The Engineering Design Process (Chapter 1)
Chapter 1 – Learning Objectives

By the end of this chapter, you should:

- Understand what is meant by engineering design.
- Understand the phases of the engineering design process.
- Be familiar with the attributes of successful engineers.
- Understand the objectives of this book.
ABET Definition of Engineering Design

Engineering design is the process of devising a system, component, or process to meet desired needs. It is a decision-making process (often iterative), in which the basic sciences, mathematics, and engineering sciences are applied to convert resources optimally to meet a stated objective. Among the fundamental elements of the design process are the establishment of objectives and criteria, synthesis, analysis, construction, testing, and evaluation. [ABET]
Solar and wind energy resources

On the roof of Workman!!

Wind power
by Farhad Foroutanian
Engineering Design Processes

What are design processes?

- Embody the steps required to take an idea from concept to realization of the final system, and are problem-solving methodologies that aim to develop a system that best meets the customer’s need within given constraints.

- Different methodologies or design processes are applied in different projects. Two design processes are: Prescriptive and Descriptive.
Why use design processes?

The design processes are sometimes viewed as common sense and thus ignored, resulting in failed products. There are two good reasons to adhere to design processes:

- They formalize thought processes to ensure good practices are followed.
- They keep all members of the team synchronized in terms of understanding where they are in the design process.
General types of design processes

Prescriptive

- An exact process, or systematic recipe, for realizing a system. Prescriptive design processes are often algorithmic in nature and expressed on flow charts with decision logic.

Descriptive

- Less formal, describing typical activities involved in realizing designs with less emphasis on exact sequencing.
A Prescriptive Process

1. Identify Problem & Needs
2. Determine Requirements
3. Do requirements satisfy needs?
   - Yes
   - No
A Descriptive Process
Elements of the Design Process

Problem identification
- Identify the problem and customer needs.

Research phase
- The team conducts research on the basic engineering, related technologies, and existing solutions.

Requirements specification
- Articulates what the system must do for it to be successful and to be accepted by the customer.
Elements of the Design Process

Concept generation
- Many possible solutions to the problem are developed.

Design phase
- The team iteratively develops a technical solution, ultimately producing a detailed system design.

Prototyping and construction phase
- Different elements of the system are constructed and tested.
Elements of the Design Process

System integration
- All of the subsystems are brought together to produce a complete working system.

Test phase
- The overall system is tested to demonstrate it meets the requirements.

Maintenance phase
- The system is maintained, upgraded to add new functionality, or design problems are corrected.
VLSI Design Process

Is this prescriptive or descriptive?
Embedded Systems Design Process

Prescriptive or descriptive?
Waterfall Software Development

Prescriptive or descriptive?
The world-Class Engineer

The ability to effectively design is important for engineers, requiring strong technical skills and an understanding of the design process.

The characteristics of a successful engineer are:

I. Aware of the World – Sensitive to cultural differences, environmental concerns, and ethical principles.

II. Solidly Grounded – Thoroughly trained in the fundamentals of engineering. Has a historical prospective and remains aware of advances in science.
The world-Class Engineer

III. Technically Broad – Understands that real-life problems are multidisciplinary. Is conversant in several disciplines.

IV. Effective in Group Operations – Cooperative in an organization of individuals working toward a common creative goal. Effective in written and oral communication.

V. Versatile – Innovative in the development of products and services. Sees engineering as applicable to problem solving in general.
The world-Class Engineer

VI. Customer Oriented. – Realizes that finding and satisfying customers is the only guarantee of business success. Understands that products and services must excel in the test of cost-effectiveness in the global marketplace.
Design Processes – WHO CARES?

What is the value of the design process?

How much does it cost to correct problems as process proceeds?
Cost to Implement Changes

Cost to implement changes

Project lifetime
Other material in the Chapter

- Penn State World-Class Engineer Description.
- Overview of the book.
1.4 Summary

- Engineering design is an iterative process.
- Design problems are open-ended with many potential solutions.
- Design processes represent best practices for realizing a system.
- Design processes may be prescriptive or descriptive.