INTRODUCTION TO DESIGN

What is Engineering?

- Definitions: Salt p2 (several definitions from different sources), Kemper p207, 208 (also has differentiation between scientists and engineers)
- Summary: "Application of scientific knowledge (especially the physical sciences) to solve problems"

What do engineers do?

- Rephrasing the definition above, they facilitate the solving of problems by applying scientific knowledge within their area of expertise.
- This can also be considered design, which is, in effect, almost everything that engineers do. This "facilitating" may also involve the application of a wide variety of skills gained from training, experience etc., and not just technical (e.g. project management)
- In a broad sense, the process of facilitating this journey from recognizing a problem to implementing a solution can be called **design**, and is a very common role for an engineer.

Problem

⇒perceived need, desire

⇒ role of the engineer (ref: Fig 1.1)⇒

Solution

⇒ product, process, system, program, report…

Design Process (ref: Fig 2.1)

Objective: to get from *problem* to *solution*

Major stages:

Define the problem (Question: What is the problem….really? N.B. Not the *solution!*)

Two main steps:

1. Find out what the "customer" really wants / needs
    a. How? investigation, research, questions, interviews, "needs assessment'
    b. Output: Problem Statement (Definition) - in the customer's language!
2. Describe the problem in detailed technical terms
    a. How? block diagrams, defining inputs & outputs (interfaces)
    b. Output: Requirements Specification - should also include the criteria that can be used to determine if the problem is really solved i.e. Test Plan

Find a Solution (generate an acceptable strategy (plan) to solve the problem)

Main steps:

1. conceive a possible solution (or number of solutions) (synthesize)
2. look at them a bit closer to see if they will work or if they need to be modified so that they will actually solve the problem (analyze)

(re: definitions of analysis, synthesis in Salt ~ p9)

3. decide which approach(s) to follow, usually by applying some number of "goodness" criteria to help determine which possible solution best solves the problem (with all its conditions or restrictions)

Output: System Specification (tells how the proposed solution will work)

Work out the Details (do all the fine calculations, investigations, prototyping etc.)
Output: Detailed Design Document

Implementation: (the Solution!)
Actually build and debug etc. May not be required in all circumstances - it may be passed on to another individual or organization (thus the need for complete and effective documentation).

Design Methodologies

Two "extremes to consider (ref: game show example 2.2, salt p15):

1) Synthesize a solution and take it through to implementation and then check to see if it is acceptable (or optimum). If it is not, repeat the process until the stakeholders are satisfied with the solution.
2) Synthesize a very large number of possible solutions, analyze them in as much detail as possible to select the best one and then complete a detailed design and implementation of that one (Note: doesn't guarantee that the selected one will definitely work or be the optimum, just improves the probability!)

Many variations of design methodologies are somewhere between the extremes. The objective is always to improve the efficiency of the design process by making more effective use of time and resources. Which method is best depends on the situation (i.e. many variables!)

Practically speaking, most design methodologies include varying amount of iteration either be design or by default. (ref: Fig 2.6, Salt p22)