330:135g Design for Manufacturing

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1. Why study the Design process?

- There are many designs
- Products are becoming more complex
- Needs design teams to completely design a product
- Identify tools to be used in the designing process

Variables in engineering process

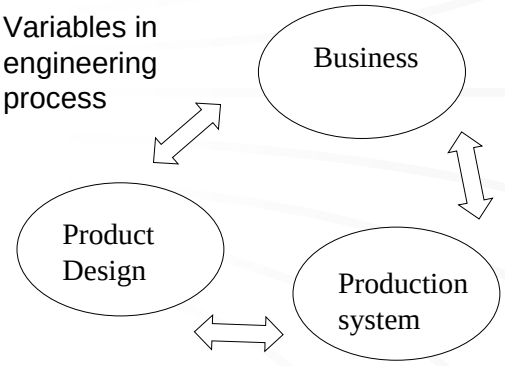
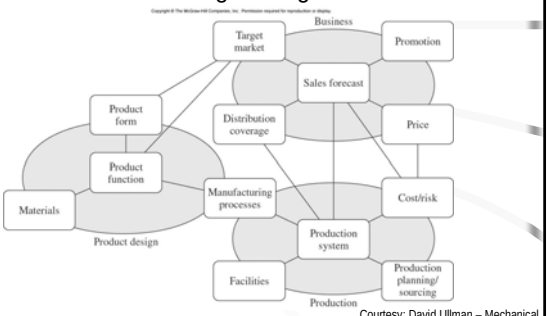


Fig. 1-1 Controllable variables in concurrent engineering



Courtesy: David Ullman – Mechanical Design Process, McGraw Hill, 2003

Measuring the design process

- Measure of effectiveness of a design process
  - Product cost
  - Product quality
  - Time to market

Fig. 1-2 Design cost as fraction of manufacturing cost

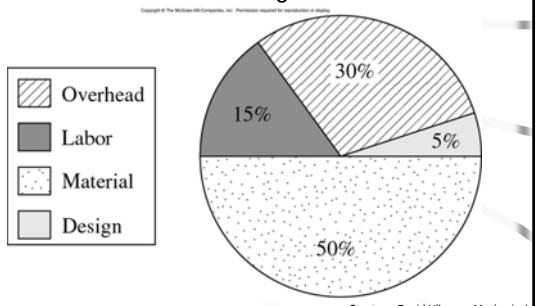


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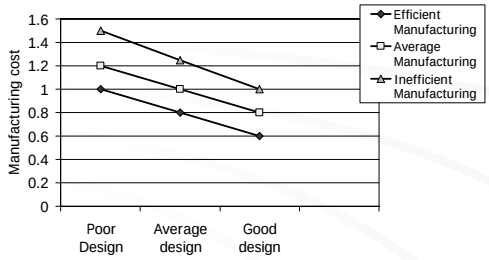
Fig. 1-3 The effect of design on manufacturing cost (18 coffee makers analyzed)



Courtesy: David Ullman – Mechanical Design Process, McGraw Hill, 2003

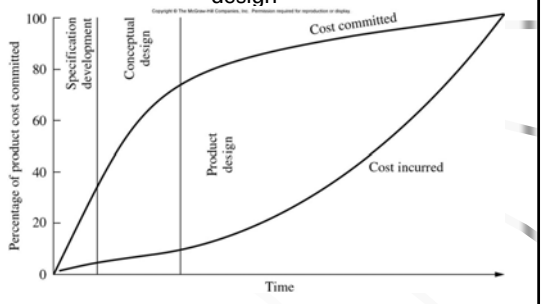
Design decisions

- Xerox – 50% of the final cost to the results of the design process
- Design decisions influence
  - Materials used
  - Goods purchased
  - The parts
  - The shape of those parts
  - The products sold
  - The price of the product, and
  - The sales

Measuring the design process

- Product cost is committed early in the design process and spent late in the process

Fig. 1-4 Manufacturing cost commitment during design



Courtesy: David Ullman – Mechanical Design Process, McGraw Hill, 2003

Product Quality

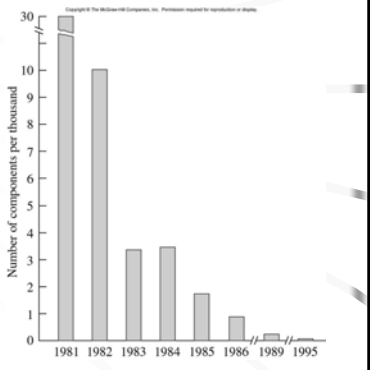
- Quality cannot be manufactured into a product unless is designed into it.

American Consumer survey on product quality
(What determines quality?)

	Essential	Not essential	Not sure
Work as it should	98	1	1
Lasts a long time	95	3	2
Is easy to maintain	93	6	1
Looks attractive	58	39	3
Incorporates latest technology	57	39	4
Has many features	48	47	5

Fig. 1-5 Line fallout at Xerox

Number of components that do not fit together during assembly (in comparison to Japanese manufacturers)



Courtesy: David Ullman – Mechanical Design Process, McGraw Hill, 2003

Fig. 1-6 Engineering changes during automobile development

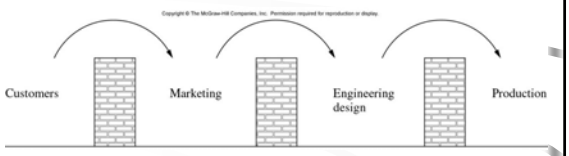
Japanese and American companies in 1980's

Courtesy: David Ullman – Mechanical Design Process, McGraw Hill, 2003

History of the design process

- The design process is the organization and management of people and the information they develop in the evolution of the product.
- Simple product can be designed and manufactured by a single person, if the processes used are simple.
- With complex processes and products, it becomes a necessity that groups of people work on a design project.

Fig. 1-7 The over the wall design method



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Key features of Concurrent Engineering

- Focus on the entire product life
- Use and support of design teams
- Realizations that processes are as important as product
- Attention to planning for information-centered tasks
- Careful product requirements development
- Encouragement of multiple concept generation and evaluation

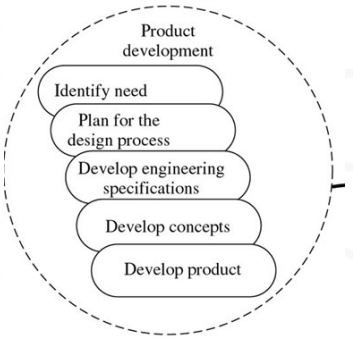
Key features of Concurrent Engineering (contd..)

- Awareness of the decision making process
- Attention to designing in quality during every phase of the design process
- Concurrent development of product and manufacturing process
- Emphasis on communication of the right information to the right people at the right time.

Concurrent Engineering

- Key point of the concurrent engineering is a concern for information.
- Drawings, plans, concept sketches, and meeting notes all provide information that must be shared with the right people at the right time.

Fig. 1-8 The life of a product



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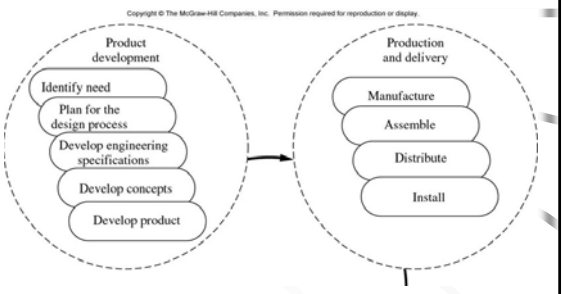

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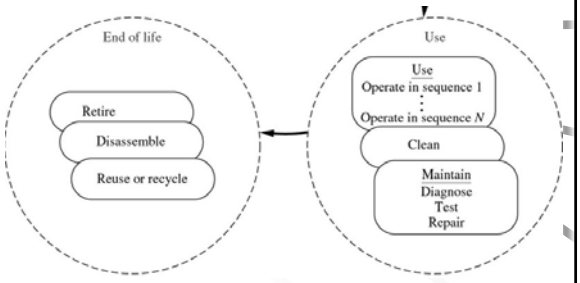

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Many solutions

- Design problem:
  - What size SAE grade 5 bolt should be used to fasten together two pieces of 1045 sheet steel, each 4 mm thick and 60 mm wide, which are lapped over each other and loaded with 100 N?

Many solutions

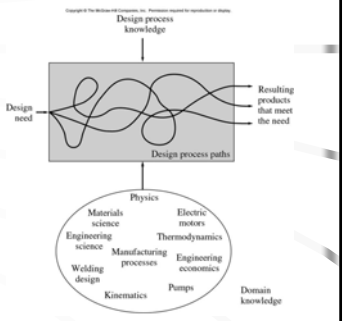
- Design problem:
  - Design a joint to fasten together two pieces of 1045 sheet steel, each 4 mm thick and 60 mm wide, which are lapped over each other and loaded with 100 N?
- Questions to be asked to understand the problem
  - Will the joint require disassembly?
  - Will it be used at high temperatures?
  - What tools are available for making the joint?
  - What skill levels do the joint makers have?

Fig. 1-9 A simple lap joint

Courtesy: David Ullman – Mechanical Design Process, McGraw Hill, 2003

- Design problems have many satisfactory solutions and no clear best solution

Fig. 1-10 The many results of the design process



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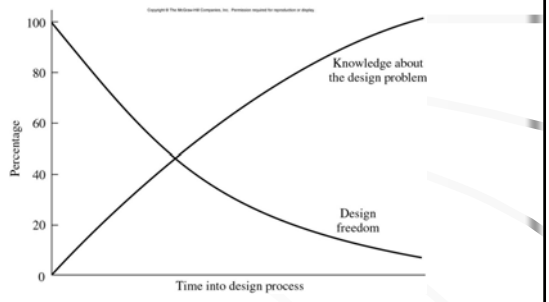
Problem Solving

- Establish the need or realize that there is a problem to be solved
- Plan how to solve the problem
- Understand the problem by developing requirements and uncovering existing solutions for similar problems
- Generate alternative solutions
- Evaluate the alternatives by comparing them to the design requirements and to each other
- Decide on acceptable solution
- Communicate the results

Knowledge and learning during design

- In the beginning not much is known about the solution
- As the design progresses, designer understand the technologies and therefore knows more alternative solutions
- But may not have freedom to change the design since resources are already committed.

Fig. 1-11 The design process paradox



Courtesy: David Ullman – Mechanical Design Process, McGraw Hill, 2003

- The more you learn the less freedom you have to choose what you know.
- The goal during the design process is to learn as much about the evolving product as early as possible in the design process, because during the early phases changes are least expensive.

Summary

- During the design process, product cost is committed early and spent late.
- The design process not only gives birth to a product but is also responsible for its life and death.
- Design problems have many satisfactory solutions and no clear best solution.
- The more you learn, the less freedom you have to use what you know.

Questions and Comments