Lecture 2.
An Overview of Engineering Design

JANUARY 2016
Importance of Engineering Design

- **70%** of a product’s total cost (design, manufacturing and installation) is determined by its design.

- Studies have shown that **50 to 80%** of the life cycle costs of products (maintenance, energy, etc.) are influenced by engineering design.

**Costs Include:**
- Material costs
- Facilities
- Tooling
- Labor
- Other support costs
What is Engineering Design?

• Engineering design is the **process** of devising a system, component or process to meet desired needs.

• In this process, basic sciences and engineering are applied to optimally convert resources to meet a stated objective.

• Among the fundamental blocks of this process are: **objectives**, **criteria**, **synthesis**, **analysis**, **construction**, **testing**, and **evaluation**.

• In addition to these blocks, it is essential to consider realistic **constraints** such as economic factors, safety, reliability, aesthetics, ethics and social factors.
An ABET Requirement
(Accreditation Board for Engineering and Technology)

• Every Engineering Department must include a major engineering design experience that builds upon the fundamental concepts of: mathematics, basic sciences, humanities, social sciences, engineering topics, and communication skills

• The scope of the design experience within a program should match the requirements of practice within that discipline

• All design work should not be done in isolation by individual students; team efforts are encouraged where appropriate
The Design Process Steps

1. Define the Problem
2. Brainstorm for creative ideas
3. Search and research
4. Develop Ideas
5. Analyze alternative solutions and choose the best one
6. Model or prototype
7. Test and Evaluate
8. Improve if needed
9. Communicate results
Problem Statement

• This is the single most important step in the design process
• Only when you can specify the problem can you hope to achieve your goal
• Loss of efforts and efficiency occurs when trying to solve unclear problems
• If this step is done incorrectly or incompletely it results in a failure of the design.
• It is important to define the true problem one is solving, not just the symptoms of the problem or the perceived problem.

Objectives

• Objectives are a function of needs
• Objectives should be **SMART**
  - **Specific**
  - **Measurable**
  - **Achievable**
  - **Realistic**
  - **Time-bounded**
Step 1: Problem Statement

Problem Statement:
“The current box is easily damaged during transportation”

Objective
“Design a stronger box for our new product”
Another Objective
“Design an improved box”

Importance of Accurate objective and statement

- Problem Definition
- Design
- Installation
- Customer Need
Step 2: Brainstorming

• Think outside the box
• Generate creative ideas
• Explore other members’ ideas
• Avoid criticism/judgment

(do not criticize during brainstorming!
Criticism will be applied at a later stage)
Step 3: Search and Research

- **Search**: for finding a product or checking the price of an item
- **Research**: finding the answers to more complicated questions or looking at multiple aspects of an issue

- Possible resources: Publications, Internet, Market, Patent listings, Sales catalogs, Experts
Step 4: List and Evaluate Alternative Solutions

• Be critical
• Edison: “It is easy to obtain 100 patents if you also have 5000 unsuccessful inventions”
## Step 5: Choose the Best Solution

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<th>Rate for Design 1</th>
<th>Rate for Design 2</th>
<th>Rate for Design 3</th>
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<td><strong>Production difficulty</strong></td>
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Step 6: Construction, Analysis and Testing

An Iterative process

Step 7: Final Evaluation

Develop the best design
Step 8: Communication

Communicate and report on all the final details of the design through:

- Engineering Notebook (logbook)
- Written reports
- Technical presentation
- Training material, catalogue, manuals