Computers in Manufacturing Enterprises

COMPUTER INTEGRATED MANUFACTURING SYSTEMS

Automation, Production Systems and CIM by M.P. Groover
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DISCUSSION ON MINOR 2 EXAM

- Minor 2 copies were shown
- Student queries and concerns were resolved
- Discussed the question paper

CIM: INTRODUCTION

- concept was introduced by Dr. J. Harrington, Jr. in 1973
- defined as:
  "use of computers in manufacturing to control the entire production process"
- both a method of manufacturing and a computer-automated system in which individual engineering, production, marketing, and support functions of a manufacturing enterprise are organized
- integration of processes and information

http://webpages.dcu.ie/~arishaa/CIMweb_files/Body.htm

SUBSYSTEMS OF CIM

Computer-aided techniques:	Devices and equipment required	Technologies
CAD (computer-aided design)	CNC, Computer numerical controlled machine tools	FMS, (flexible manufacturing system)
CAE (computer-aided engineering)	DNC, Direct numerical control machine tools	ASRS, automated storage and retrieval system
CAM (computer-aided manufacturing)	PLCs, Programmable logic controllers	AGV, automated guided vehicle
CAPP (computer-aided process planning)	Robotics	Robotics
CAQ (computer-aided quality assurance)	Computers and Software	Automated conveyance systems
PPC (production planning and control)	Controllers	
ERP (enterprise resource planning)	Networks	
A business system integrated by a common database.	Interfacing	

wikipedia

SUBSYSTEMS 1: COMPUTER AIDED DESIGN (CAD)

- any design activity that uses computer to create, modify, or document an engineering design
- CAD/CAM term is used to refer the system supporting both design and manufacturing activities
- reasons for using CAD system:
  - to increase productivity of designer
  - to improve design quality
  - improved design documentation
  - creating a manufacturing database

APPLICATION OF COMPUTERS IN DESIGN

Synthesis (Geometric modelling)	• concerned with the mathematical geometry of the objects • 2D and 3D • wireframe models: uses interconnecting lines to depict an object • solid models: object is modelled in 3D • color and animation
Analysis and Optimization (engineering analysis)	• software available in CAD system increases designers analyzing ability • 2 types are: mass properties and finite-element system analysis • mass properties: volume, area, weight and centre of gravity • finite-element analysis: stress /strain analysis, heat transfer analysis, simulation
Evaluation (design review and evaluation)	• Automatic dimensioning routines: determines precise distance between surfaces on the model • Inference checking routines: identify whether 2 objects occupy the same space • Kinematics routines: used to test the operation of mechanical linkages
Presentation (automated drafting)	• used to prepare accurate engineering drawings quickly

COMPUTER AIDED MANUFACTURING (CAM)

- use of computer / technology in planning, management and control in manufacturing function
- applications of CAM
  - Manufacturing planning
  - Manufacturing control

CAM : MANUFACTURING PLANNING APPLICATIONS

- indirect support in production function
- provides information for effective planning and management of production activities
- important applications are:
  - ***Cost estimating***: calculate labor and overhead costs and then adds them up
  - ***Computer aided process planning (CAPP):*** help in preparing routing details of workcentres
  - ***Computerized machinability data systems:*** data obtained in either factory or laboratory about tool life and cutting conditions is used to suggest appropriate speeds and feeds for cutting different materials
  - ***Computer assisted NC part programming:*** for complex NC part programming (planning and documentation of sequence of processing steps performed on NC machine) computer assistance is more efficient

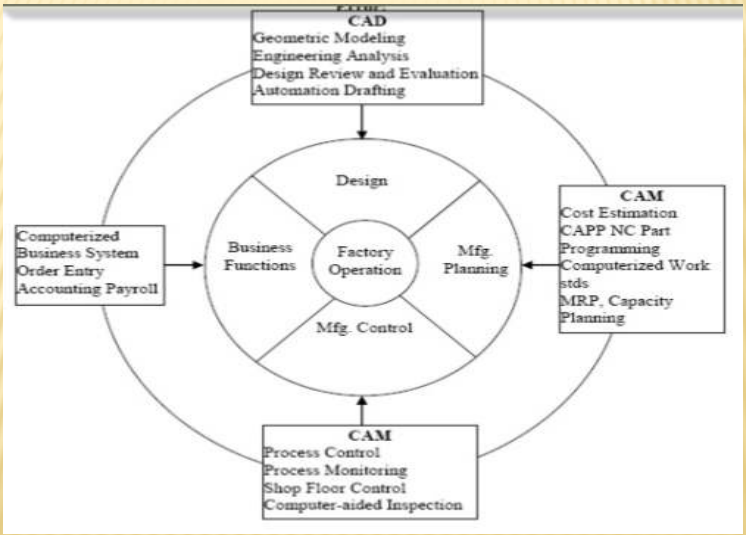
CAM : MANUFACTURING PLANNING APPLICATIONS

- applications:
  - ***Development of work standards:*** calculates the total standard time for a job by adding individual elements of the basic work
  - ***Computer-aided line balancing:*** finding best allocation of work elements among workstations
  - ***Production and inventory planning:*** maintenance of inventory records, automatic reordering of stock if inventory is depleted, material requirement planning etc

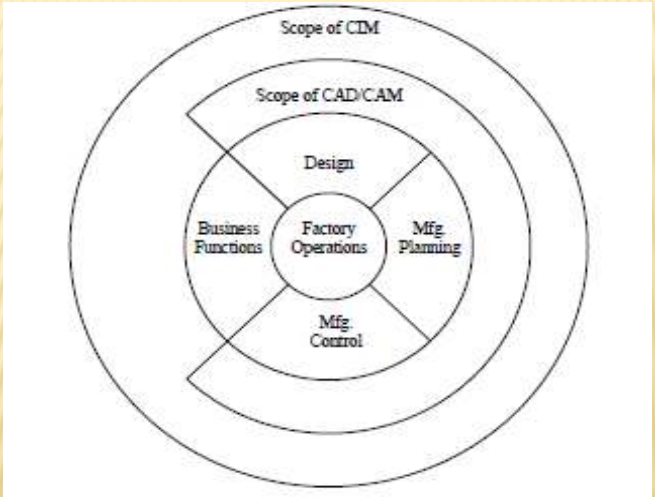
CAM : MANUFACTURING CONTROL

- concerned with managing and controlling physical operations in a factory
- includes process control, quality control, shop floor control and process monitoring
- shop floor control implies production management techniques for collecting data from factory operations and using it to manage production and inventory

COMPUTERIZED ELEMENTS OF CIM



SCOPE OF CAD/CAM AND CIM



http://www.ignou.ac.in/upload/UNIT%201-55.pdf

CAD / CAM : EXAMPLE OF BOEING 757

- used in development of the 757 airplane
- first plane Boeing produced that was completely designed by CAD systems
- benefits of CAD/CAM were seen most clearly in the post-design phases of production
- CAD/CAM enabled the more precise fit of parts, the result being that the first 757 required only ***six shims***, compared to ***several hundred*** for the first 747
- ***scheduled ten days*** for the assembly of the fuselage and wing spares of the first 757, but actual assembly took ***only two days***
- Boeing estimated that the use of CAD throughout the design process ***lowered*** overall person hours for assembly ***by one-third***
- analysis functions of CAD enabled the number of working prototypes to be ***reduced to 3, down from 12*** in 747

http://www.referenceforbusiness.com/encyclopedia/Clo-Con/Computer-Aided-Design-CAD-and-Computer-Aided-Manufacturing-CAM.html

COMPUTERIZED MANUFACTURING PLANNING SYSTEMS

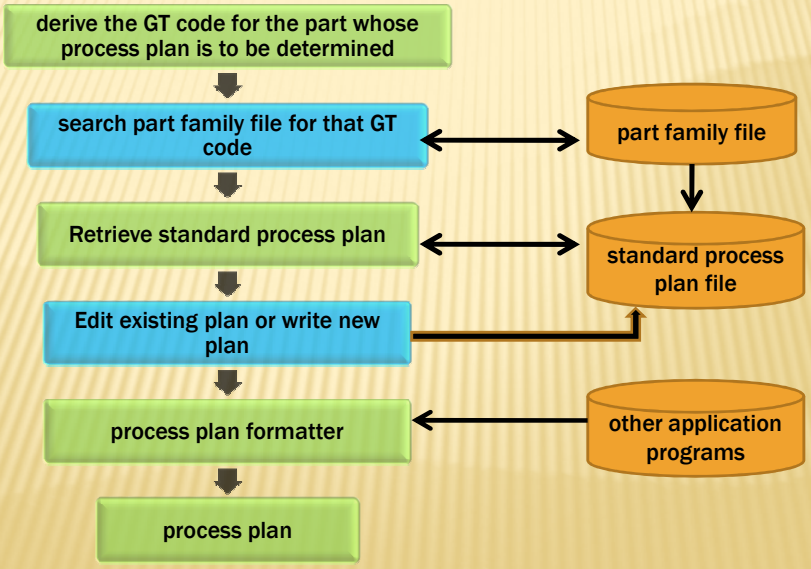
- process planning
  - concerned with finding the sequence of processing and assembly steps required to make a product
- processing steps are documented on a form called a ***route sheet***
- route sheets generally contains:
  - operations in production
  - machine cells or workstations where each operation is performed
  - fixtures and tooling required
  - standard time for each task
- ***Computer Aided Process Planning (CAPP)*** represents link between CAD/CAM system
  - CAPP systems automate the task of process planning
  - can be used to develop a product manufacturing plan based on projected variables such as cost, lead times, equipment availability, production volumes, potential material substitution routings and testing requirements

Computer Aided Process Planning (CAPP)

COMPUTER AIDED PROCESS PLANNING (CAPP)

- designed around 2 approaches:
  - retrieval or variant CAPP systems
    - based on principles of GT and parts classification and coding
    - retrieve and edit an existing plan contained in computer database
  - generative CAPP systems
    - represent and alternative approach to automated process planning
    - a process plan is created based on logical procedures

RETRIEVAL CAPP SYSTEMS



GENERATIVE CAPP SYSTEMS

- process plans are generated by means of decision logic, formulas, technology algorithms, and geometry based data to perform uniquely processing decisions
- starts with the product design specifications and can generate a detailed process plan complete with machine settings
- Expert systems are based on decision rules and have been used in some generative CAPP systems

BENEFITS OF CAPP

- Process rationalization and standardization
  - more logical and consistent
  - results in lower manufacturing costs and higher product quality
- Increased productivity of process planners
  - availability of process plans in data files leads to more work being done
- Reduced lead time for process planning
  - route sheets can be prepared in a shorter time
- Improved legibility
  - computer prepared route sheets are neater and easier to read
- Other application programs can be incorporated
  - CAPP programs can be interfaced with other applications such as cost elimination, work standards etc

Computer Integrated Production Planning Systems

COMPUTER INTEGRATED PRODUCTION PLANNING

- earlier planning department prepared the plans and took decisions on inventory, work assignment etc
- for plants producing large volume and complex parts, workload and decision problem is very significant

COMPUTER INTEGRATED PRODUCTION PLANNING

Problem	Result	Computerized Production Planning System
Plant Capacity • manpower and equipment shortage	• excessive overtime • customer complaints • production behind schedule	Capacity Planning
Suboptimal production scheduling • wrong jobs are scheduled due to lack of clear orders • inefficient scheduling rules	• interruption in production runs by jobs with increased priorities • increased machine setups • jobs behind schedule	Master Production Schedule • shop floor control
Long manufacturing lead times • to compensate for problem 1 and 2	• overloaded shop and long lead times	
Inefficient inventory control • high inventories for raw materials, WIP, finished products but stockout for individual item	• high inventories -> high carrying costs • stockouts -> production delay	Material Requirements Planning • Inventory management • purchasing

COMPUTER INTEGRATED PRODUCTION PLANNING

Low work center utilization • poor scheduling of job • other factors (strikes, breakdowns, reduced demand etc)	• minimal usage of machines	**Master Production Schedule**
Process planning not followed • planned routing is disturbed with ad hoc process sequence (bottlenecks at work centres in the planned sequence	• longer setups, improper tooling and less efficient processes	**Master Production Schedule**
Errors in engineering and manufacturing records • old routing sheets, fault in inventory records, bills are not current	• delays in production	**Master Production Schedule** • engineering and manufacturing database
Quality problems	• delay in shipping schedule	**Master Production Schedule**

MATERIAL REQUIREMENTS PLANNING

MATERIAL REQUIREMENTS PLANNING (MRP)

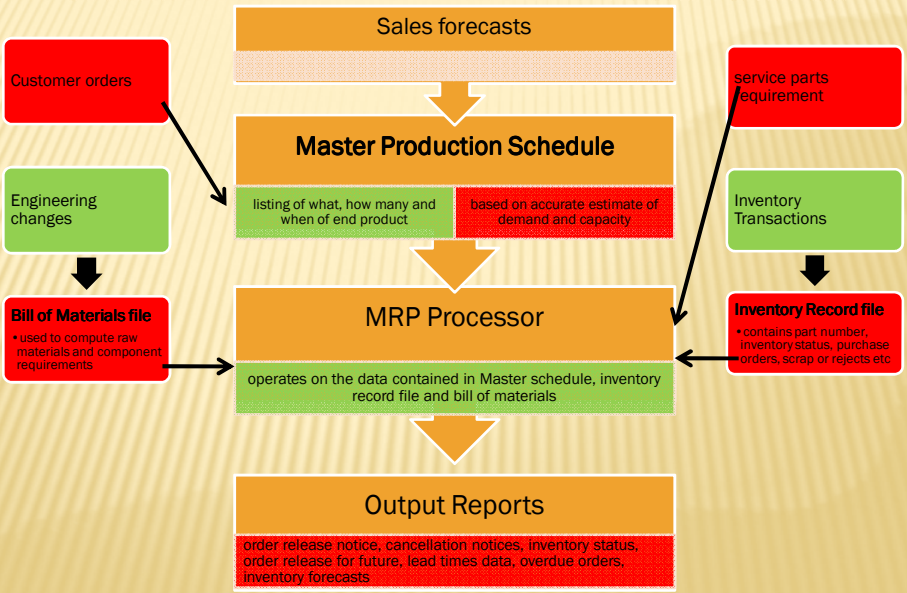
- computer-based production planning and inventory control system
- attempts to keep adequate inventory levels to assure that required materials are available when needed
- effective tool for controlling unnecessary inventory investment
- complicated system because it processes large data

http://www.columbia.edu/~gmg2/4000/pdf/lect_06.pdf

MATERIAL REQUIREMENTS PLANNING - CONCEPTS

- **independent vs dependent demand**
  - independent demand: demand for a product is not directly related to demand for other items; for eg: end products and spare parts
  - dependent demand: demand of the product is directly related to demand for other items
    - item being component of other product
  - demand for end products is mostly forecasted
  - requirements for components and raw materials can be calculated once the delivery schedule of end product is determined
- **lead times**
  - time allowed for a job to complete (from start to finish)
  - *ordering lead time:* time required for an item from generation of purchase request till it is received from vendor
  - *manufacturing lead time:* time taken for manufacturing
- **Common use items**
  - raw materials and components being used in more than one product
  - MRP takes into account these items in ordering

MATERIAL REQUIREMENTS PLANNING - INPUTS



MATERIAL REQUIREMENTS PLANNING - DEMO

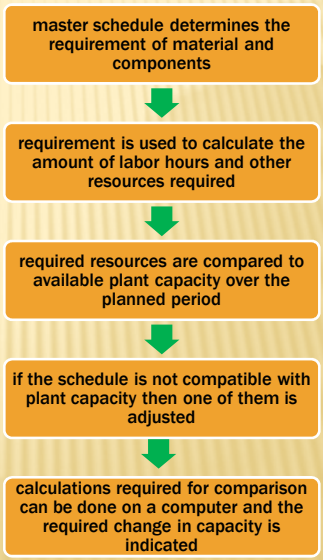
SAP Business One Product Demo - Material Requirements Planning MRP

(http://www.youtube.com/watch?v=oJ8Jo3ASbx0)

CAPACITY PLANNING

CAPACITY PLANNING

- determines the amount of labor and equipment required to meet the current capacity as well as future demand
- identify the limitations of resources so that unrealistic Master Production Schedule is not planned



CAPACITY PLANNING: ADJUSTMENTS

- ***short term***
  - *employment levels*
    - can be increased or decreased
  - *number of work shifts*
    - can be increased or decreased
  - *labor hours*
    - use overtime or reduced hours
  - *inventory stockpiling*
  - *order backlogs*
    - delivery could be delayed during busy periods
  - *subcontracting*
    - letting of jobs to others in peak demand and taking in extra work during slack time
- ***long term***
  - *new equipment investment*
    - *investing in new machines for increased future requirements or investing in new machines for future changes in product design*
  - *new plant construction or purchase*
  - *plant closings*
    - *close the plant not needed in future*