KING FAHD UNIVERSITY OF PETROLEUM & MINERALS
ELECTRICAL ENGINEERING DEPARTMENT

EE 411	Engineering Design	Handout # 2

DESIGN OVERVIEW

Engineering design is the creative process of identifying needs and then creating a design to fill those needs (product). As shown in Figure 1, engineering design is the central activity in meeting needs. If you understand the requirements involved, then you can develop a creative design to satisfy them.

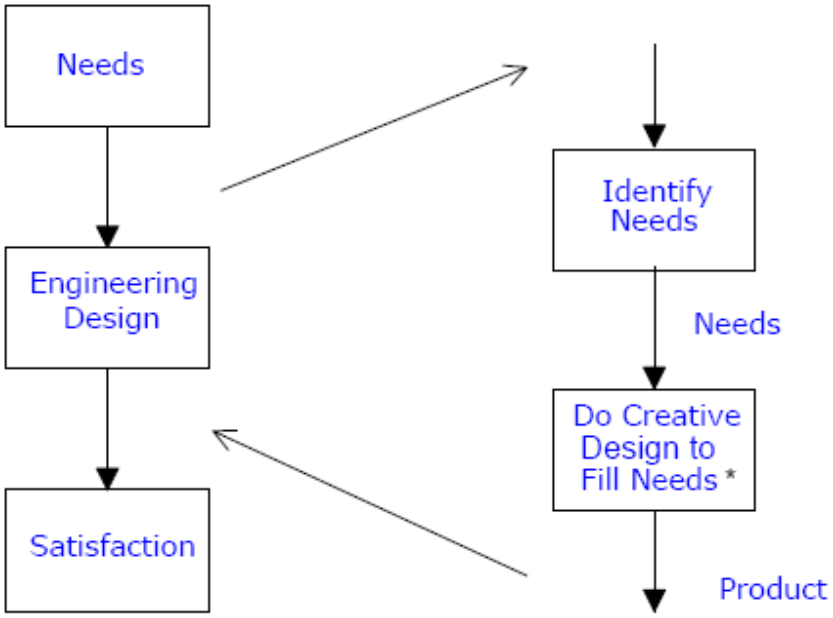

Figure 1

The creative design process involves making a:

- project plan
  1. outlining the various needs and reducing them to a set of specifications.
  2. identifying the various tasks and when to do them
- project implementation: designing and developing the final

The project plan is a non technical document and can be easily summarized and put in the form of a proposal, which is used to communicate the design plan to others. The project implementation, on the other hand, is a technical document that involves specifications, hardware and software design and development, documentation, prototype construction, and testing. Both parts of the creative design process require problem solving. Figure 2 shows the two parts of the creative design process.

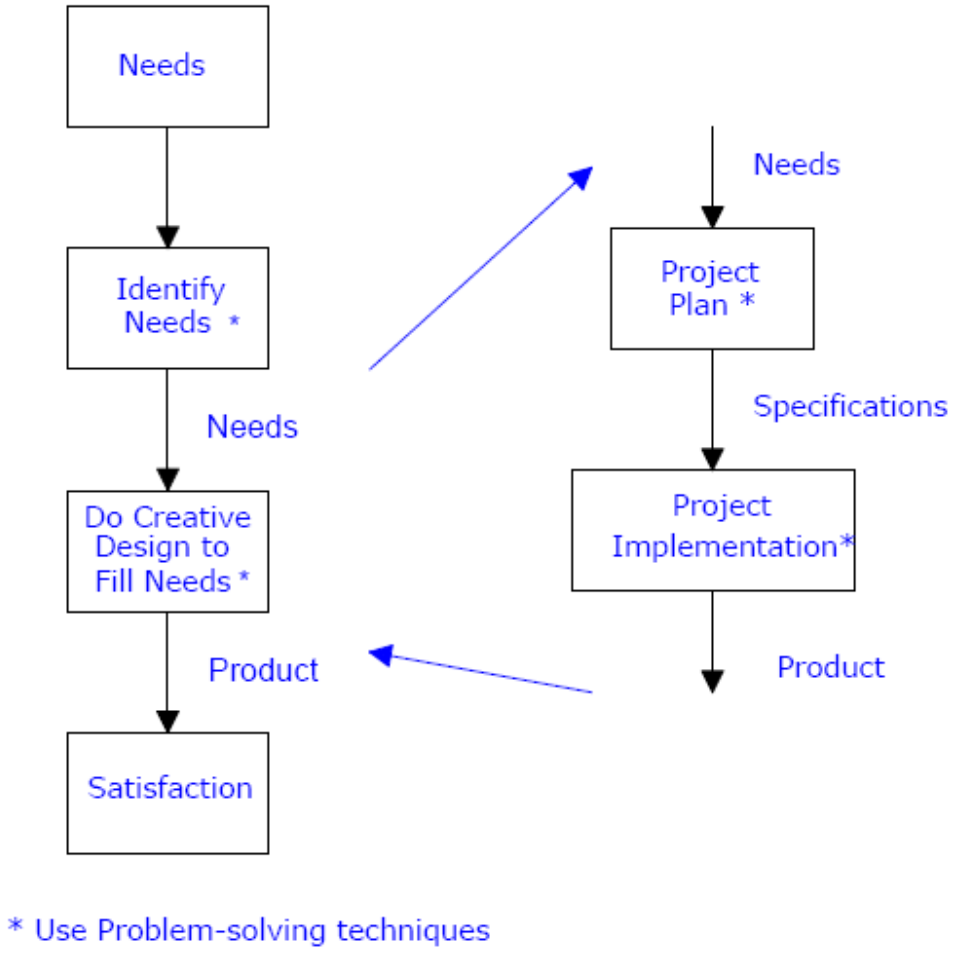

Figure 2

PROBLEM SOLVING

Problem solving is the process of determining the best possible action to take in a given situation. An outline of a problem-solving method suitable for engineering design is shown in Figure 3. This method can be used in working through both the project plan and the project implementation. The general problem-solving activities of analysis, synthesis, evaluation, decision making, and action are the essence of engineering design.

PROJECT PLANNING

The project plan outlines the various needs and reduces them to a set of specifications. It also helps you to identify and schedule the various tasks. Figure 4 presents a general outline of steps to follow when planning a project.

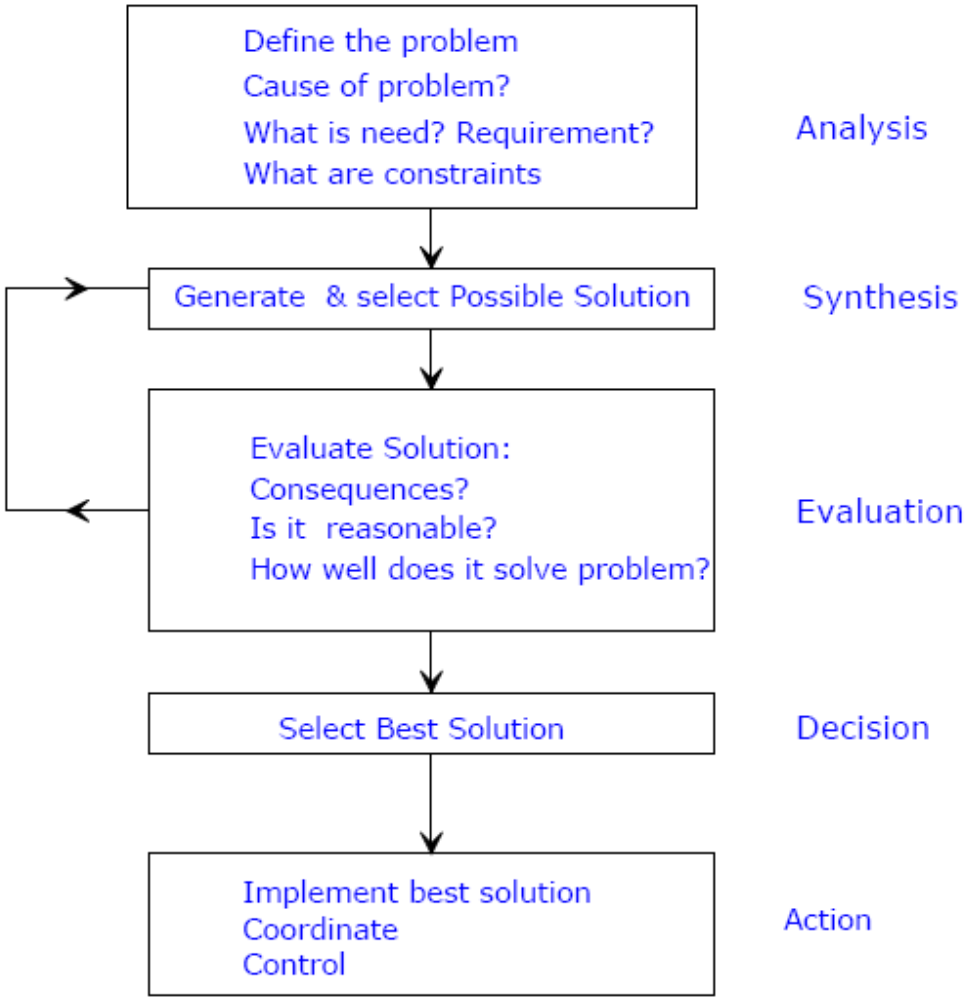

Figure 3

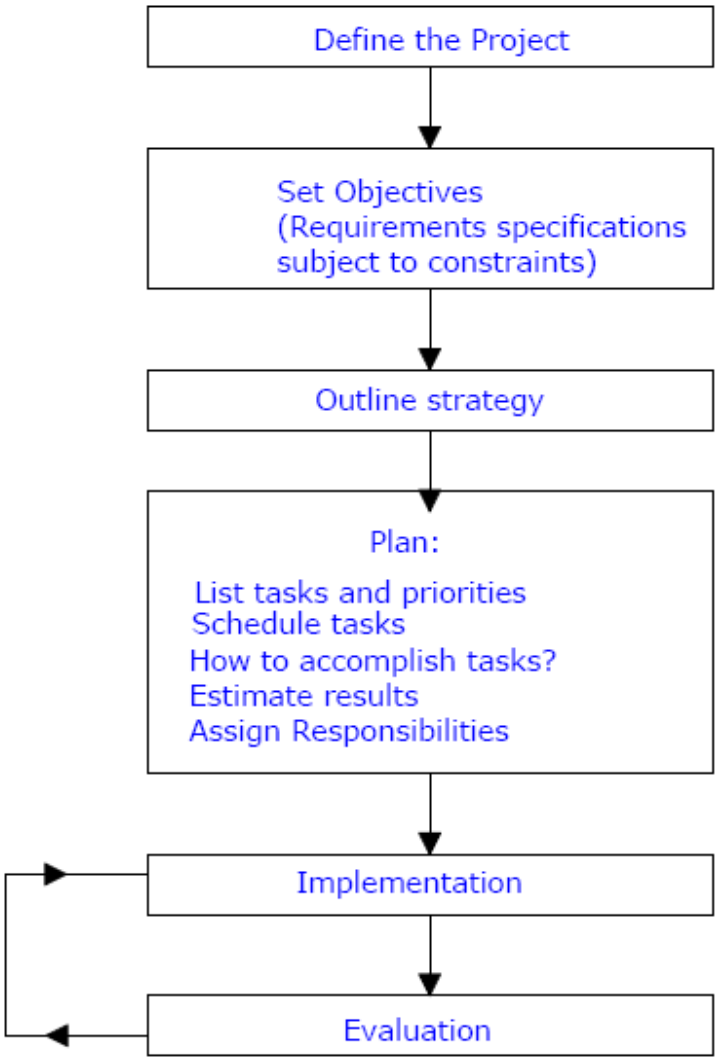

Figure 4

EXAMPLE: Temperature monitor

The **project definition** is to design, build, and test a meter that you can use to measure and record air temperature.
The **project objectives** are:

- Temperature range -40 to $+100)\,C$
- Accurate to within $1)C$
- Display either Fahrenheit or Celsius temperature
- Calculate minimum and maximum temperatures during last 24 hours
- Calculate and display 24-hour average temperature
- Calculate and display daily heating degree days
- The meter will be portable and battery operated

The **project strategy** might be:

- Breadboard a prototype model of the analog circuitry
- Add A/D converter + an interface to a PC
- Write programs to handle calculations and displays

The **plan of action** might look like:

- Get a breadboard and power supply for the prototype
- Look for articles and designs on temperature measurement
- Select temperature sensor and A/D converter
- Sketch tentative circuit and calculate circuit values
- Build the analog circuits and take measurements
- Connect the analog circuit to the A/D converter
- Test the circuit completely for proper performance
- Design the PC interface logic
- Connect the PC and test the interface
- Write a simple program to read the temperature
- Unforeseen tasks and programs

The next step is to schedule the project tasks. To avoid loosing track of when each task should start and end, you may want to use a **bar-chart** graphical representation of your schedule, such as the one shown in Table 1.

Table 1 BAR-CHART SCHEDULE OF TASKS NEEDED TO BUILD A SIMPLE TEMPERATURE METER

	Week Beginning March			
	3	10	17	24
Get breadboard, etc	**			
Get articles	***			
Select sensors	****			
Sketch circuits	****			
Build analog and test	*******			
Connect analog and D/A	*******			
Test completely		******		
Design interface		*****		
Connect microcomputer		*****		
Write simple program		*******		
Write more programs		*********		
Unknown extra tasks			*********	

It is likely that someone will want to be apprised regularly of how well you are keeping to your schedule and whether you need help with any problems. Several progress reports might be required from you. A **progress report** describes the current status of your project, the work completed, the work in progress and your plans leading up to the next report. A sample progress report is shown in Table 2.

Table 2 SAMPLE PROGRESS REPORT COVERING THE SECOND WEEK OF THE TEMPERATURE METER PROJECT

Progress report Temperature-Meter Project-- Week 2	
Current status	The analog design has been completed and successfully tested. There have been no delays and I am on schedule.
Work completed	During the week since the last report, I completed the building and testing of the analog circuit- I used the temperature sensor and measured the output of its amplifier and plotted a graph of its response. I connected the A/D converter and tested its performance by varying the temperature sensor voltage.
Current work	During the last day of this week I started work on the interface design and I am now in the middle of connecting it to the microcomputer board.
Future work	During the third week I plan to finish the connection to the microcomputer board and to write a program to test the A/D converter. Then I plan to write a more complex program to display the temperature in either Celsius or Fahrenheit.

Finally , you can easily summarize all the steps of your project plan in the form of a proposal, shown in Table 3.

Table 3 PROPOSAL OF A PROJECT

PROPOSAL
TEMPERATURE Monitor

Project definition	The goal of this project is to design. build. and test a meter than can be used to measure and record air temperature.
Project Objectives	At the end of four weeks, the temperature monitor will be completely built and tested. It will perform to these specifications: • Temperature range of (-40 to +100 C) • Accurate to within 1°C • Display ether Fahrenheit or Celsius temperature • Display minimum and maximum temperature during the last 24 hours • Calculate and display 24-hour average • Calculate and display heating degree days • In addition to these performance requirements, the meter will be portable and capable of battery operation. Parts for the prototype will cost less than $150.
Strategy to achieve objectives	The analog circuitry and temperature sensor will be prototyped on a temporary breadboard. An analog-to-digital converter plus interface circuit will be added to allow the unit with a microcomputer system. After the temperature is being properly read by the computer, a number of display and calculation programs will be written.
Plan of action	The various tasks needed to implement the strategy are as follows: • Get prototype breadboard and power supply • Look for articles and designs on temperature measurement • Select temperature sensor and A/D converter • Sketch tentative circuit and calculate circuit values • Build analog circuit and take measurement • Connect analog circuit to the A/D converter • Test the circuit completely • Design the microcomputer interface logic • Connect microcomputer and test interface • Write simple program to read temperature • Programs and tasks I cannot estimate now The schedule necessary to finish the project in the required four weeks is attached.
Reporting	Weekly progress reports will be made. At the end of the project a working prototype will be presented.
Budget	Initial funding of $150 is necessary to purchase the prototype analog parts and the microcomputer.
Evaluation	Verification of how well the prototype meets the design specifications subject to the constraints will be made weekly and at the end of the project. The final evaluation will be conducted by the design engineer and the customer.