

EENG 4910/4990

Engineering Design



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Engineering Design Process

- *En-gi-neer(n): 1. One versed in the design, construction and use of machines.*
 - *2. One who employs the innovative and methodological application of scientific knowledge and technology to produce a device, system, or process, which is intended to satisfy human needs.*
- *American College Dictionary*

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.
- *Definition of Engineering Design by ABET Inc. (formerly known as Accreditation Board for Engineering and Technology).*

ABET Engineering Criteria

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Overview of Design

- In a perfect world, the steps of design include:
- Problem identification
- Research
- Requirements specification
- Concept generation
- Design
- Prototype
- System integration
- Test
- Maintenance and upgrading

Problem Identification

- What are you trying to do – articulate your goals
- How is it done today – limitation of present methods
- What is new in your approach – would it succeed?
- If successful, what difference does it make?
- What risks? What payoffs?
- How much will it cost? How long will it take?
- How do you check progress? (similar to midterm and final)
- How do you check if performance criteria is met?

Design Thinking - I

- Understand desired properties of *requirements* and know how to state them.
- Understand requirements applicable to EE systems
- Engineering requirements/performance requirements
- Constraints
- Standards
- Resources and current practices

Design Thinking - II

- Constraints – economic, environmental, ethical and legal, health and safety, manufacturability, political, social, sustainable etc.
- Standards – safety, testing, reliability, communications, data formats, documentation, design methods, programming languages, connectors
- Concepts – knowledge gained through studying mathematics, science, engineering science, and EE topics
- Methods – analog/ digital/software/subsystem/system/nonelectronic
- Much of the information comes in bits and pieces
- You have to develop a bigger scheme in using the pieces to solve major design problem

Use Creativity

- Have a questioning attitude
- Practice being creative
- Suspend judgment (have an open and flexible mind)
- Allow incubation time
- Think like a beginner
- Substitute/combine/modify/eliminate/reverse
- All ideas are recorded
- Avoid barriers –
perceptual/emotional/environmental/intellectual

Decision-making

- By Authority
- Expert member
- Average member opinion
- By authority after discussion
- Consensus
- Assign tasks
- Respect other opinions
- Manage conflicts
- **If you fail to plan, you plan to fail**
- Document, document, document
- Present ideas repeatedly to peers

Continuum of engineering tasks

- Initiation of task – idea, request, market needs
- Design – concept, requirements, preliminary design, performance, preliminary analysis
- Detailed analysis, simulation/prototyping
- Specification for materials and components
- Construction
- Quality control, testing
- Maintenance
- Upgrade
- Rebuilding/recycle