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What is "Engineering Design"?

ABET (the accreditation board for engineering) in Criterion 5 (Curriculum) defines engineering design as follows:

> *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 the engineering sciences are applied to convert resources optimally to meet these stated needs.*

Fundamental elements of the design process include:

- the establishment of objectives and criteria,
- synthesis,
- analysis,
- construction,
- testing
- evaluation

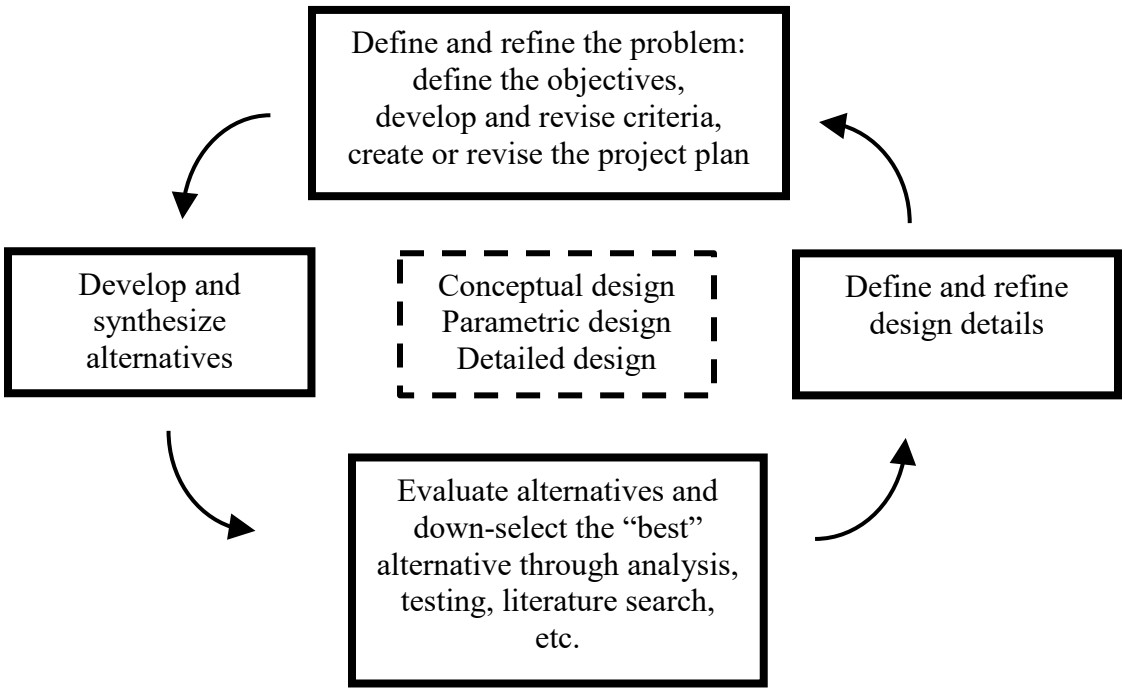
The engineering design should include the following:

- creativity
- solving open-ended problems
- use of modern design methodology
- formulation of design problem statements and specification
- consideration of alternative solutions
- feasibility considerations
- production processes
- concurrent engineering design
- detailed system description.

Through the capstone design project, students should demonstrate *an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.*

What are steps in "*the design process*"?

Engineering projects maybe broken into several distinct phases – although in reality, the phases overlap or may be different altogether. It is ***rarely a linear*** process – it is iterative in nature. Each design project is unique – there is no one process to follow for design. In general, the design process can be described as: Define the problem (which includes establishing objectives and criteria, and developing a plan), develop alternatives (by synthesizing math, science and engineering knowledge), evaluate the alternatives (through testing, analysis, literature search, etc.) and selecting the best alternative based on how well it satisfies the criteria. This process starts with conceptual design and proceeds to ever more refined details until the finished product or design has been completed.



A flow diagram for engineering design.

The flow diagram shows the overall essence of the design process, however there are several different approaches. Two general approaches are:

- Traditional – relatively linear approach with minimal overall project iterations. This works well for modifications to existing products where the challenges and obstacles of a successful design are well understood from the onset.
- Rapid Learning – in the software world, a widely used rapid learning process is referred to as "Agile development". It has been very successful in software development, but is not directly implementable in mechanical design. However, "rapid learning cycles" and "scrum" are similar to Agile, and are successfully used in mechanical design. These are highly iterative process where learning is achieved in small steps – perhaps through testing of prototypes. It is especially effective when designing something relatively new where the challenges and obstacles may not be well understood or known at the onset.