating at different hierarchical levels - typically from mainframe host computers to plant computers to the machine controller.

Today the CNC systems are built around powerful 32 bit and 64 bit microprocessors. PC based systems are also becoming increasingly popular. Manufacturing engineers also started using computers for such tasks like inventory control; demand forecasting, production planning and control etc. CNC technology was adapted in the development of co-ordinate measuring machine's (CMMs) which automated inspection. Robots were introduced to automate several tasks like machine loading, materials handling, welding, painting and assembly. All these developments led to the evolution of flexible manufacturing cells and flexible manufacturing systems in late 70's.

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:

- Objectives of the system are determined.
- Structuring the system and set definable system boundaries.
- Significant components for a system are determined.

- A detailed study of the components is carried out keeping in view the overall integration of the system.
- Analyzed components are synthesized into the system.
- On the basis of the performance criteria, predetermined system is evaluated.
- For continuous improvement, Step „b" to Step „f" are constantly repeated.

Manufacturing engineers are required to achieve the following objectives to be competitive in a global context.

- Reduction in inventory
- Lower the cost of the product
- Reduce waste
- Improve quality
- Increase flexibility in manufacturing to achieve immediate and rapid response to:
- Product changes
- Production changes
- Process change
- Equipment change
- Change of personnel

Nature And Role Of The Elements Of Cim System

Nine major elements of a CIM system are in Figure 2 they are,

- Marketing
- Product Design
- Planning
- Purchase
- Manufacturing Engineering
- Factory Automation Hardware
- Warehousing
- Logistics and Supply Chain Management
- Finance

- Information Management

Figure 2 Major elements of CIM systems

Components of Computer Integrated Manufacturing System

Subsystems

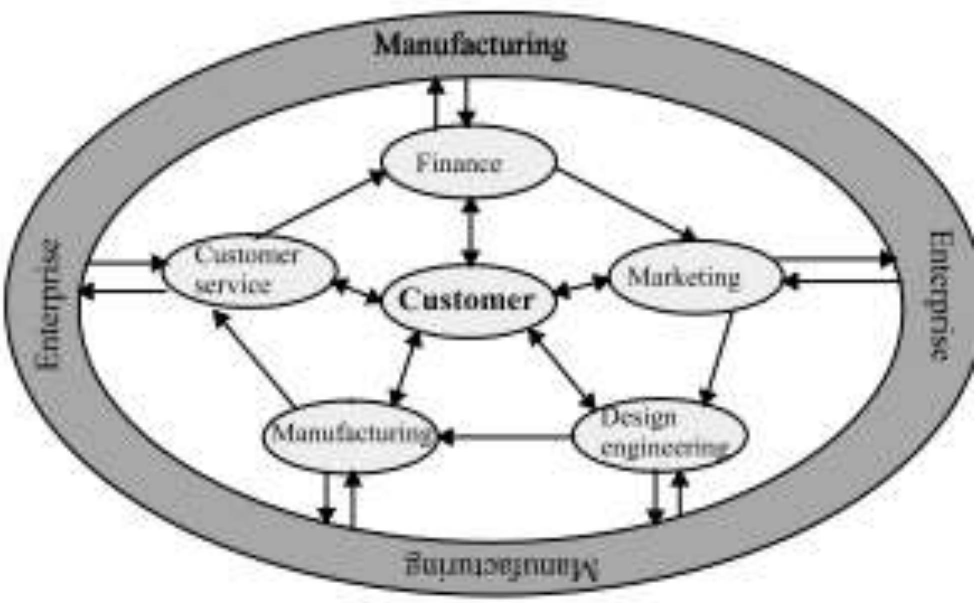
- CAD (computer-aided design)
- CAE (computer-aided engineering)
- CAM (computer-aided manufacturing)
- CAPP (computer-aided process **planning**)
- CAQ (computer-aided quality assurance)
- PPC (production **planning** and control)
- ERP (enterprise resource **planning**)

computer-ıntegrated manufacturıng topıcs:

devıces and equıpment requıred:

- cnc, computer numerical controlled machine tools
- dnc, direct numerical control machine tools
- plcs, programmable logic controllers
- robotics
- computers
- software
- controllers
- networks
- ınterfacing
- monitoring equipment

CIM wheel componet



Machine Tools & Related Equipment

- Standard CNC machine tools
- Special purpose machine tools
- Tooling for these machines
- Inspection stations or special inspection probes used with the machine tool

The Selection of Machine Tools

- . Part size
- Part shape
- Part variety
- Product life cycle
- Definition of function parts
- Operations other than machining - assembly, inspection etc.

3.1. **Material Handling System**

A. The primary work handling system

used to move parts between machine tools

in the CIMS. It should meet the following requirements.

- Compatibility with computer control
- Provide random, independent movement of palletized work parts between Machine tools.
- Permit temporary storage or banking of work parts.
- Allow access to the machine tools for maintenance tool changing & so on.
- Interface with the secondary work handling system etc.

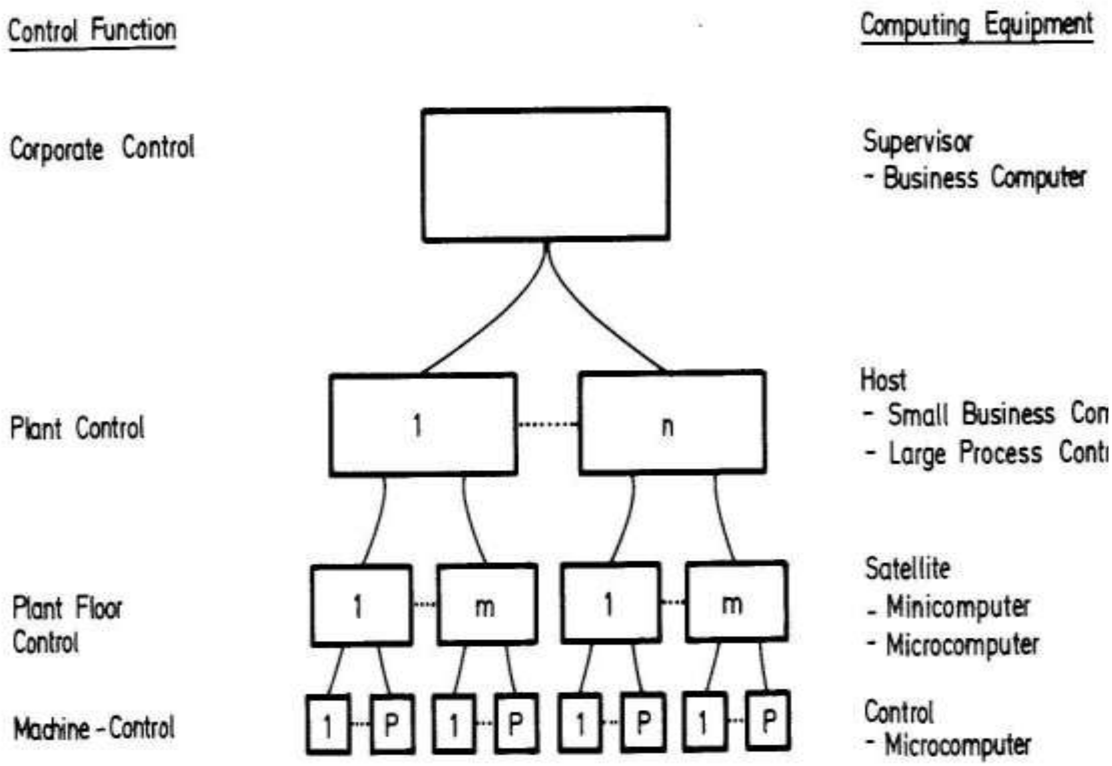
B. The secondary work handling system - used to present parts to the individual

Machine tools in the CIMS.

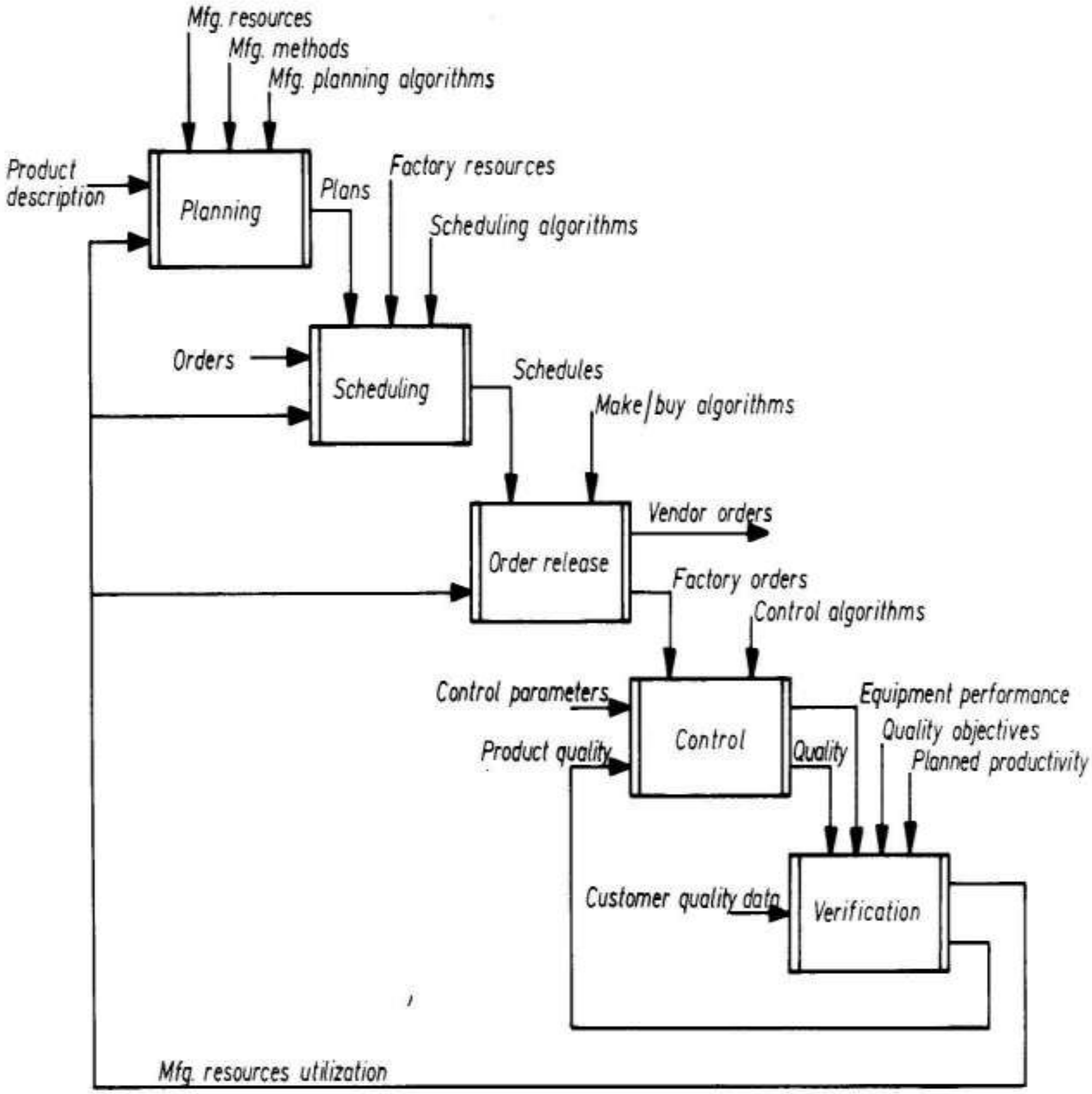
- Same as (i).
- +Same as A(iii)
- Interface with the primary work handling system

Computer Control System –

Control functions of a firm and the supporting

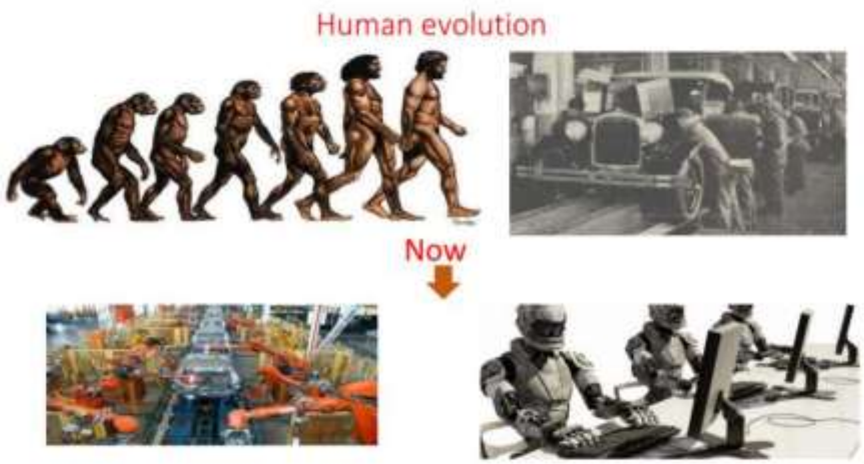


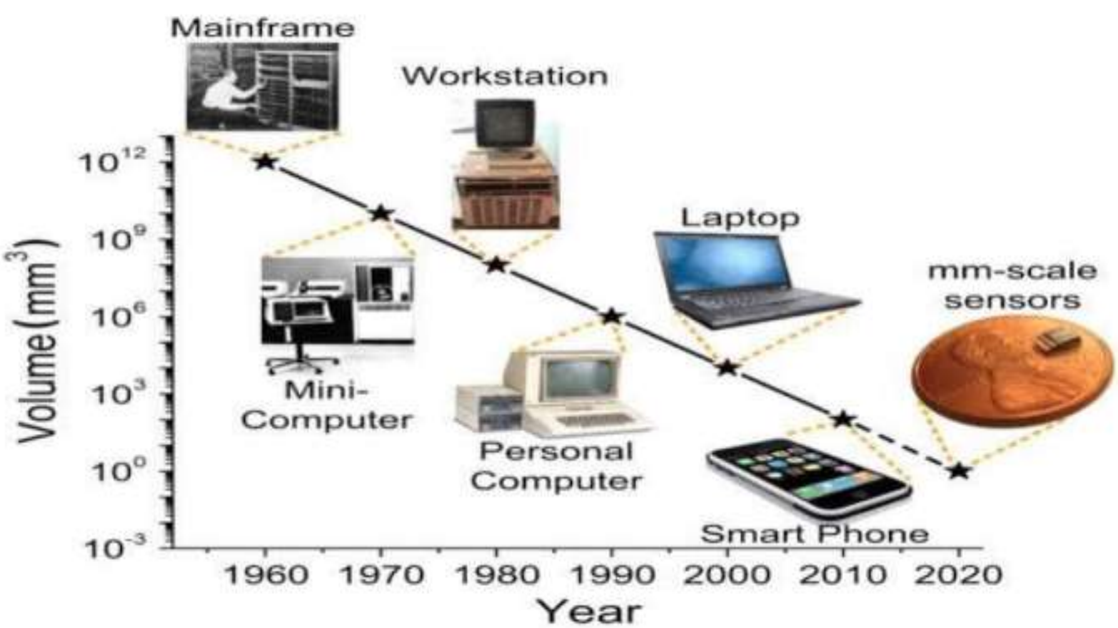
Control Loop of a Manufacturing System

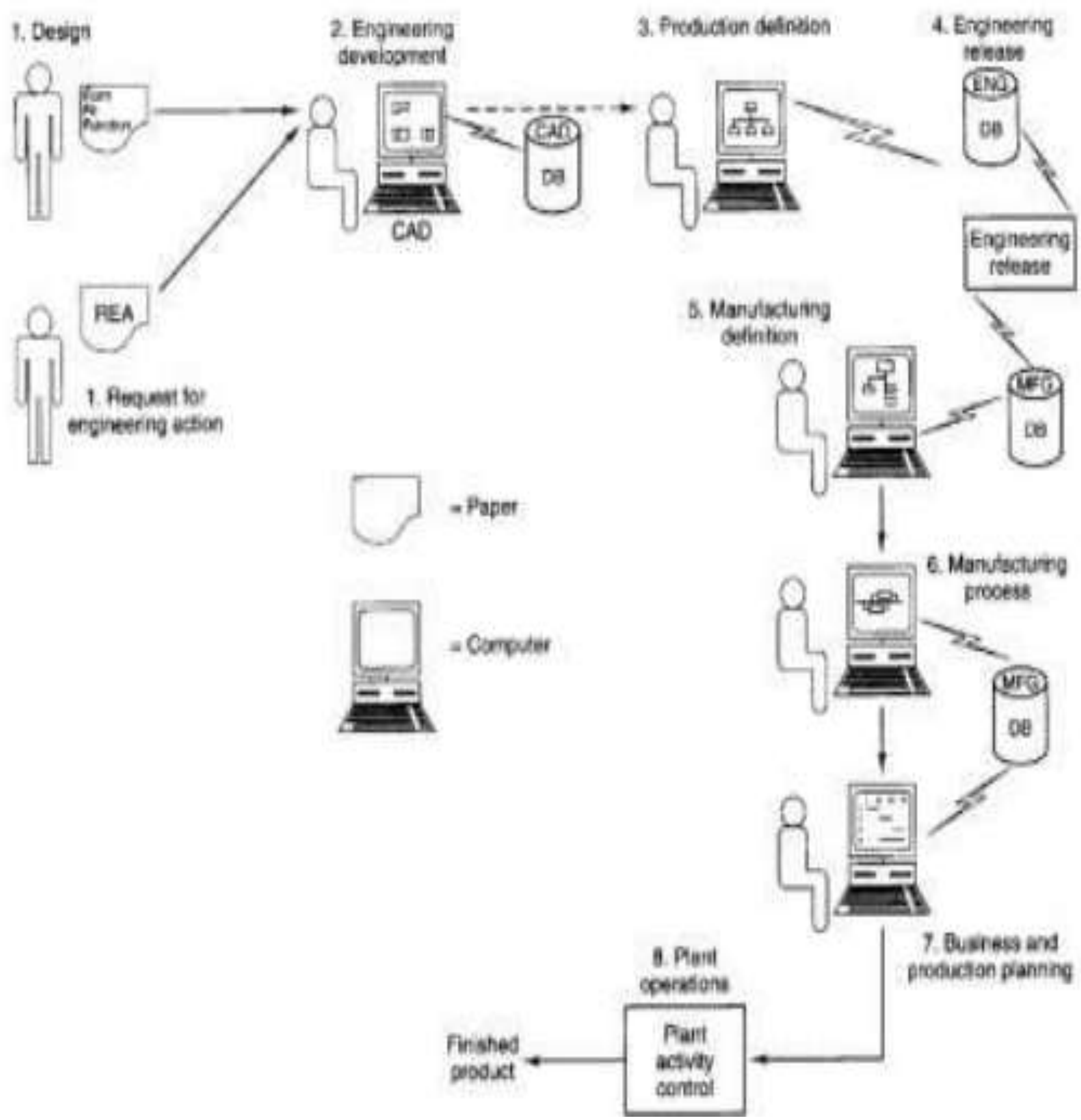


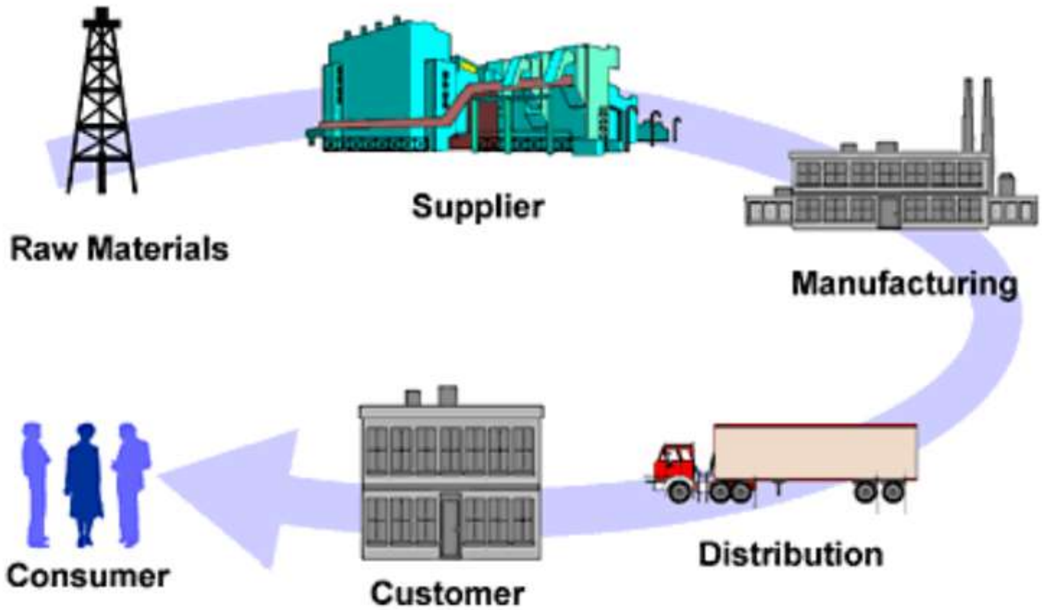
Information Sheet -4	Consulting technical managers and senior design engineers

4.1. Evolution technology



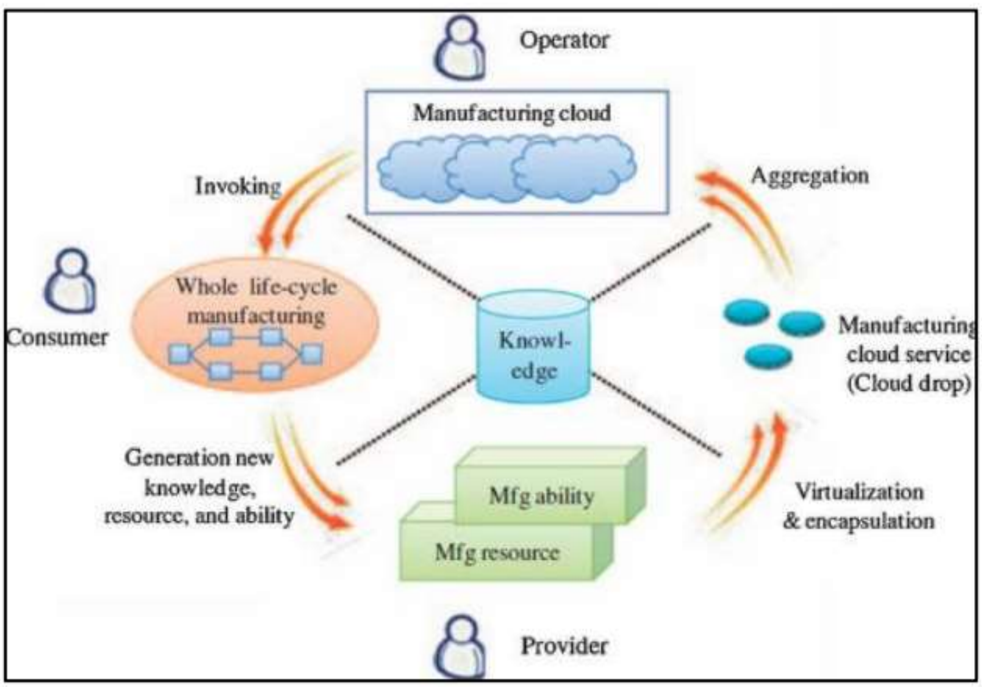



1. Design
2. Engineering development
3. Production definition
4. Engineering release
CAD
DB
ENG
DB
Engineering release
REA
1. Request for engineering action
5. Manufacturing definition
MFG
DB
= Paper
= Computer
6. Manufacturing process
MFG
DB
7. Business and production planning
8. Plant operations
Plant activity control
Finished product



senior designer engineers Consulting…

Cloud based manufacturing :



Information Sheet – 5 Collecting and presenting preliminary advice on feasibility of manual or CIM project

5.1. Area to consider as part of a feasibility study.

- The size of the manufacturing company
- The capital budgetary requirement
- Initial investment
- Cash flow projection
- Overhead & operational cost
- The raw material market availability
- Government regulations and policies
- The product market acceptability
- Bank provision policies

5.2. feasibility of manual or CIM project

These are traditional financial formulas which management can use to determine the value of CIM to the company. However, the justification process for advanced manufacturing technologies in CIM must be viewed differently from the traditional process for three reasons:

- **Project Size.** CIM investments are projects without ends. Investments made today eventually will be replaced by new technology. Most benefits from CIM accrue with time as advances in both hardware and software take hold.
- **Project components**. Since CIM requires various successful installations of advanced manufacturing technology, benefits will accrue due to the synergism of various pieces on the shop floor. The integration of advanced manufacturing technology long term is what makes CIM a self-liquidating expense.
- **Identification of CIM soft benefits**. The installation of advanced manufacturing technology in a manufacturing environment can provide significant intangible

benefits that traditional financial justification methods don't recognize. The benefits most often cited by business executives are reduced manufacturing costs, improved flexibility on the shop floor, responsiveness to the market, improved product quality, improved product design, small lot manufacturing, reduced inventories, and optimal customer service. While these benefits are hard to quantify, they can reduce operating costs, improve customer relations, and stimulate sales. The key to evaluating these soft benefits is to understand that a CIM environment allows for fewer levels of management and therefore provides for better use of the business's assets, both human and mechanical. The result for the company is improved decision making and significantly improved profitability. Computer integrated manufacturing, by joining all the functional areas in the business, can provide a variety of automated services in the factory. For businesses to remain competitive, advanced manufacturing technologies must characterize the factory of the future. In this regard, computer integrated manufacturing have many applications: Order management: CIM allows for faster delivery and responsiveness to customers and to customer orders through electronic data interchange. In essence, customers will 29 electronically secure and lock in supplier capacity for the product. Additionally, a business will be able to respond to inquiries from its customers instantaneously through electronic data interchange. Being able to respond to customers with rapid information will result in extra business, retaining customers, and getting closer to the customer. Computer-aided design (CAD). Through CAD, CIM allows the computer to assist in minute details and specifications of a customer order or to simulate variations of the order. Manufacturing resource planning (MRP II): This allows the production schedule to be simulated and integrated using one information base to direct the operations on the plant floor to balance supply and demand. Computer technology: CIM allows different hardware to be integrated to communicate with one another (open system). It provides a database foundation for both artificial intelligence and expert systems.

Computer-aided manufacturing (CAM): CAM allows for factory machinery to be programmed through numeral controls (NC) tape preparation and computer numerical control (CNC). Robotics: Robotics allow for the minimization of human activity in the areas of pick/pack, excessive lifting, transportation, and repetitive manufacturing operations. Automated guided vehicle systems (AGV's). AGV's allow for driverless forklifts and automated storage and retrieval systems. As JIT becomes more imbedded in future manufacturing disciplines, the role of computerized material-bundling equipment will become more vital.

Group technology: Allows for the coding and classification system to group various families of parts or activities, and to aid in both inventory use and part standardization. Vendor scheduling: CIM provides for improved scheduling of customer orders to improve delivery and internal processing. In the future, orders will be booked directly via electronic data interchange into a vendor's upcoming production schedule.

People and their crucial contribution to manufacturing

- "Manufacturing, in general, has not done a very good job of understanding how you link the people and the process into this CIM In the past, CIM projects became automated disasters because management became enamored with the technology and computer side of the program. They completely forgot about the people side and neglected to incorporate people into the development process. Information technology will reshape every company that survives through the 90s. However, businesses will not be able to incorporate technology advances if they do not find a way to make workers comfortable with computers. Additionally, workers will not have the requisite skills and abilities to succeed and advance if they are not able to work with computers. Almost every white-collar job in America requires some level of familiarity with computers. Additionally, it is estimated that 75% of industrial workers also need at least elementary computer skills. Management must understand what enables workers at any skill level to be able to master their computers. Companies that have transformed their 31 work forces with technology have distilled a set of principles that apply equally to workers on an assembly line or in the front office.

LG #29	**LO #2-** Prepare production process including possible CIM system.

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Performing investigations and measurements.
- Carrying out modeling and calculations using software and validation techniques.
- Generating conventional and CIM production solutions.
- Standard and codes.
- Checking feasibility and evaluate solutions.
- Determining social and sustainability implications of solutions.
- Reviewing concept proposals.

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Information Sheet –1	Performing investigations and measurements

1.1. System Performance Monitoring & Reporting

The system computer can be programmed to generate various reports by the management on system performance.

- **Utilization reports** - summarize the utilization of individual workstation as well as overall average utilization of the system.
- **Production reports** - summarize weekly/daily quantities of parts produced from a CIMS (comparing scheduled production vs. actual production)
- **Status reports** - instantaneous report "snapshot" of the present conditions of the CIMS.
- **Tool reports** - may include a listing of missing tool, tool-life status etc

Information Sheet –2 .. Carrying out modeling and calculations using software and validation techniques.

2.1. Techniques of CIM

Today the CNC systems are built around powerful 32 bit and 64 bit microprocessors. PC based systems are also becoming increasingly popular. Manufacturing engineers also started using computers for such tasks like inventory control; demand forecasting, production planning and control etc. CNC technology was adapted in the development of co-ordinate measuring machine's (CMMs) which automated inspection. Robots were introduced to automate several tasks like machine loading, materials handling, welding, painting and assembly. All these developments led to the evolution of flexible manufacturing cells and flexible manufacturing systems in late 70's.

CAD in fact owes its development to the APT language project at MIT in early 50's.Several clones of APT were introduced in 80's to automatically develop NC codes from the geometric model of the component. Now, one can model, draft, analyze, simulate, modify, optimize and create the NC code to manufacture a component and simulate the machining operation sitting at a computer workstation. If we review the manufacturing scenario during 80's we will find that the manufacturing is characterized by a few islands of automation. In the case of design, the task is well automated. In the case of manufacture, CNC machines, DNC systems, FMC, FMS etc provide tightly controlled automation systems. Similarly computer control has been implemented in several areas like manufacturing resource planning, accounting, sales, marketing and purchase. Yet the full potential of computerization could not be obtained unless all the segments of manufacturing are integrated, permitting the transfer of data across various functional modules. This realization led to the concept of computer integrated

10 manufacturing. Thus the implementation of CIM required the development of whole lot of computer technologies related to hardware and software.

2.2.1. Software options for control and data sharing.

CIM Hardware comprises the following:

- Manufacturing equipment such as CNC machines or computerized work centers, robotic work cells, DNC/FMS systems, work handling and tool handling devices, storage devices, sensors, shop floor data collection devices, inspection machines etc.
- Computers, controllers, CAD/CAM systems, workstations / terminals, data entry terminals, bar code readers, RFID tags, printers, plotters and other peripheral devices, modems, cables, connectors etc.,

CIM software comprises computer programs to carry out the following functions:

- Management Information System
- Job Tracking
- Sales
- Inventory Control
- Marketing
- Shop Floor Data Collection
- Finance
- Order Entry
- Database Management
- Materials Handling
- Modeling and Design
- Device Drivers
- Analysis
- Process Planning
- Simulation
- Manufacturing Facilities Planning
- Communications
- Work Flow Automation

CIM Hardware and CIM Software

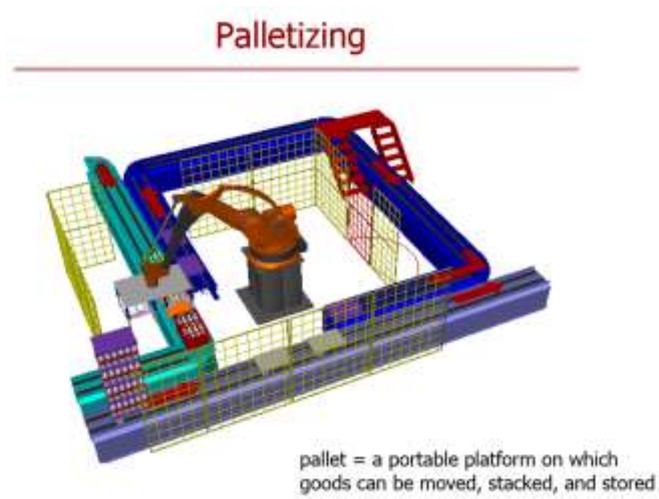
2.2.2. Selecting and using software and validation techniques

The physical integration of industrial controllers with Computer Aided Design (CAD) systems and manufacturing management systems has become one of the most important issues in the field of Computer Integrated Manufacture (CIM). Communications links between these intelligent, computer based systems are a vital part of all modern, manufacturing organizations endeavoring to integrate management systems and production systems into a more efficient, responsive and cohesive unit.

Communications within a manufacturing organization can take on many forms. At a basic level it is often necessary to reliably transfer data or programs, developed on a Computer, to a Computer Numerical Control (CNC) machine tool, robot or Programmable Logic Controller (PLC). At a higher level it may be necessary to integrate CAD workstations, industrial controllers (CNCs & PLCs) and manufacturing management computer systems through a Local Area Network (LAN).

However, in order to establish links and networks that can function with industrial equipment, there needs to be an understanding of the basic mechanisms and problems of data communications and the special needs of the manufacturing environment.

Modern design using an example of palletizing



Information Sheet –3	Generating conventional and CIM production solutions.

3.1 Objectives and Implementation of a CIM System

The overall job of computer integrated manufacturing strategic planning requires acomprehensive look at the process equipment, facilities, personnel structure and roles, plus the scheduling and control requirements. Implementation of CIM requires the development of a CIM master plan, which encompasses a critical look at the current plant scheduling and control hierarchy (if in an existing facility), a detailed description of the desired plant scheduling and control system hierarchy, and a plan to manage the transition from the current state to the desired future state. This plan must incorporate all functions of the operation (marketing, personnel, engineering, etc.) in their relationships to manufacturing and production control. In order to provide for the overall objectives must be defined of the organization, objectives for the various technology systems expected to be required to meet the business's long range needs. These systems include database management systems, communications networks, process controls, process optimization, and process improvement and decision support systems. Database management systems should be open in nature and must interconnect, interrelate, and integrate all department and area databases of the business, including 35 corporate, division, research, and marketing strategies, as well as plant operations and production control. Communication networks must provide plant-wide information exchanges with appropriate interactive work stations and permit ready access to plant information by all users of the data. Additionally, they must provide for intra-plant, intradivision, and intra-organization communication as needed. Process control must make computer automated control available in all areas of the manufacturing process. In addition, the technology must expand the scope of conventional control to include the following supporting goals: a. Minimize the manual entry and recording of all measurements and operational decisions to minimize errors and expedite data acquisition. b. Simplify the conducting of economic and operational studies to permit quick analysis of unusual operating conditions. c. Increase the process and system engineer's productivity through readily accessible, efficient and comprehensive analysis and design tools. d. Increase the scope and interactive access to history data to permit thorough analysis of process and operational problems. e. Expedite the process of system expansion and growth. Process optimization must permit the expansion of efforts in simulation, optimization, and scheduling of process operations. Process improvement must make use of the available plant-wide information to modify the overall process so as to reduce the number of rejects which are produced.

After completion of the objectives analysis the major steps in the implementation of a CIM system are:

- Analysis of the existing manufacturing system (if existing plant) or

new facility design for compatibility with CIM technology.

- Analysis of the existing

and proposed management and personnel structure for the plant in view of its compatibility with the proposed CIM system.

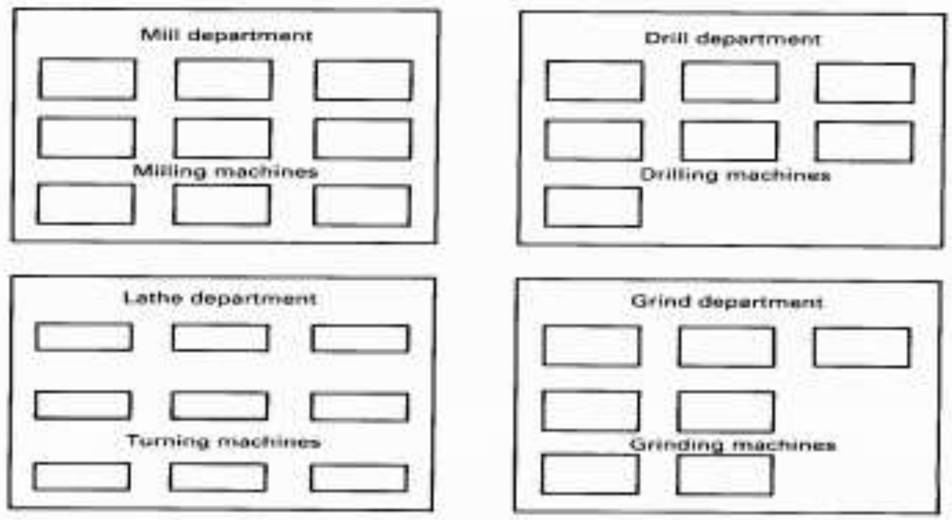
- Development of the system master

plan for designing and implementing the CIM scheduling and control hierarchy.

- Develop expected systems costs and project timing in conjunction with systems benefits and projections, thereby establishing justification concerning systems costs and anticipated payout. 36
- Iterate the steps outlined above until acceptance is obtained from all personnel concerned and company justification criteria is satisfied.
- Implement and execute system master plan vii. Follow up and adjust as

necessary.Conventional Approaches to Manufacturing Conventional approaches to manufacturing have generally centered around machines laid out in logical arrangements in a manufacturing facility. These machine layouts are classified by:

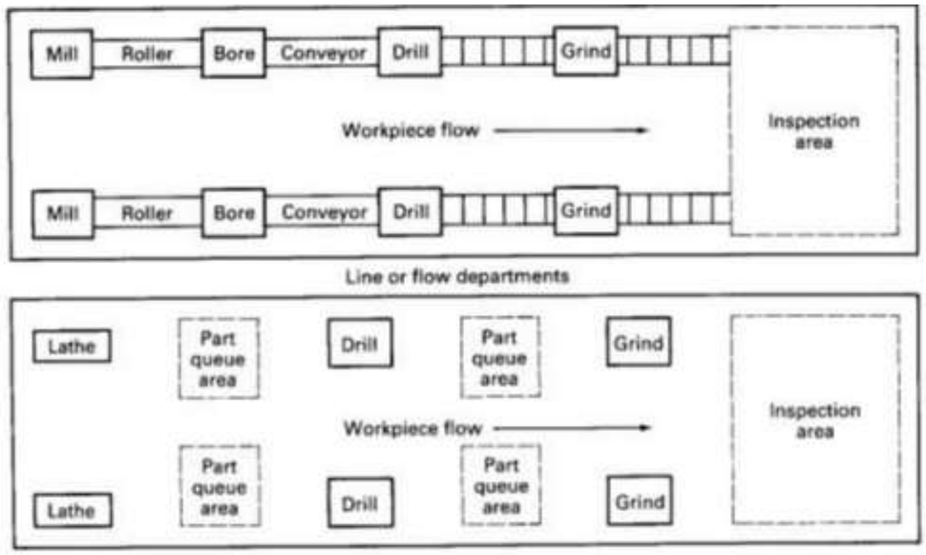
.1. **Function** - Machines organized by function will typically perform the same function, and the location of these departments relative to each other is normally



Machine layout by function.

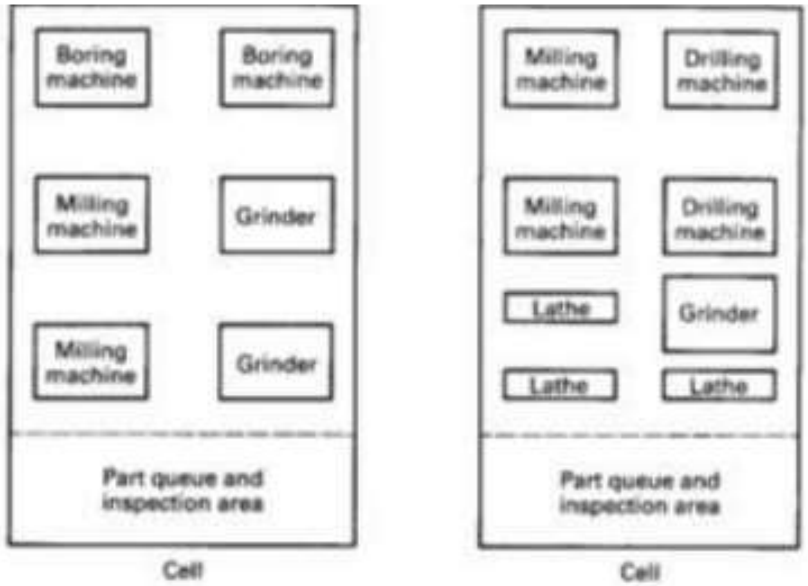
arranged so as to minimize interdepartmental material handling. Workpiece produced in functional layout departments and factories are generally manufactured in small batches up to fifty pieces (a great variety of parts).

2**. Line or flow layout** - the arrangement of machines in the part processing order or sequence required. A transfer line is an example of a line layout. Parts progressively move from one machine to another in a line or flow layout by means of a roller conveyor or through manual material handling. Typically, one or very few different parts are produced on a line or flow type of layout, as all parts processed require the same processing sequence of operations. All machining is performed in one department, thereby minimizing interdepartmental material handling



Line or flow machine layout.

3. **Cell** - It combines the efficiencies of both layouts into a single multi-functional unit. It referred to as a group technology cell; each individual cell or department is comprised of different machines that may not be identical or even similar. Each cell is essentially a factory within a factory, and parts are grouped or arranged into families requiring the same type of processes, regardless of processing order. Cellular layouts are highly advantageous over both function and line machine layouts because they can eliminate complex material flow patterns and consolidate material movement from machine to machine within the cell



Machine layout by cell based on part families to be processed

Information Sheet –4	Standard and codes A particular task

Example of a robot program written in the language *Movemaster Command* for picking and placing operations in positioning locations 1 and 2

Row number	Program instruction	Description
10	PD 10,0,0,20,0,0,0	Defines the aerial distance (*position definition*) of travel from position 1 (Z = 20 mm)
20	PD 20,0,0,30,0,0,0	Defines the aerial distance (*position definition*) of travel from position 2 (Z = 30 mm)
30	SP 18	Sets the initial speed (*speed*)
40	MA 1,10,O	Opens hand and moves 20 mm above the position 1
50	MO 1,O	Moves (*move*) with open hand to position 1
60	GC	Closes hand (*gripper close*) and grasps the workpiece
70	MA 1,10,C	Moves (*move*) 10 mm above position 1 with hand closed
80	MA 2,20,C	Moves (*move*) 30 mm above position 2 with hand closed
90	MO 2,C	Moves (*move*) and puts the workpiece in position 2
100	GO	Opens hand (*gripper open*) and releases the workpiece
110	MA 2,20,O	Moves (*move*) 30 mm above position 2 with hand opened
120	GT 40	Repeats this program (Jumps to line 40) (*go to*)

Ways to Identify Part Families

1**. Visual inspection** - using best judgment to group parts into appropriate families, based on the parts or photos of the parts

2. **Production flow analysis** - using information contained on route sheets to classify parts

3. **Parts classification and coding** –

identifying similarities and differences among parts and relating them by means of coding scheme Parts Classification and Coding

- Most classification and coding systems are one of the following
- Systems based on part design attributes
- Systems based on part manufacturing attributes
- Systems based on both design and manufacturing attributes

Part Design Attributes

- Major dimensions
- Basic external shape
- Basic internal shape
- Length/diameter ratio
- Material type
- Part function
- Tolerances
- Surface finish

Part Manufacturing Attributes

- Major process
- Operation sequence
- Batch size
- Annual production
- Machine tools
- Cutting tools
- Material type

Information Sheet –5	Checking feasibility and evaluate solutions.

Area to consider as part of a feasibility study.

- The size of the manufacturing company
- The capital budgetary requirement
- Initial investment
- Cash flow projection
- Overhead & operational cost
- The raw material market availability
- Government regulations and policies
- The product market acceptability
- Bank provision policies

Principles of CIM

For CIM to be successful businesses must consider the following five fundamental issues involved:

- People and their crucial contribution to manufacturing
- Top management's commitment to the philosophy
- CIM should be put in the context of a well-defined business Strategy or vision
- The technology plan, the system architecture for cim, must Include all elements of the company
- It is extremely important when choosing suppliers to access both The breadth and depth of their support capabilities

People and their crucial contribution to manufacturing

"Manufacturing, in general, has not done a very good job of understanding how you link the people and the process into this CIM In the past, CIM projects became automated disasters because management became enamored with the technology and computer side of the program. They completely forgot about the people side and neglected to incorporate people into the development process. Information technology will reshape every company that survives through the 90s. However, businesses will not be able to incorporate technology advances if they do not find a way to make workers comfortable with computers. Additionally, workers will not have the requisite skills and abilities to succeed and advance if they are not able to work with computers. Almost every white-collar job in America requires some level of familiarity with computers. Additionally, it is estimated that 75% of industrial workers also need at least elementary computer skills. Management must understand what enables workers at any skill level to be able to master their computers. Companies that have transformed their 31 work forces with technology have distilled a set of principles that apply equally to workers on an assembly line or in the front office. These principles include the following:

- **Think of How to Empower Your Workers,** Instead Of Dumping
- **Technology on Them**- The most advanced enterprises have realized that they have got to deal with the people side at the same time they deal with the technology.
- **Listen to Your Employees** When Designing a System (Bottom Up)

-Managers of highly automated operations are unanimous, if you don't involve the users, you will develop the wrong system. Nobody understands the job like the people who do it. They can tell you how to design the tools that will let them work more efficiently. They will trust new technology more if they had a say in it and knew it was coming. The company wins more commitment from its workers when they feel their contributions were valuable in the design of the system.

- Understand and Communicate Your Business Objectives- Employees will accept and learn new technologies if they understand their importance. Fancy computers seldom make much difference in productivity if workers do not understand how the technology helps achieve business goals. It is important tosee new technology as only part of a total vision of changed organizations. Therefore, management must look at the information employees need, the materials they need, the incentives they need, and all other

- aspects of the business, not just automating. Teach Your Employees by Helping Them Improve Their Performance-The most important aspect of incorporating new technology is learning to do the job better, not learning how to operate the computer. Traditional classroom instruction is seldom the best way to go. The most usefultraining comes only when workers need it.

CIMS Benefits:

- . Increased machine utilization
- Reduced direct and indirect labor
- Reduce mfg. lead time
- Lower in process inventory
- Scheduling flexibility

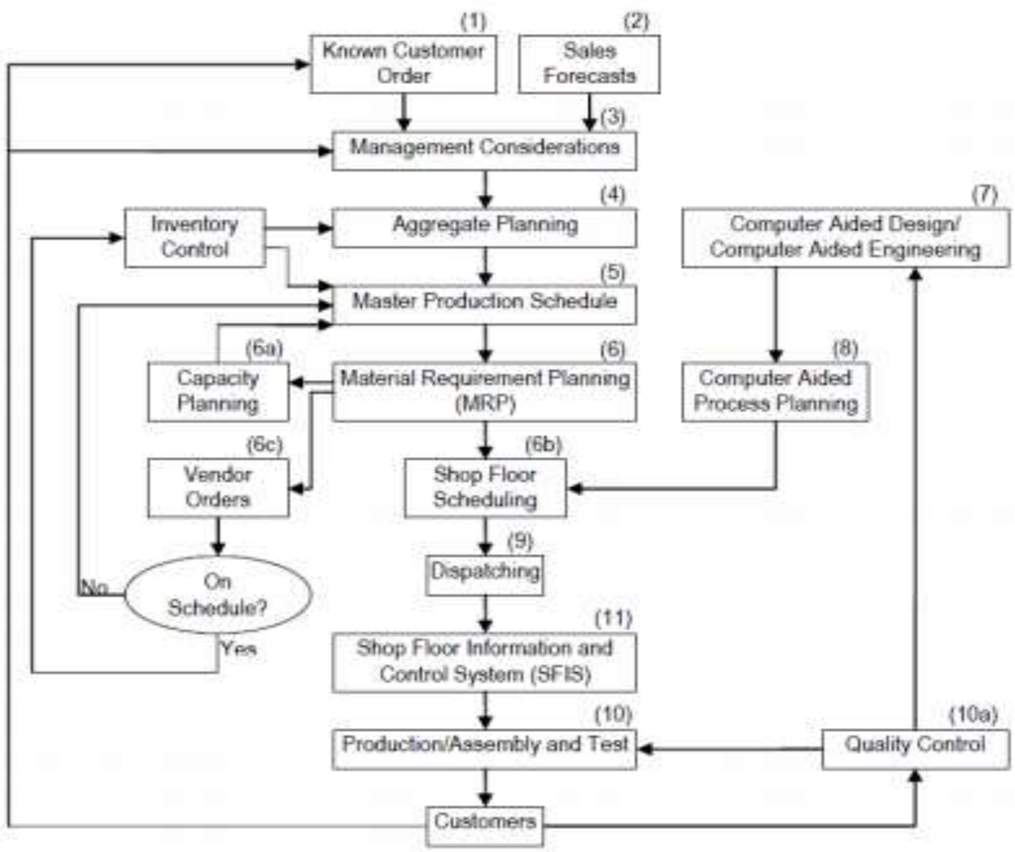


Fig 5: Flow of Operations in CIM

Information Sheet –6	Determining social and sustainability implications of solutions

The meaning and origin of CIM

The CIM will be used to mean the integration of business, engineering, manufacturing and management information that spans company functions from marketing to product distribution.

The changing and manufacturing and management scenes

The state of manufacturing developments aims to establish the context within which CIM exists and to which CIM must be relevant. Agile manufacturing, operating through a global factory or to world class standards may all operate alongside CIM. CIM is deliberately classed with the technologies because, as will be seen, it has significant technological elements. But it is inappropriate to classify CIM as a single technology, like computer aided design or computer numerical control.

External communications

Electronic data interchange involves having data links between a buying company's purchasing computer and the ordering computer in the supplying company. Data links may private but they are more likely to use facilities provided by telephone utility companies.

Islands of automation and software

In many instances the software and hardware have been isolated. When such computers have been used to control machines, the combination has been termed an **island of automation**. When software is similarly restricted in its ability to link to other software, this can be called an island of software.

Dedicated and open systems

The opposite of dedicated in communication terms is open. Open systems enable any type of computer system to communicate with any other.

Manufacturing automation protocol (MAP)

The launch of the MAP initiates the use of open systems and the movement towards the integrated enterprise.

Product related activities of a company

1. **Marketing**
    - Sales and customer order serviceing
2. Engineering
    - Research and product development
    - Manufacturing development
    - Design
    - Engineering release and control
    - Manufacturing engineering
    - Facilities engineering
    - Industrial engineering
3. Production planning
    - Master production scheduling
    - Material planning and resource planning
    - Purchasing
    - Production control
4. Plant operations
    - Production management and control
    - Material receiving
    - Storage and inventory
    - Manufacturing processes

40Test and inspection

- Material transfer
- Packing, dispatch and shipping
- Plant site service and maintenance

5. Physical distribution
    - Physical distribution planning

- Physical distribution operations
- Warranties, servicing and spares

6. Business and financial management
   - Company services
   - Payroll
   - Accounts payable, billing and accounts receivable

Initially CIM and sustanebility

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. A CIM System consists of the following basic components:

- Machine tools and related equipment
- Material Handling System (MHS)

- Computer Control System
- Human factor/labor

Information Sheet –7 Reviewing concept proposals

LG #30	**LO #2-** Perform supervision of conventional and /or CIM supported production

Instruction sheet

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Planning conventional production processes.
- Providing documentation, drawings, specifications and instructions.
- Consulting client and stakeholders.
- Preparing drafte production process.

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, **you will be able to**:

- Plan conventional production processes.
- Provide documentation, drawings, specifications and instructions.
- Consulteclient and stakeholders.
- Prepare drafte production process.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below.
3. Read the information written in the “Information Sheets”. Try to understand what are being discussed. Ask your trainer for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks” which are placed following all information sheets.
5. Ask from your trainer the key to correction (key answers) or you can request your trainer to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets
7. Perform “the Learning activity performance test” which is placed following “Operation

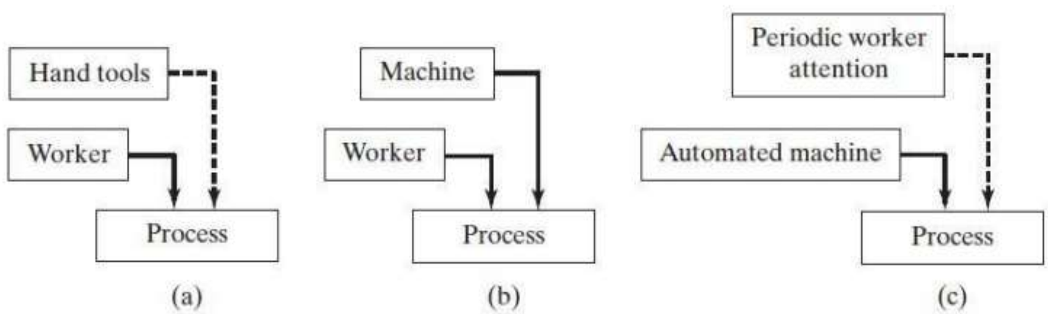
sheets" ,

8. If your performance is satisfactory proceed to the next learning guide,
9. If your performance is unsatisfactory, see your trainer for further instructions or go back to "Operation sheets".

Information Sheet –1	Planning conventional production processes

It is classified in three categories in terms of the human participation in the processes performed by the manufacturing system:

- Manual work system - a worker performing one or more tasks without the aid of powered tools, but sometimes using hand tools
- Worker-machine system - a worker operating powered equipment
  - Automated system - a process performed by a machine without direct participation of a human

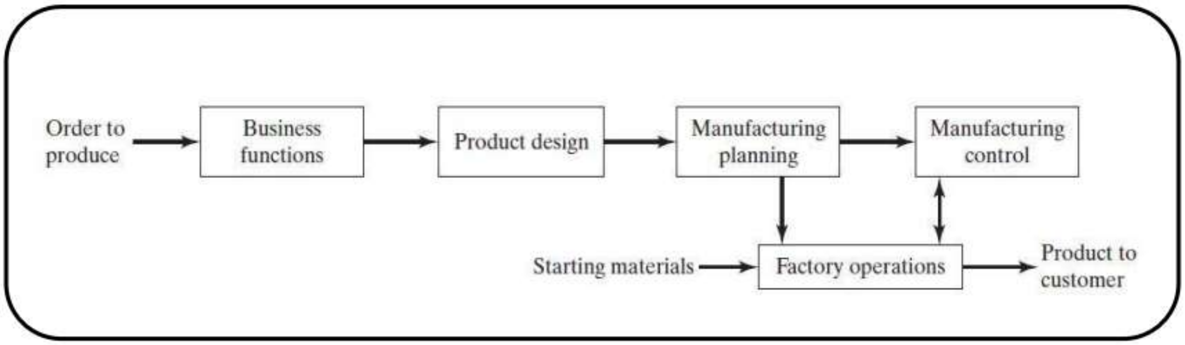


(a) Manual work system, (b) worker-machine system, and (c) fully automated system

Manufacturing support involves a sequence of activities that consists of four functions:

- Business functions - sales and marketing, order entry, cost accounting, customer billing
- . Product design - research and development, design engineering, prototype shop
- Manufacturing planning - process planning, production planning, MRP, capacity planning
- Manufacturing control - shop floor control, inventory control, quality control

.



Expert system in CIM

Expert systems are nothing more than sophisticated computer programs, that emulate the problem solving and decision making ability of human expert. A typical area which can be relatively easily imagined and where expert systems have a solid ground in CIM is for example fault analysis. But there are many other fields as well when expert systems under development can be essential in the design and operation phases of complex systems, such as FMS, CAD/CAM and CIM.

Expert systems are applied in fields where decision making is difficult because of the complexity of the task and because the reasoning cannot be expressed in an algorithmic way.

Human experts can achieve outstanding performance in solving problems because they are knowledgeable and experienced. Expert performance in expert systems depends on the knowledge, thus collecting, storing, retrieving and duplicating knowledge in computer readable format are the key points.

Types of expert systems include:

- Design systems capable of creating new combinations and configurations, of mechanical, structural etc systems meanwhile satisfying certain predefined constraints and relationships between components.
- Planning systems involved in decision making, forecasting, project planning
- Expert control systems, Utilizing adaptive control techniques and capable of adopting their behavior to the environmental conditions in scheduling components in FMS, in selecting cutting parameters and etc..

- ❖ Manufacturing expert systems selecting optimum cutting conditions, assembly motions of robots, robot task planning, routing etc…
- ❖ diagnosis systems observing malfunctions and irregularities in complex software systems
- ❖ Repair systems capable of advising their users on how the diagnosed problem should be tackled considering all important aspects of the problem.

Computer Aided Design/ Computer Aided Manufacturing (CAD/CAM)

Computer-Aided Design

Computer-aided design (CAD) is the creation and manipulation of pictures (design prototypes) on a computer to assist the engineer in the design process.

CAD History:

- CAD research began in the 1960.s in the automotive and aerospace industries (General Motors, McDonnell Douglas)
- In 1963, Ivan Sutherland developed the first interactive sketch pad for manipulating computer graphic images
- As computers have become faster and more powerful, CAD software packages have become commonplace in the modern industrial workplace
- Boeing's 777 airplane was designed entirely on computer, without the construction of an initial prototype

Computer-Aided Manufacturing

In Computer-Aided Manufacturing, numerical code is used to control a machining and manufacturing operation

CAM History

- In the 1950.s MIT demonstrated the numerical control of a machine using a computer language called Automatically Programmed Tool (APT)
- Numerically Controlled (NC) machinery has been developed to perform a diverse array of operations, such as milling and turning
- Other techniques for prototyping include stereo-lithography, lamination methods, and selective laser sintering
- More advanced machining cells have been developed that integrated many of these machining functions

In general the technology of CAD/CAM is concerned with the use of digital computers to perform certain functions in design and production. This technology is moving in the direction of greater integration of design and manufacturing, two activities which have traditionally been treated as distinct and separate functions in a production firm.

The cad hardware typically includes the computer, one or more graphics display terminals, keyboards, and their peripheral equipment. The cad software consists of the computer programs to implement computer graphics on the system plus application programs to facilitate the engineering functions of the user company. Examples of these applications programs include stress-strain analysis of components, dynamic response of mechanisms, heat transfer calculations, and so on.

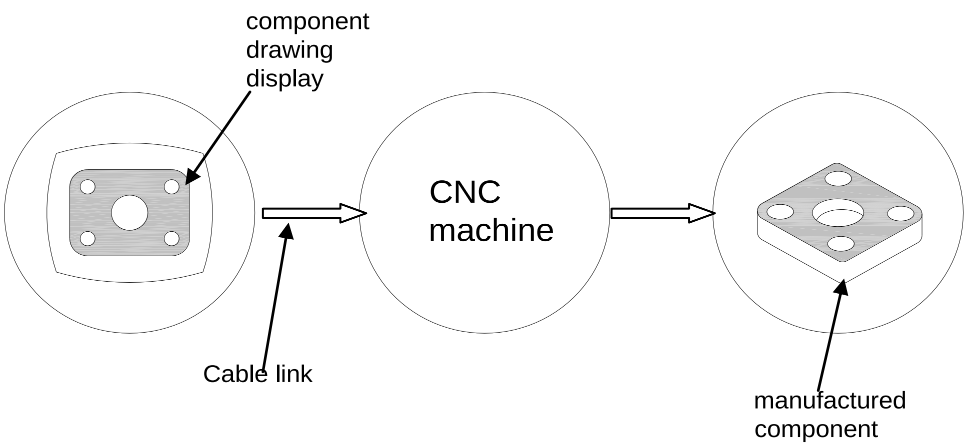


Fig 1.Simplified principle of the linked CAD/CAM

System Control

The brain of the FMS is the system controller. The typical controller is a computer with an attendant worker who keeps track of performance and intercedes when necessary to change priorities or solve problems. The controller must be capable of keeping track of system status. System status involves the location of all parts, tools, and carts, including those waiting to be loaded, and the operational status of each machine.

Based on current status and production plans, the controller downloads commands to the individual system components. The components acknowledge receipt of the command and later respond that the command has been executed (or failed to execute). Unless individual machine computers have sufficient storage capability to maintain all part plans, the controller may store part programs, which are downloaded to individual machines as required. The controller must also decide when and how parts should be loaded.

In a sophisticated system, the controller is thinking ahead. Predicted part-completion times could be used to send empty carts to a picking site in advance. Instead of having a predetermined machine sequence, changed only in case of break downs, parts can be dynamically routed to the closest available machine with the necessary tooling.

The functions performed by the FMS computer control system can be grouped in to the following categories:

- NC part program storage. The programs for the parts that are machined at the various work stations on the line must be stored.

- Distribution of the part programs to the individual machine tools. This must be accomplished in the correct (post processor) format for that machine.
- Production control. This function includes decisions on part mix and rate of input of the various parts onto the system. These decisions are based on data entered into the computer, such as desired production rate per day for the various parts, numbers of raw work parts available, and number of applicable pallets. The computer performs its production control function by routing an applicable pallet to the load/unload area and providing instructions to the operator to load the desired raw part. A data entry unit (DEU) is located in the load/unload area for communication between the operators and the computer.
- Work handling system monitoring. The computer must monitor the status of each cart and/or pallet in the primary and secondary handling systems as well as the status of each of the various work part types in the system.
- Tool control. Monitoring and control of cutting tool status is an important feature of a FMS computer system. There are two aspects to tool control: Accounting for the location of each tool in the FMS and tool life monitoring

The first aspect of tool control involves keeping track of the tools at each station on the line. If one or more tools required in the processing of a particular work part are not present at the workstation specified in the part's routing, the computer control system will not deliver the part to that station. Instead, it will determine an alternate machine to which the part can be routed, or it will temporarily "float" the part in the handling system. In the second case, the operator is notified via the data entry unit what tools are required in which workstation. The operator then manually loads the tools and notifies the computer accordingly. Any type of tool transaction (e.g., removal, replacement, addition) must be entered into the computer to maintain effective tool control.

The second aspect of tool control is tool life monitoring. A tool life is specified to the computer for each cutting tool in the FMS. Then, a file is kept on the machining time usage of each tool. When the cumulative machining time reaches the life for a given tool, the operator is notified that a replacement is in order.

- System performance monitoring and reporting. The FMS computer can be programmed to generate various reports desired by management on system performance.

Data collected during monitoring of the FMS can be summarized for preparation of performance reports. These reports are tailored to the particular needs and desires of management. The following categories are typical:

1. *Utilization reports.* These are reports that summarize the utilization of individual work stations as well as over all average utilization for the FMS.
2. *Production reports*. Management is interested in the daily and weekly quantities of parts produced from the FMS. This information is provided in the form of production reports which list the required schedule together with actual production completions.
3. *Status reports*. Line supervision can call for a report on the current status of the system at any time. Of interest to supervision would be status data on work parts, machine utilization, pallets, and other system operating parameters.
4. *Tool reports*. These reports relate to various aspects of tool control. Reported data might include a listing of missing tools at each workstation.

Information Sheet –2 Providing documentation, drawings, specifications and instructions.

Advantages of CAD

In general, use of CAD have the following advantages.

Faster rate of producing drawings: on average, a draughtsman using a CAD system can produce drawings about three times as fast as could be done on a drawing board. This speeds up the whole design process and gets the product onto the market more quickly.

Greater accuracy of drawings: a conventional drawing is accurate only to the eye of the draughtsman and the thickness of the pencil lead. By contrast, any point on a cad drawing has an exact position, and zooming allows to be blown up to show components in more detail. Therefore all detail and assembly drawings produced by CAD are completely accurate.

Neater drawings: the presentation of a conventional drawing is entirely dependent upon the line work and printing skills of the individual draughtsman, whereas the plotter of a cad system produces superior line work and text whoever operates the system. Cad allows any number of lines to be quickly erased without leaving any trace on the final drawing which cannot be possible in the conventional one.

No repetition of drawings: once a drawing or part-drawing is completed, it may be stored in the computer memory for future use. This is particularly useful when drawing a range of components with a similar shape. A stored drawing can also be recalled to design jigs and fixtures, analyze tool paths, and design press tools. By conventional means, a separate drawing is required for each of these tasks.

The computer memory is also ideal for compiling libraries of symbols, standard components, and geometric shapes.

Special drafting techniques: apart from zooming, CAD systems have many more special drafting techniques which were not available by conventional mean.

Quicker design calculations and analysis: there is now a vast range of computer software for carrying out design calculations in a fraction of the previous time.

Superior design form: powerful computer modeling techniques, such as finite element analysis, have freed the designer from the shackles of restrictive conventional formula and allowed more inventive shapes to be developed. These shapes may be quickly modified and optimized for cost savings to an extent which would have previously been too time-consuming.

Less development required: CAD simulation and analysis techniques can drastically cut the time and money spent on prototype testing and development.

Integration of design with other disciplines: the vast superior communications available under an integrated computer network enables CAD to work far more closely with other engineering departments.

Computer aided Manufacturing (CAM)

CAM (computer aided manufacturing) uses computer systems to plan, manage, and control the operations of a manufacturing plant through either direct or indirect computer interface with the plant’s production resources. The application of CAM is classified into:

1. Manufacturing planning
2. Manufacturing control

Manufacturing planning

In manufacturing planning the computer provides information for the planning and management of production activities.

- cost estimating provides a appropriate labor and overhead rates to the planned operation
- computer aided process planning(CAPP) the preparation of route sheets
- Computerized machinability data system. the appropriate cutting conditions to use for different materials
- computer assisted NC part programming- is more efficient method than manual part programming
- development of work standards- standardize time data for basic work elements of any task
- computer aided line balancing- allocation of work elements among stations
- production and inventory planning include maintenance of records for the different production order material planning requirement and capacity planning

Manufacturing Control

Manufacturing control is concerned with managing and controlling the physical operations in the factory and includes process control, quality control, shop floor control, and process monitoring.

The most important elements of CAM

1. CNC manufacturing and programming techniques
2. Computer controlled robotics manufacture and assembly
3. Flexible manufacturing systems
4. Computer aided inspection techniques
5. Computer aided testing techniques

Some of the advantages of CAM are as follow

- Higher production rates either lower workforces
- Less likelihood to human error and consequences of human unreliability
- Greater versatility of manufactured form
- Cost savings due to increased manufacturing efficiency eg. Less material wastage
- Repeatability of production processes via storage of data

- Superior product

Reference Materials

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