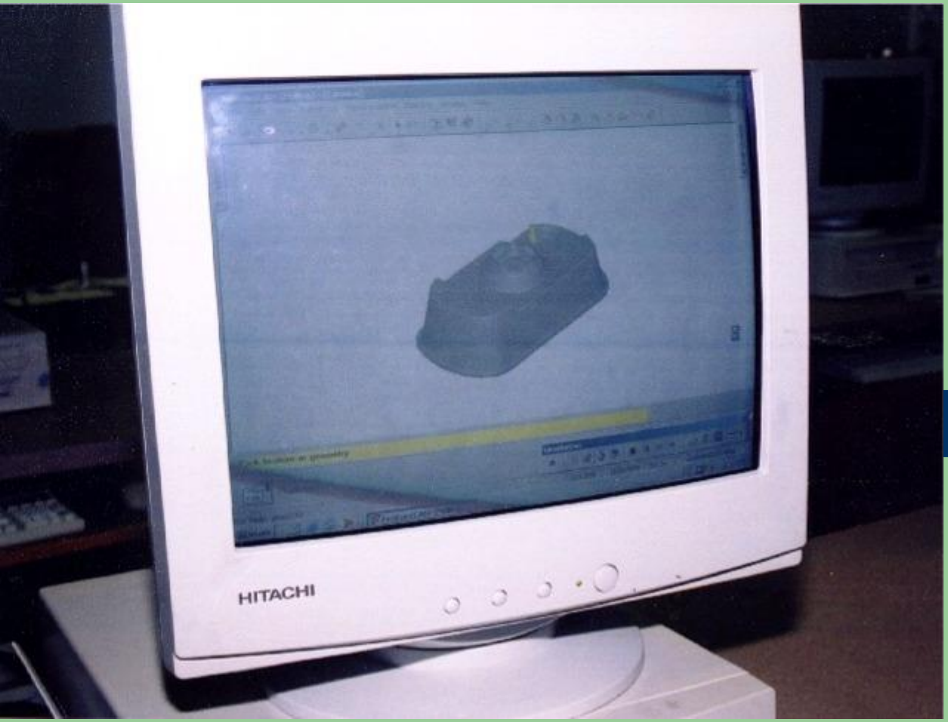
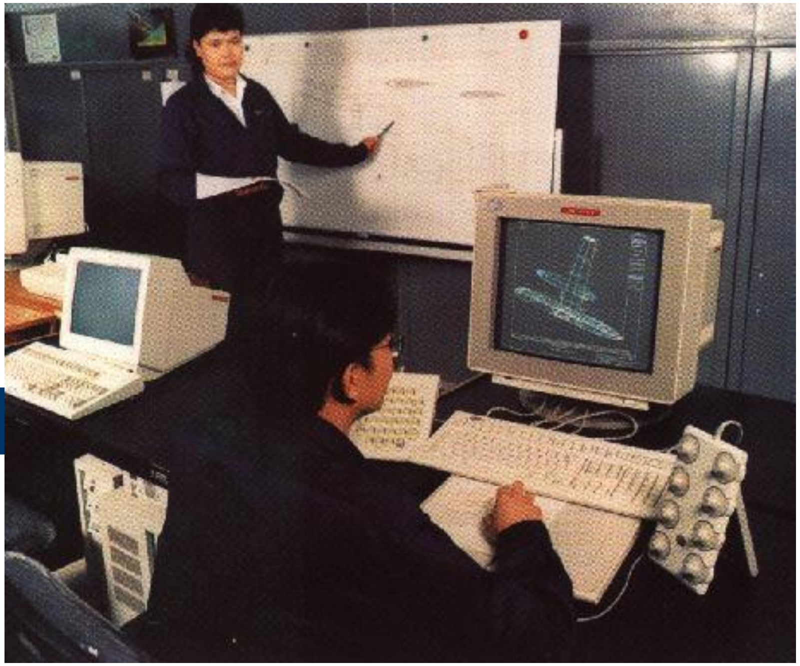
Computer-Aided Manufacturing



Manufacturing

- Efficiency
- Cost

Integration



High quality/low cost can be achieved by:

- Computer-Aided Manufacturing
- Computer-Aided Design
- Computer-Aided Engineering
- Computer-Aided Process Planning
- Simulator of Process and System

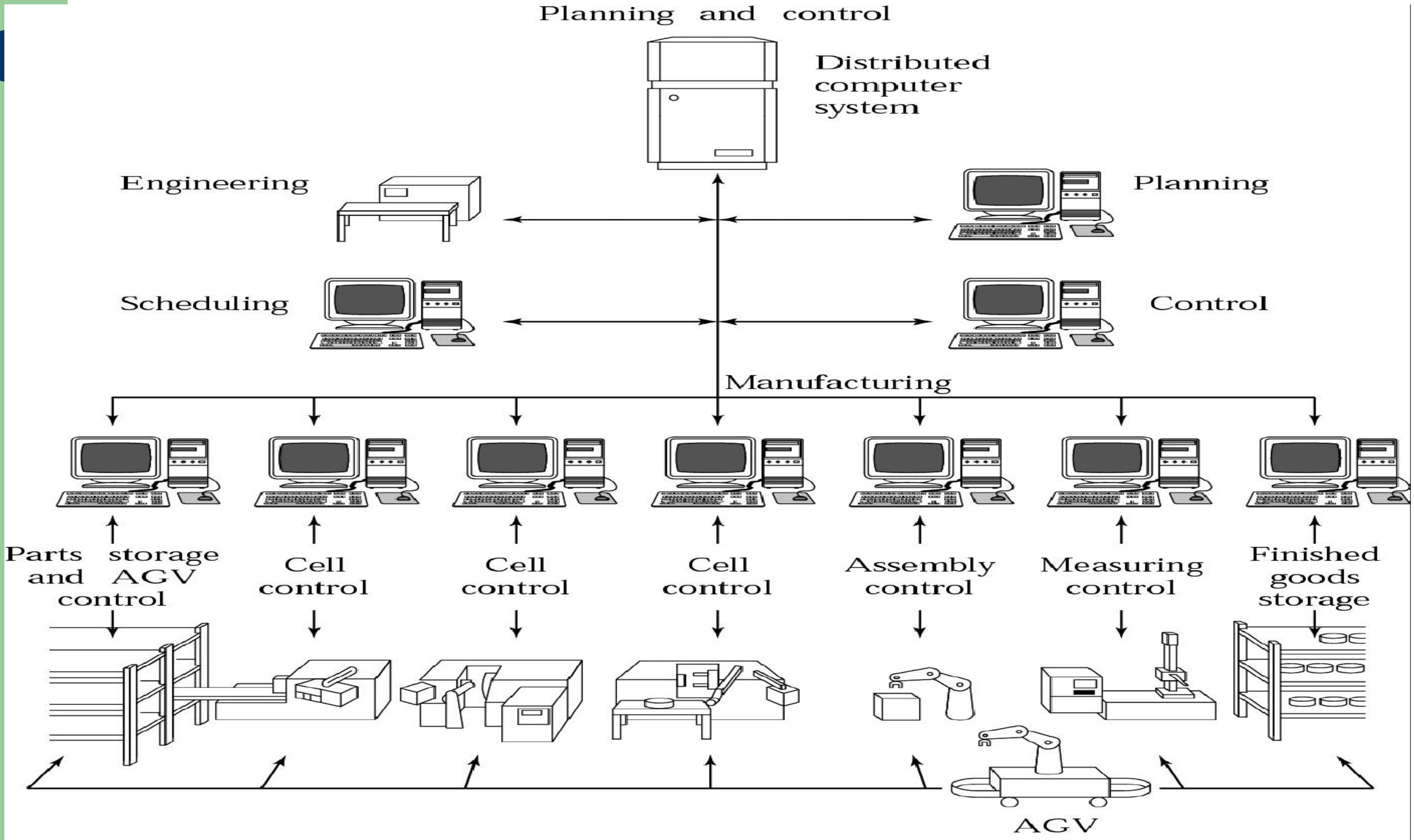
Manufacturing System

- Flexible system to accommodate changes
- Global events/economy affects manufacturing
- Predictions

Computer-Integrated Manufacturing (CIM)

- Computerized integration
- Instantaneous communication of subsystems
- Can be expansive

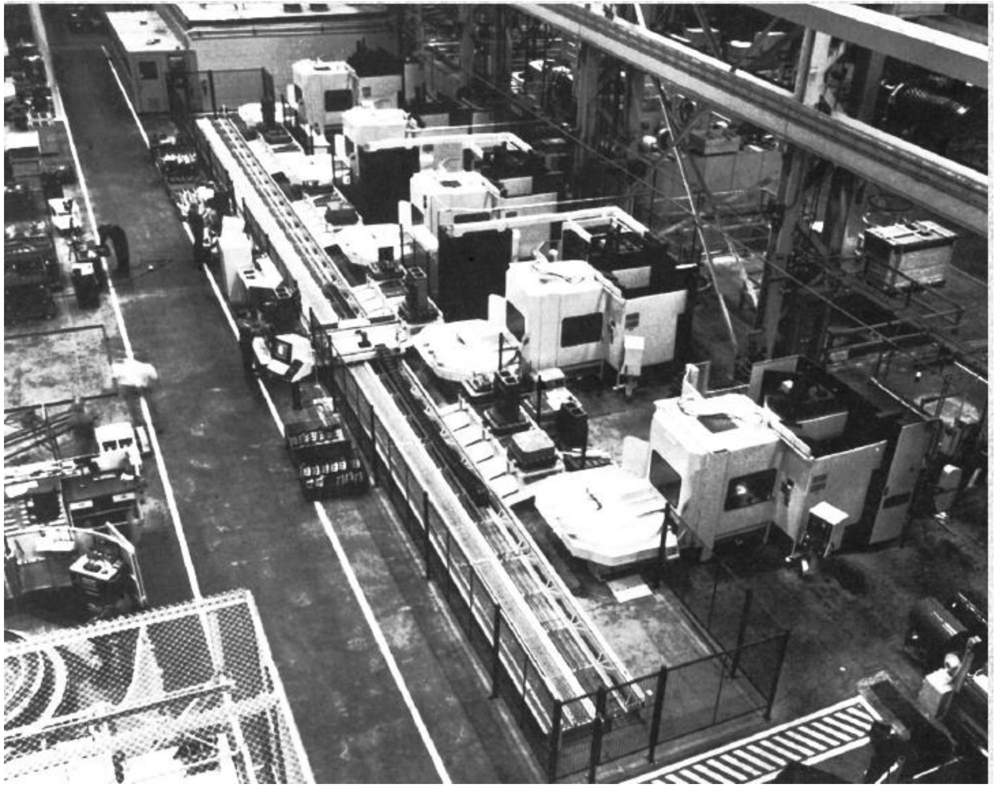
Computer-Integrated Manufacturing (CIM)



Computer-Integrated Manufacturing (CIM)

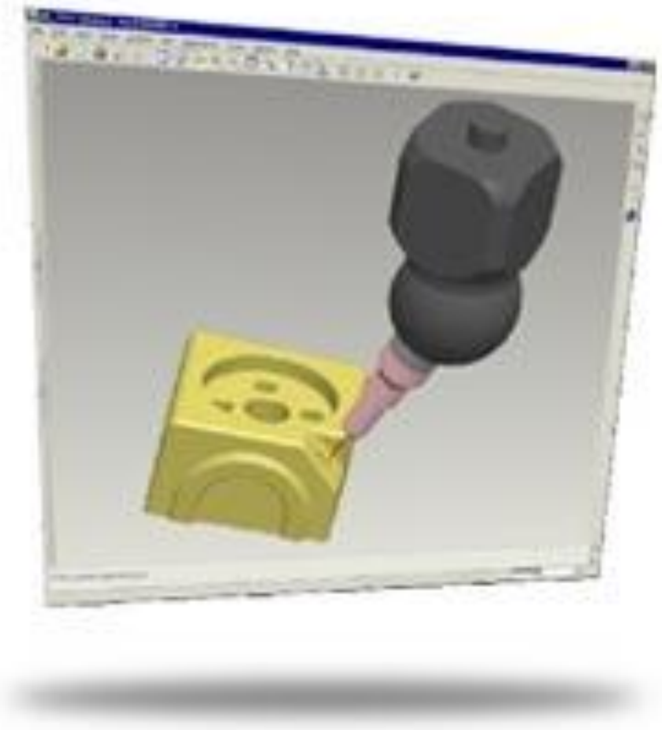
Benefits:

- Better process control
- Product quality
- Efficiency
- Total control



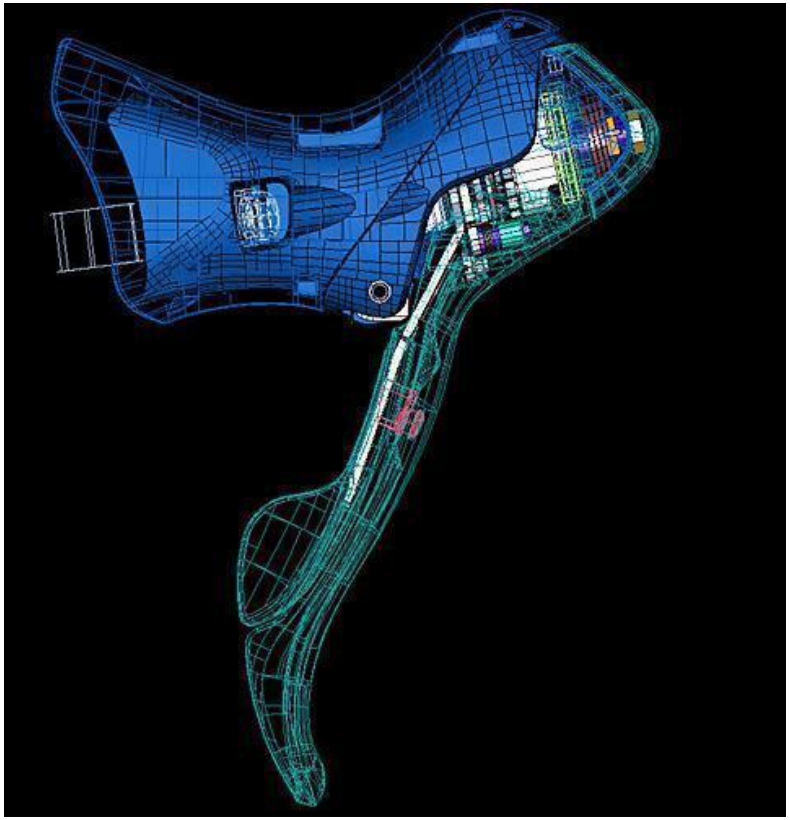
Computer-Aided Design and Engineering

- Drawing Exchange Format (DFX) are softwares that convert data between different CAD vendors. Ex. *Pro-E* and *Solidworks*
- *Autodesk* can do just that



Design Analysis and Optimization

- To analyze stresses, strains, deflections, and other physical or temperature tolerances
- Able to determine product effectiveness



Computer-Aided Manufacturing (CAM)

Involves the use of computers in all phases of manufacturing. A process known as knowledge based machining.

Computer-Aided Design (CAD) and Computer-Aided Manufacturing (CAM)

Some typical applications of CAD/CAM

- Process planning and scheduling.
- Programming for numerical control and industrial robots.
- Design of dies and molds for casting.
- Die for metal working operations.
- Design of tooling and fixtures and EDM electrodes.
- Quality control and inspection.
- Plant layout.

Computer-Aided Process Planning (CAPP)

Computer-Aided Process Planning is concerned with the preparation of a **route sheet** for the engineering drawing of the work part which must be interpreted in terms of manufacturing process to be used. The route sheet is a listing of the sequence of operations. Closely related to process planning are the functions of determining appropriate cutting conditions for the machining operations and setting the time standards for the operations which are aided by computers.

ROUTING SHEET

CUSTOMER'S NAME: Midwest Valve Co. PART NAME: Valve body

QUANTITY: 15 PART NO.: 302

Operation no.	Description of operation	Machine
10	Inspect forging, check hardness	Rockwell tester
20	Rough machine flanges	Lathe No. 5
30	Finish machine flanges	Lathe No. 5
40	Bore and counter bore hole	Boring mill No. 1
50	Turn internal grooves	Boring mill No. 1
60	Drill and tap holes	Drill press No. 2
70	Grind flange end faces	Grinder No. 2
80	Grind bore	Internal grinder No. 1
90	Clean	Vapor degreaser
100	Inspect	Ultrasonic tester

CAD/CAM Flow Chart

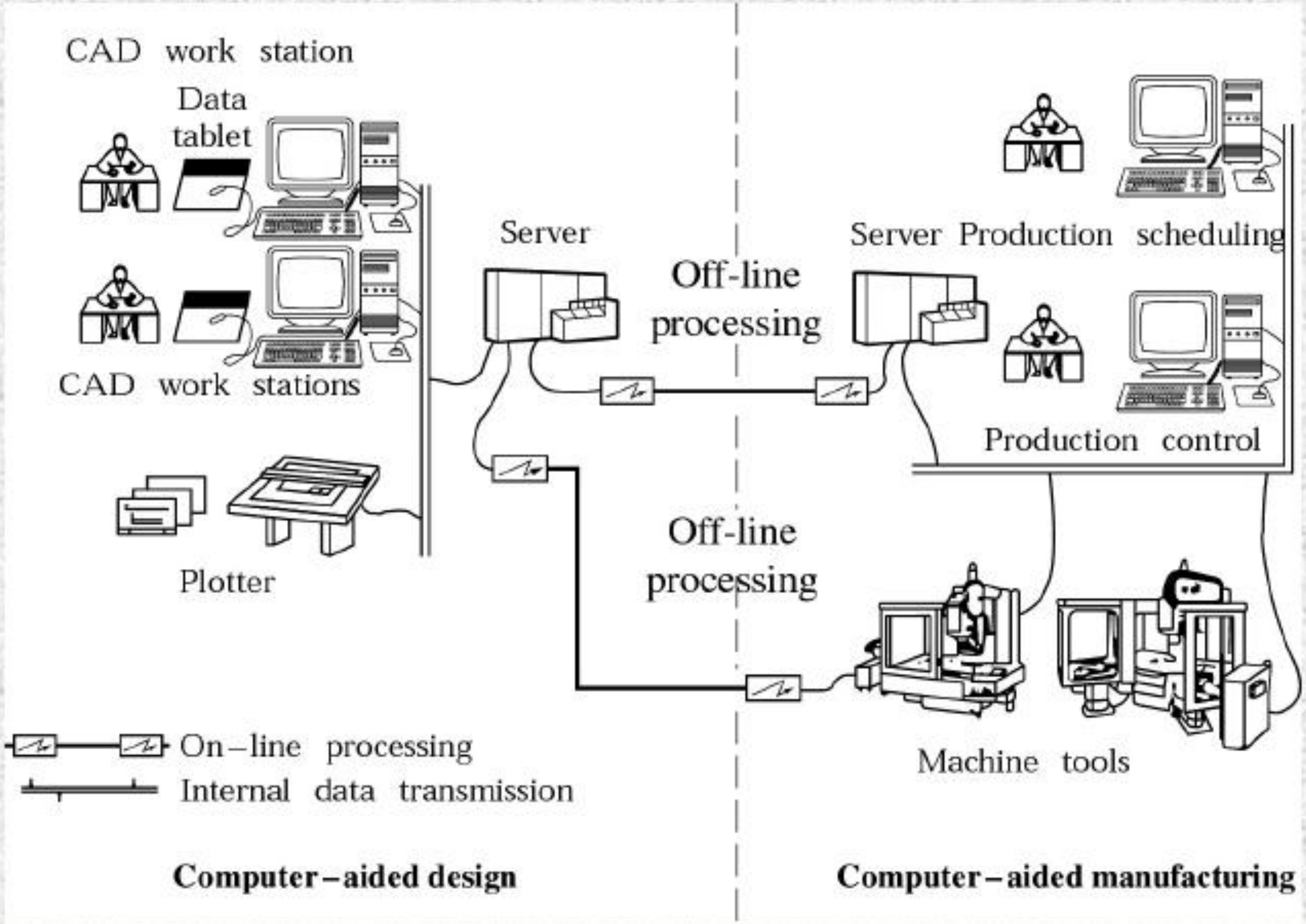


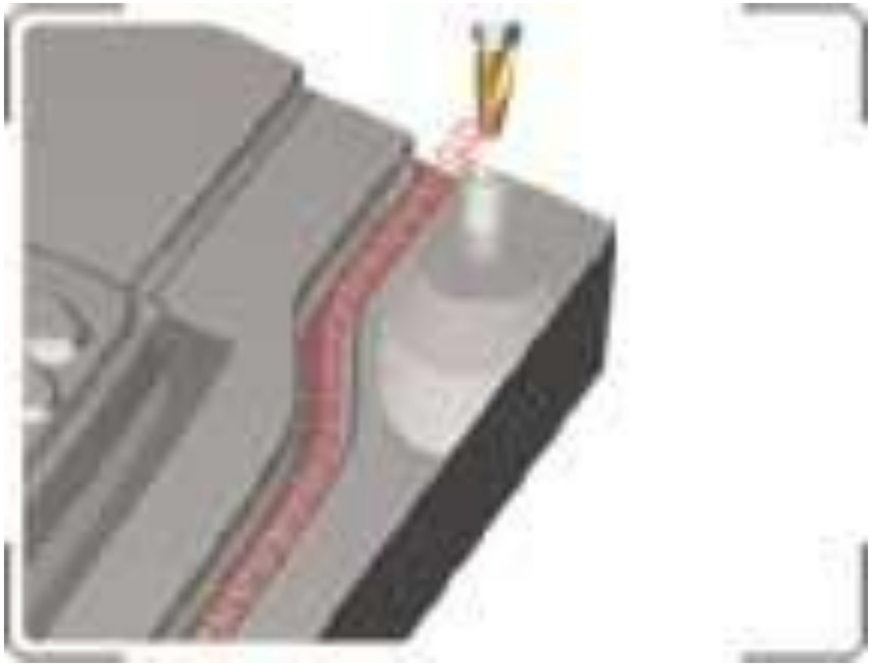
Figure 39.2 Information flow chart in CAD/CAM application.

CAPP Systems

Two types of CAPP systems

- Variant - Contain a standard process plan.
- Generative –

  Creates a new plan.



Material-requirements planning and manufacturing resource planning (MRP)

MRP keep complete records of inventories of

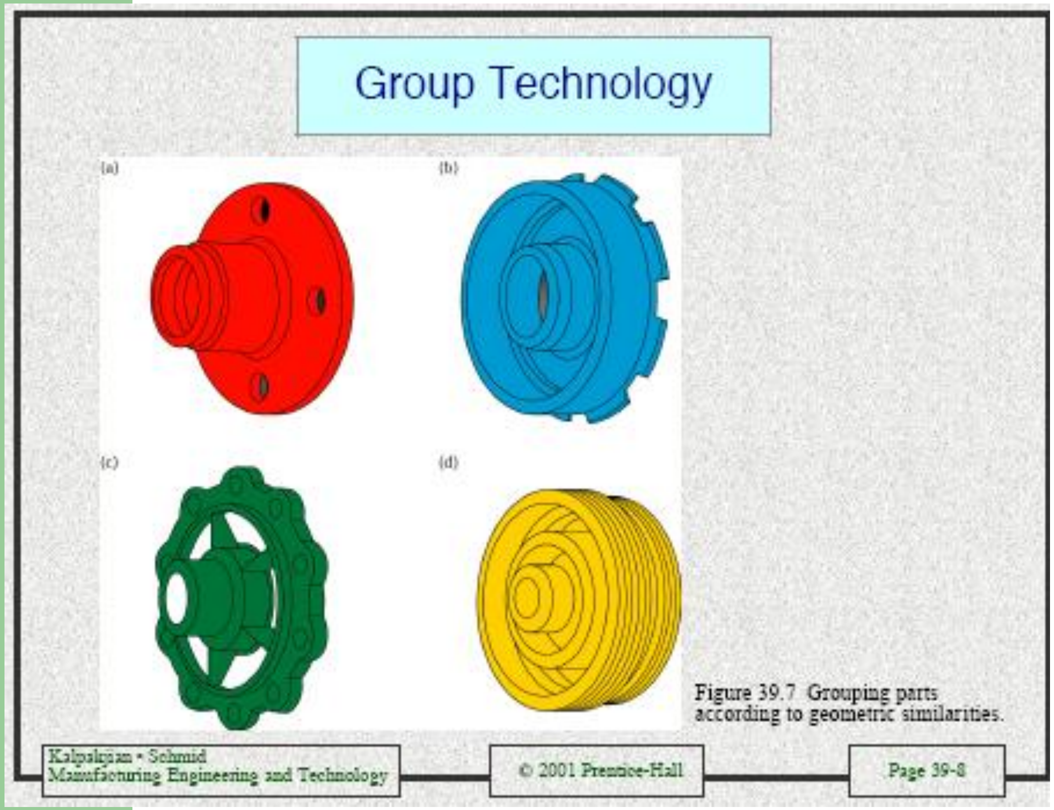
- Materials,
- Supplies,
- parts in various stages of production,
- Orders,
- Purchasing, and
- Scheduling.

Computer simulation of Manufacturing Processes and Systems

Simulation takes two forms:

- It is a model of a specific operation intended to determine the viability of a process or to optimize or improve its performance.
- It models multiple processes and their interactions to help process planners and plant designers in the layout of machinery and facilities.

Group Technology (GT)



Group technology takes advantage of the design and processing similarities among parts to be produced. By grouping these parts into families related to one another by **code** and **classification.**

Classification and coding of parts

Is a critical and complex process and is done according to two attributes:

- Design - this attribute is related in the similarities in geometric features of the part.
- Manufacturing -this attribute is related by the similarities in manufacturing processes performed on the part.

Coding

The coding of parts can be company owned or purchased commercially.

The three basic codes vary in degree of complexity:

- Hierarchical coding
- Polycodes
- Decision-tree coding

Opitz Classification and Coding System

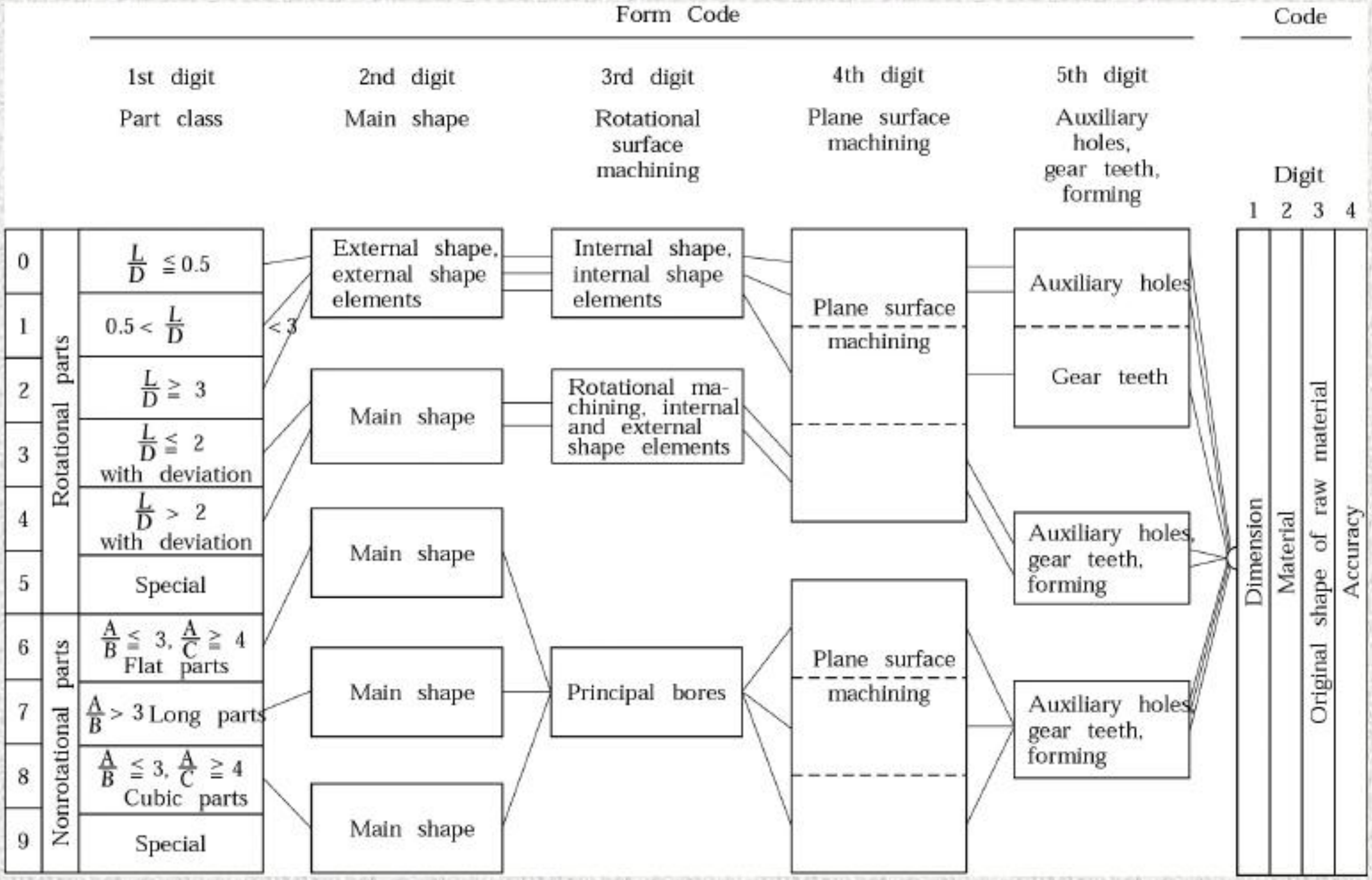


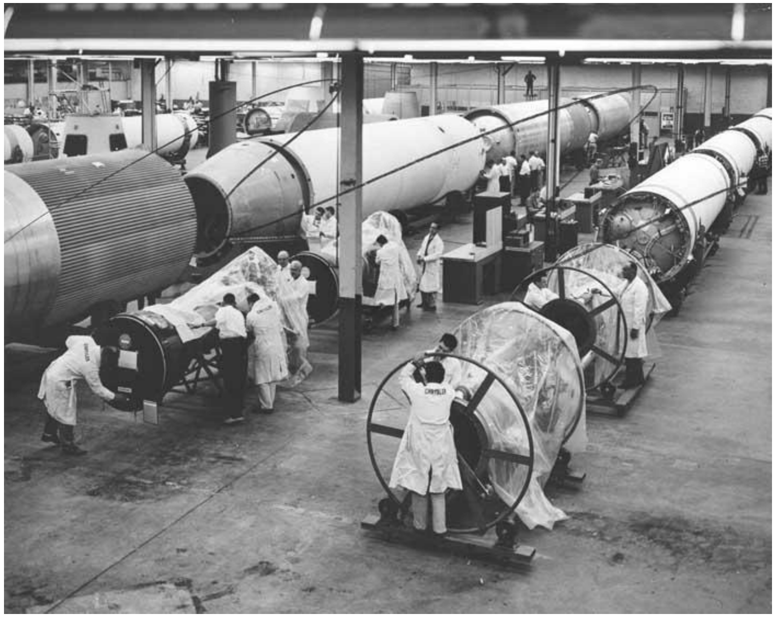
Figure 39.10 Classification and coding system according to Opitz, consisting fo 5 digits and a supplementary code of 4 digits.

Summary

The computer age has provided for improvements in all manufacturing processes.

Product Design and Process Selection

- As engineers, we must design products that are cost effective to manufacture
- Designing cheap parts that still maintain high-quality requires an understanding of all parts of the manufacturing process



Factors For Competitive Design

- Product design
- Product quality and life expectancy
- Life-cycle assessment and engineering
- Material selection/ substitutions
- Manufacturer process capabilities
- Manufacturing cost and cost reduction

Product Design

- DFMA-design for manufacture and assembly
- Reduce number of components
- Use commercially available parts such as fasteners
- Use fewer, stronger fasteners
- Consider surface finishing processes and how they will affect dimensional tolerances

Quantity of Materials in Design

- As production rates go up, costs of materials used and wasted can make a substantial difference in cost
- This can be achieved by using different materials or manufacturing techniques
- Reducing the materials used too much can lead to difficulty in manufacture or product failure

Product Quality and Life Expectancy

- Quality and life expectancy affect cost
- We must limit how much is spent on quality improvements; eventually this is not cost effective
- Product life must meet customer's expectations
- Product must function properly over it's lifetime
- Must be able to be manufactured at a rate to meet customer demand

Life Cycle Assessment and Engineering

- This is also known as Sustainable Manufacturing, where long-term resource availability and conservation are considered
- Life Cycle Assessment modeling is done to assess every step in manufacturing a product
- Engineers must design products that are environmentally friendly to make
- Waste products from manufacture can often be recycled or reused

Material Selection for Products

- We must consider mechanical, chemical, and physical properties
- Some materials can be replaced by lighter or less expensive ones
- Materials must meet minimum design specifications and requirements
- Must have reliable and readily available supply of raw materials

Shapes of Commercially Available Materials

- Raw metals come in one of several standard shapes, such as rods, ingots, plate or sheet, foil, wire, tubing, and some structural shapes such as I-beam
- We must select the raw material that requires the least additional processing to form the final part

Additional Material Selection Factors

- Manufacturing characteristics of materials-can our stock withstand the stress of manufacture without adverse affects?
- Reliability of material supply
- Recycling considerations
- Material and processing cost

Material Substitution

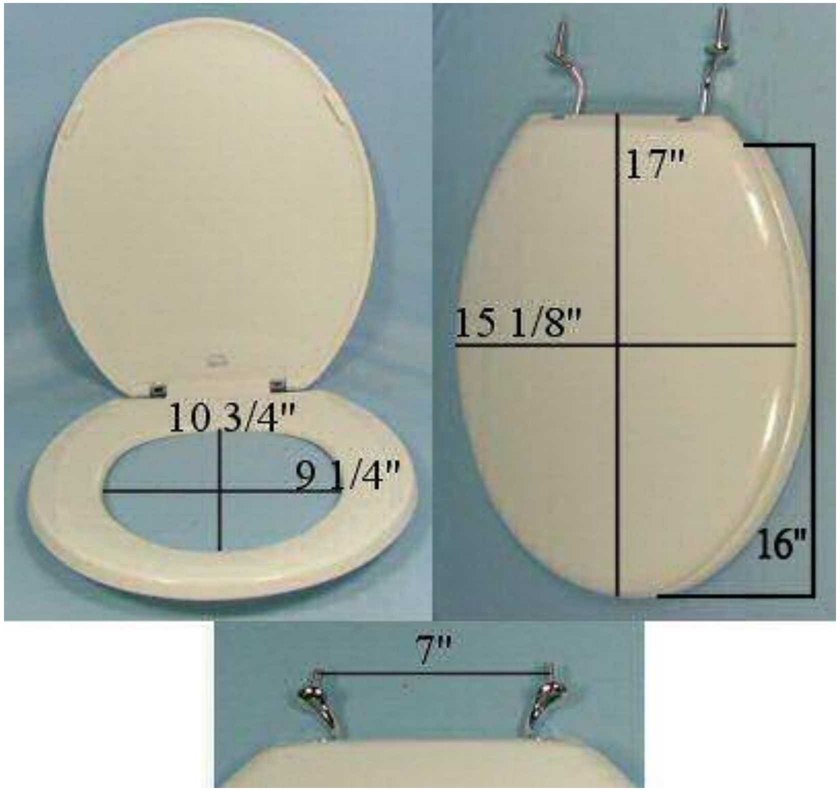
- Substituting materials can allow products to be made lighter and more cheaply
- Materials can be used that provide resistance to wear, corrosion, and fatigue
- Common materials can be substituted for scarce ones

Materials Substitution cont.

- Adjustments can be made based on market availability of materials
- Potentially dangerous materials (such as lead) substituted for safe ones
- These practices are used extensively in the automotive and aerospace industries

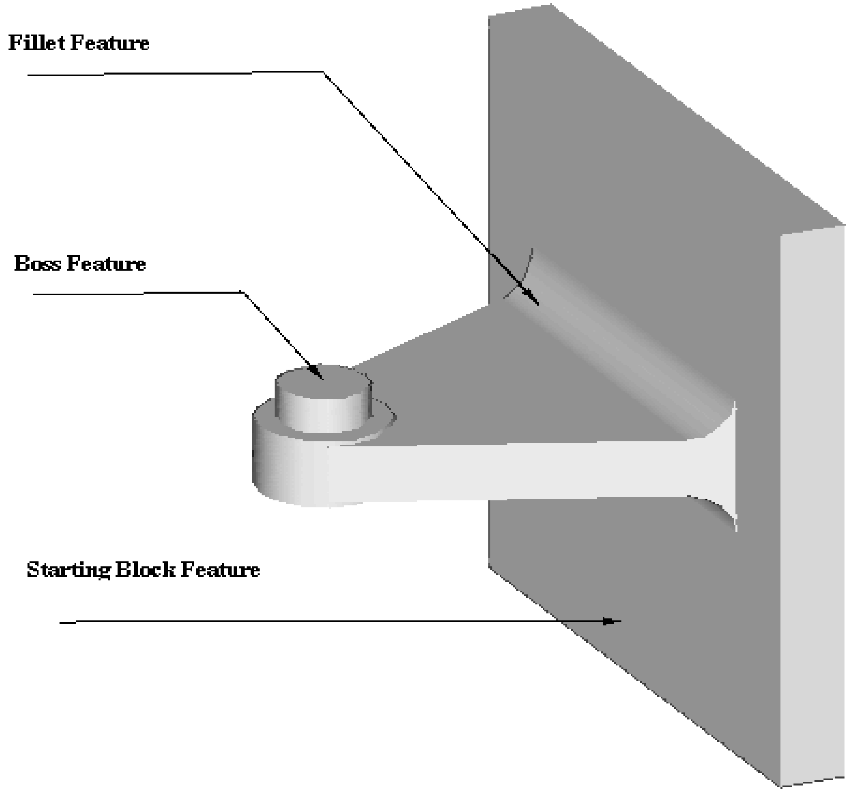
Manufacturing Process Capabilities

- Dimensional tolerances and surface finish
- Production Quantity
- Production Rate
- Lead Time



Process Selection

- Characteristics of the workpiece material
- Geometric Features of the part
- Production rate and quantity
- Process selection considerations



Important Questions

- Is the tooling required available in the plant?
- Can the part be produced to final dimensions without requiring additional processing?
- Are the processing parameters optimized?
- Is scrap minimized?
- Have all alternative manufacturing processes been investigated?

Methods of Making a Simple Part

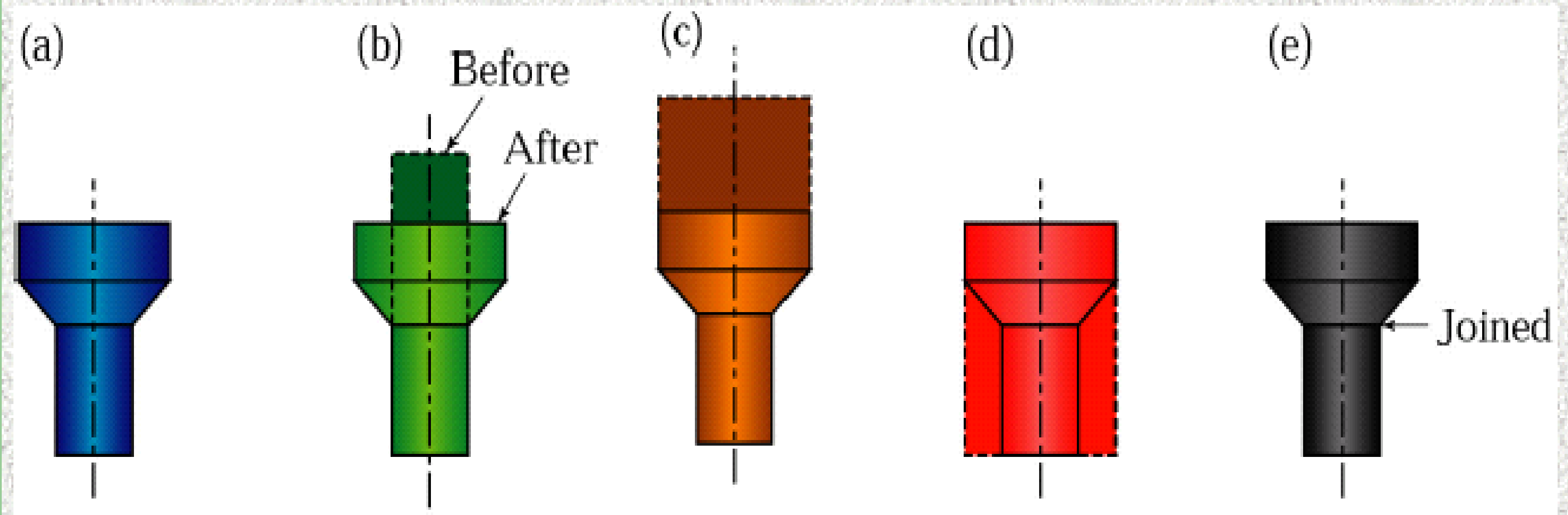


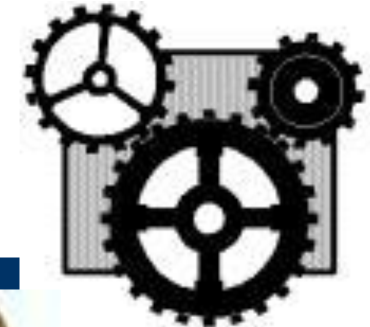
Figure 40.2 Various methods of making a simple part: (a) casting or powder metallurgy, (b) forging or upsetting, (c) extrusion, (d) machining, (e) joining two pieces.

Manufacturing Costs and Cost Reduction

- Material cost
- Tooling cost
- Fixed cost
- Capital costs
- Direct/indirect labor costs

- Manufacturing costs and production quantity
- Cost reduction

Tooling Costs



Boring mill	M-H
Deep Drawing	M-H
Extrusion Press	M-H
Gear Shaping	L
Milling	L-M
Roll Forming	L-M
Sand Casting	L-M

L: low; M: medium; H: high; VH: very high

Fixed Costs

- Electric power
- Fuel
- Taxes on real estate
- Rent
- Insurance
- Capital

** Not sensitive to production volume!

Capital Costs

- Investment in buildings
- Land
- Machinery
- Tooling
- Equipment

Direct and Indirect Labor Costs

- Direct Labor Cost

  * Includes all labor from the time the raw materials are first handled to the time when the product is finished.

- Indirect Labor Cost

  * Includes the servicing of the total manufacturing operation.

Cost Reduction

Design	5%
Material	50%
Direct Labor	15%
Overhead	30%

ELECTRIC MOTOR

Value Analysis

- A really cool system that evaluates each step in design, materials, processes, and operations in order to manufacture a product that performs all of its intended functions at the lowest cost!!

$$\text{Value} = \frac{\text{(Product function and performance)}}{\text{Product Cost}}$$

Value Analysis Phases

1. Information Phase
2. Analysis Phase
3. Creative Phase
4. Evaluation Phase
5. Implementation Phase
6. Review Phase

Work-Cited

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