King Fahd University for Petroleum and Minerals

Mechanical Engineering Department

Design

Senior Design Project
ME415

WHAT IS DESIGN ?

Design establishes and defines solutions to pertinent structures for problems that have not been solved, or solved in a different way.

Analysis and Synthesis

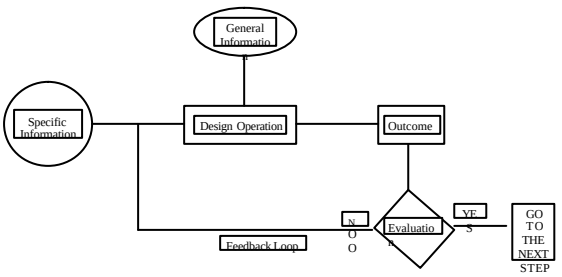
Typically we approach complex problems, like design, by ***decomposing*** the problem into manageable parts.

- Parts performance in service must be understood, therefore, we must study the parts behavior by using the appropriate discipline of engineering science as well as the necessary computational tools. This is called ***ANALYSIS.*** It usually involves the simplification of the real world problems through models.
- ***SYNTHESIS*** involves the identification of design elements that will comprise the product, its decomposition into parts, and the combination of the part solutions into a total workable system

The Four C's of Design

- **Creativity :** Requires creation of something that has not existed before or not existed in the designer's mind before.
- **Complexity:** Requires decisions on many variables and parameters.
- **Choice:** Requires making choices between many possible solutions at all levels, from basic concepts to smallest detail of shape.
- **Compromise:** Requires balancing multiple and sometimes conflicting requirements.

The Design Process- A Simplified Approach



Definition of the Problem

- The most critical step in the solution of a problem is the problem definition.
- The true problem is not always what seems at first glance.
- Because this step seemingly requires such a small part of the total time to reach a solution, its importance is often overlooked.
- The formulation of the problem should start by writing down ***a problem statement.***
- This document should express as specifically as possible what the problem is.
- It should include objectives and goals, the current state of affairs and the desired state, any constraints placed on the solution of the problem, and the definition of any special technical term.

Gathering Information

- Technical reports published as a result of governmental-sponsored R &D, company reports, trade journals, patents, catalogs, handbooks, literature published by vendors and suppliers of material and equipment are important sources of information in addition to textbooks and articles published in scholarly technical journals which is usually of less importance.
- The internet is becoming a very useful resource.
- Often the missing piece of information can be supplied by a telephone call or an e-mail to a key supplier.
- Discussions with in-house experts (often in the corporate R&D center) and outside consultant may prove helpful.

How to Obtain Info

- What do I need to find out?
- Where can I find it and how can I get it?
- How credible and accurate is the information?
- How should the information be interpreted for my specific need?
- When do I have enough information?
- What decisions result from the information?

Generation of Alternative Solutions

- Generating alternative solutions involves the use of creativity simulation methods, the application of physical principles and qualitative reasoning, and ability to find and use information.
- Experience helps greatly in this task.
- The ability to generate high-quality alternative solutions is vital to a successful design.

Evaluation of Alternatives

- **The evaluation of alternatives involves systematic methods for selecting the best among several designs, often in the face of incomplete information.**
- **Engineering analysis procedures provide the basis for making decisions about service performance.**
- **Cost estimation and design for manufacturing analyses provide other important information.**
- **Simulation of performance with computer models is finding wide usage. Simulated service testing of an experimental model and testing of full-sized prototypes often provide critical data.**
- **Without this quantitative information it is impossible to make valid evaluation.**
- **An important consideration at every step in the design, but especially as the design nears completion, is checking. In general, there are two types of checking that can be made: mathematical check and engineering-sense checks.**

- **Mathematical checks** are concerned with checking the arithmetic and the equations used in the analytical model. Incidentally, the frequency of careless math errors is a good reason why you should adopt the practice of making all your design calculations in a bound notebook. In that way you will not miss any vital calculation when you go back and check things out.
- **Engineering-sense checks** have to do with whether the answers " feel right". Even though the reliability of your feeling of rightness increases with experience, you can now develop the habit of staring at your answer for a full minute, rather than rushing on to do the next calculation.

Communication of the Results

- It must be always kept in mind that the purpose of design is to satisfy the needs of a customer or client. Therefore, the finalized design must be properly communicated, or it may lose much of its impact or significance.
- The communication is usually by oral presentation to the sponsor as well as by a written design report. A recent survey showed that design engineers spent 60 % of their time in discussing design and preparing written documentation of designs, while only 40 % of the time is spent in analyzing designs and doing the design.
- Detailed engineering drawings, computer programs, and working models are frequently part of the "deliverables" to the customer. It hardly needs to be emphasized that communication is not a one-time occurrence to be carried out at the end of the project. In a well-run design project there is continual oral and written dialog between the project manager and the customer.