

# CH 19

## Design

### Definitions of Design

Wh...neers d...  
s to la...encies

### Short Activity

- ▶ Take out a sheet of paper.
- A customer has approached us and asked us to produce a design for a chair for their son.

### Involvement

- ▶ Design activities always include at least three stakeholders:
- The **CLIENT**
- The **USER**
- The **DESIGNER**

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    graph TD
      Client([Client]) <--> Designer([Designer])
      Client <--> User([User])
      Designer <--> User
    
```

### Designer

- ▶ Nature of work depends on two types of design

1. **Conceptual Design**  
Design stage where basic questions of form and content for the design are established, including the nature of the goals of the designed item

### Designer

- ▶ Nature of work depends on two types of design
- 2. **Detailed Design**
  - Design stage after conceptual design (and after preliminary or embodiment design), when specific details particular to the design are resolved.

## Defining

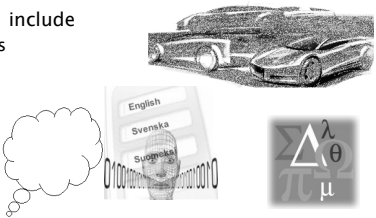
- ▶ Examples of definitions that have been used:
  1. Engineering Design
    - A systematic, intelligent generation of specifications for artifacts whose form and function achieve stated objectives and satisfy specified constraints.
      1. Artifacts: **human-made objects**
      2. Form: **shape of the artifact**
      3. Function: **what the artifact is supposed to do**
      4. Specifications: **descriptions of properties of the object**
      5. Objectives: **attributes of the designed artifact that make it "good"**
      6. Constraints: **specifications which the artifact must meet to be acceptable**

## Defining

- ▶ Examples of definitions that have been used:
  2. Engineering Design
    - The organized thoughtful development and testing of characteristics of new objects that have a particular configuration or perform some desired function(s) that meets our aims without violating any specified limitations.
      - Design is a thoughtful process that can be understood.
      - Design can be aided by the use of formal methods.
      - Communication is a key issue in successful design.

## Design and Engineering Design

- ▶ Nature of design activity includes a studio aspect.....or learning by doing
  - I.e. Project #1, 2, 3, 4, 5
  - "Languages" include
    - Mathematics
    - Sketches
    - Speech
    - Thought



## Problems

- ▶ Open-ended
  - Having more than one acceptable solution
    - Solutions are not usually unique
- ▶ Ill-structured
  - Problems cannot be readily formulated as a mathematics problem, especially as first conceived by clients and users

## History Unveils

- ▶ Engineering Designers have moved from craft (where the designer makes the artifact) to fabrication specifications (where someone else makes the design)
  1. This increases responsibility on designer to communicate properly
  2. It requires a means of managing changes in design

## History Unveils

- ▶ Product design and manufacturing
  - Emphasis on VOLUME of production
    - 1950 - 1970
  - Emphasis on QUALITY during production
    - 1980s - 1990s
  - Today the Emphasis is on **TIME**
    - Shorter development time
    - Integration through design process
    - Computerization
    - Increased flow of communication
    - Concurrent Engineering
    - Team approach rather than departmental
    - Increased flexibility at all levels

### Summation of Definitions

› Involvement in Product Design includes:

- Constant decision-making process
- Problem solving in a sequential fashion
- Analysis of constraints at each step

**New Product = considerable investment in TIME, Effort and Money**

Shetty, Design for Product Success

### Basics of Design

A product life cycle has four phases:

- Identify NEEDS, PLAN and DESIGN
- MANUFACTURE and DELIVER
- USE, MAINTAIN & REPAIR
- RETIRE

### Engineering Designers vs. Industrial Designers

› Engineering Designers

- View design as a process

› Industrial Designers

- View design as a product

› Keep in mind

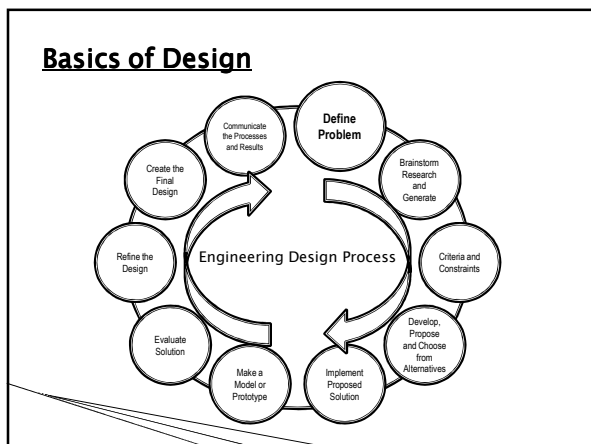
- Design is an **ANSWER** to a problem. The solution can take forms of either products or processes.
- Solution should have a **visible form, shape** and/or **function**

Shetty, Design for Product Success

### Basics of Design

› The design process can be as simple as:

- Identifying the need
- Planning for the design process
- Developing specifications
- Developing a concepts
- Developing products



### Basics of Design

1. Design is the satisfaction of a **need**.
2. Design is never an exact process, and each design will differ.
3. Try to do it right the first time.
4. Most design methods try to cut the problems into smaller problems.

*One of the common problems encountered by designers is the overwhelming number of details.*

### Establishing Design Criteria

- ▶ **Constraints**
  - Factors that affect the outcome of the project and can't be changed
- ▶ **Facts**
  - Listed to help clarify what is known, and what may need to be found out prior to proceeding with the project
- ▶ **Assumptions**
  - Facts or statements that are accepted as true, without doubt.
  - Clarify the assumption in regard to the problem
  - Modify to simplify the problem and make solvable.

### Managing Engineering Design

- ▶ **Management**
  - The "process of achieving organizational goals by engaging in the four major functions of planning, organizing, leading and controlling."
- ▶ **Planning**
  - Setting goals
- ▶ **Organizing**
  - Aligning human and non-human resources
- ▶ **Controlling**
  - Monitoring and regulating

### Problem Statement

- ▶ May contain
  - **Errors** – Incorrect or faulty information or omission of key information
  - **Biases**
    - Presumptions about the problem situation that may prove to be inaccurate or reflect a limited viewpoint of the client
  - **Implied Solutions**
    - Client's idea of how to solve the problem

### Basics of Design

- ▶ Most design methods focus on dealing with detail overload. The challenges a designer faces are,
  - multiple technologies requiring arbitrary decisions
  - a design may have many components that interact, and the effects of changes can be widespread
  - economics
  - other competitive designs

### Expanding Design Space

- ▶ Ideas?!! To Expand the design space!!
  - Thomas Register or benchmarking other products
  - *Thomas Register* is a comprehensive resource for finding information on suppliers of industrial products and services in North America
  - *Benchmarking* is the process of determining who is the very best, who sets the standard, and what that standard is. A process of searching out and studying the best practices that produce superior performance.

### Expanding Design Space


- ▶ Ideas?!! To Expand the design space!!
  - **Patents** (see External Links section on Blackboard)
    - Right to use the designs are limited but such rights can be obtained from the inventor in many cases
  - Two basic kinds of patents
    - *Design patents*
      - Granted on the form or appearance (look and feel) of an idea.
    - *Utility patents*
      - Granted for functions, how to do something or make something happen. Focus is Function not form and feel

## Expanding Design Space

- ▶ Ideas?!! To Expand the design space!!
- ▶ Group Activities
  - Useful in expanding design space by using a number of techniques developed to encourage divergent thinking
  - 6-3-5 method
  - C-sketch method
  - Gallery method

## Front-End Analysis Basics of Design

- ▶ The front-end analysis is one of the most important elements in any design process.
- ▶ It is the tool that helps the designer to understand the user(s), their needs and the demand on the work situation.



## Front-End Analysis Basics of Design

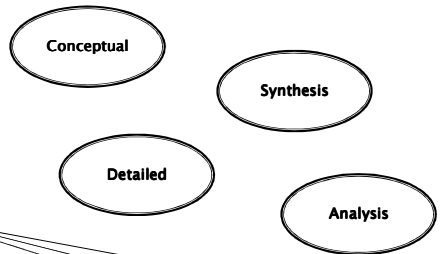
- ▶ All of the front-end analysis tools are not carried out in detail for every project but in general, the designer should be able to answer questions to the following questions before any design solutions are generated:
  - **Who** are the product/system(s) users? *(this doesn't just include the direct user but all people who will maintain, monitor, repair and dispose of the product or system)*
  - **What** are the major functions to be performed by the system, whether by person or machine? What tasks must be performed?
  - **What** are the environmental conditions where the product or system will be used?
  - **What** are the user's preferences or requirements for the product?

## Basics of Design

- ▶ Design factors commonly considered are,
  - functional requirements
  - physical constraints
  - specifications
  - aesthetics
  - usability/user interface
  - cost
  - manufacturing
  - evaluation/testing/analysis
  - maintenance
  - retirement

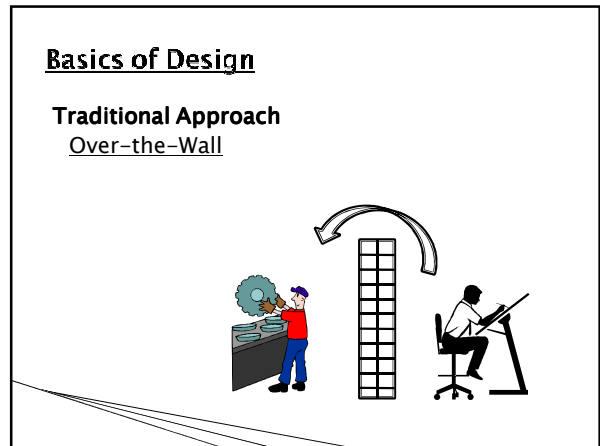
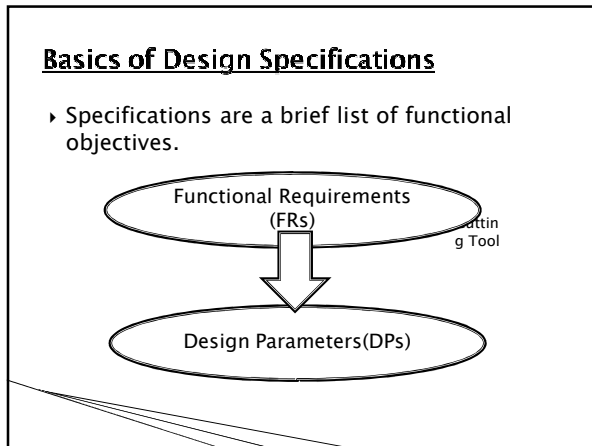
## Basics of Design

Design is typically referred to as having certain stages:



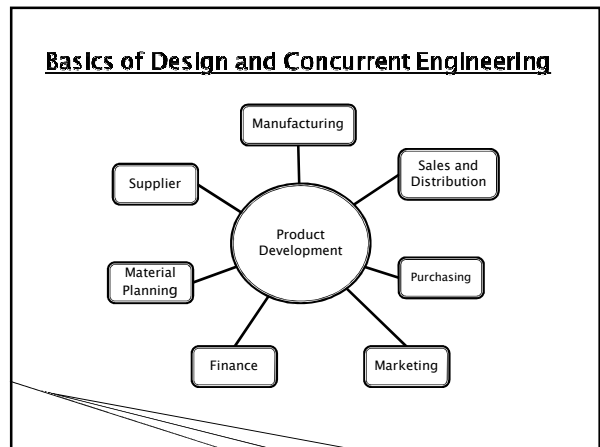
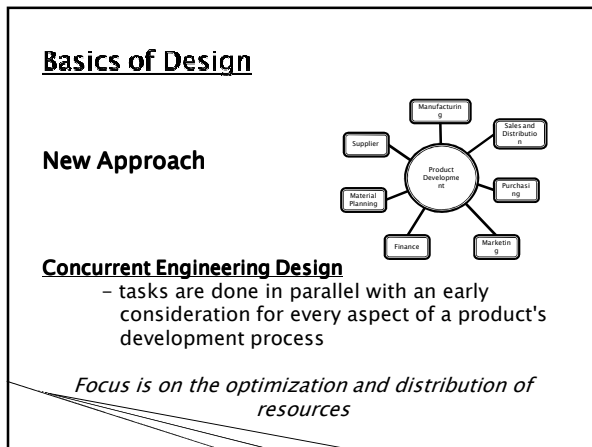
## Basics of Design Stages

- ▶ **Conceptual** - Selecting components to go into a system. At this point, the exact form has not been determined.
- ▶ **Synthesis** - At this point the general geometry, and components for the system are selected.
- ▶ **Detailed** - Exact dimensions are finally assigned to parts in the system.
- ▶ **Analysis** - The review of design details to determine suitability. It is usually done after the final design is submitted and may lead to redesign.



- ### Problems with Over-the-Wall
- The design is driven by scheduled deliverable data items.
  - There is pressure for drawings and specifications, which leads to a depth-first design search.
  - Design alternatives are quickly eliminated in the interest of time, and usually one particular idea is pursued.
  - The definition of design detail is costly in labor hours. Even with CAD/CAM tools, much manual effort is needed.

- ### Problems with Over-the-Wall
- The designer did not always understand the results of his decisions
  - More time was spent trying to get a design to work right
  - The design process is characterized by a rigid sequence of design decisions.
  - The ultimate goal is usually lower cost, when the goals should include optimal performance and ease of manufacture.



**Basics of Design and Concurrent Engineering**

- ▶ A few goals of concurrent engineering:  
*Attempt to avoid component features that are unnecessarily expensive to produce.*
- Minimize Material Costs, and better selection of materials.*
- Attempt to reduce redundancy and increase efficiency of time to market.*

**Basics of Design and Teams**

- All of these roles are important in a successful design.
- ▶ Marketing/Product manager – makes major market/customer decisions
  - ▶ Design Engineer – makes major technical decisions and assesses the results
  - ▶ Manufacturing engineer – makes decisions about producing the product
  - ▶ Designer/Engineer – does detailed design work

**Basics of Design and Teams**

- ▶ Quality control engineer – evaluates quality problems and opportunities
- ▶ Materials specialist – selects materials
- ▶ Industrial designer – makes aesthetic decisions
- ▶ Drafter – completes drawings of parts
- ▶ Technician – builds, tests, evaluates product
- ▶ Vendor/Supplier Representative – product manager from another company

**Basics of Design**

- Milestones set by management:
- set specifications
  - generate concepts
  - test concepts with prototype/simulation
  - do detailed design
  - build full prototype
  - test and evaluate prototype
  - plan for tooling and production
  - test runs
  - full runs

**Basics of Design – Conclusion**

1. Determine the need
  - a. Usually defined by customer or user
2. Work the Design through a Design Process Plan
  - a. Develop the overall design through the stages
    - i. Conceptual, Synthesis, Detailed and Analysis
3. Determine Specifications
4. Work concurrently
  - a. Use the resources of the team