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ABOUT THIS BOOK : ENGR. DESIGN FOR EE'S by A. Wilcox

There is often a large gap between the engineering design studied in school and the actual practice of engineering in industry. Little effort is made to bridge that gap in undergraduate studies, and engineering graduates are usually left to their own devices when it comes to developing procedures for successfully carrying out design tasks. This book, however, is different: it integrates the principles of engineering design with practical, hands-on, real-world experience. Its purpose is to provide a unified, methodical approach to engineering design projects. In its first four chapters, it examines project design principles: in the remaining chapters, it illustrates the application of the principles in six practice modules.

Planning and scheduling are vitally important aspects of an engineering project. Finishing the design and prototype in a reasonable time requires attention to many details. Without proper attention, even the project that is technically perfect can turn out poorly. Consequently, this book stresses how to plan a project and how to schedule a realistic completion date for the project.

ENGINEERING DESIGN

A Creative Activity that Requires Planning and Execution

C A R P E

Engineering design is fun! How else can you enjoy building a piece of complex equipment and expect to have it working in several days? If the entire circuit has not already been described in some magazine or book, you can always take parts of the circuit design from several sources and piece together a complete design ready to build. After a quick smoke test to see if you wired it properly, connect it to a computer. After a few quick patches, you can type a program from your favorite magazine and run it in a matter of hours. After the big bang test to see if you put all the code together correctly, you can congratulate yourself on a successful project!

Do you see a bit of yourself in this? We all have occasionally fallen into this approach, and generally it seems to work. It has survived the test of time to become an almost traditional way of developing new hardware and software products. Although not the most efficient way of doing a project, it does appear to get the job done.

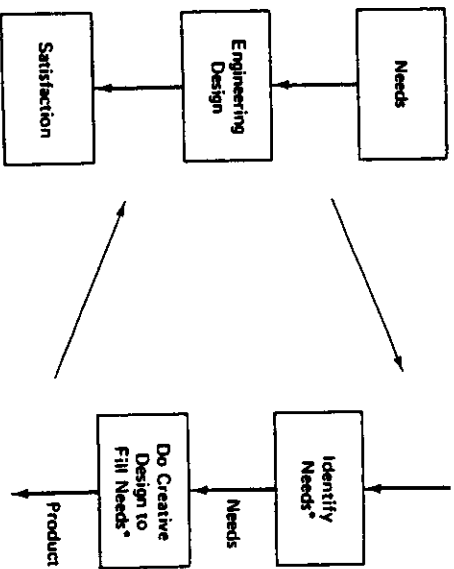
Getting the job done is certainly important, but have you really done a proper engineering design? You have been creative and solved the problem, but you might also have abandoned sound engineering practice along the way. The "product" is probably one of a kind and probably unsuitable for another person to build or for a company to manufacture.

Whether you are a student about to start a major design project or a professional engineering on the job, this hobbyist technique is clearly not satisfactory. You need a systematic way of approaching engineering design so that you can complete your project

on time and within your budget; in addition, your design must meet all specifications. In short, you must plan your project and plan it well.

1.1 DESIGN OVERVIEW

Engineering design is the creative process of identifying needs and then devising a product to fill those needs. As shown in Figure 1.1, engineering design is the central activity in meeting needs; these needs may be yours or a customer's. If you understand the requirements involved, then you can develop a creative design to satisfy them.

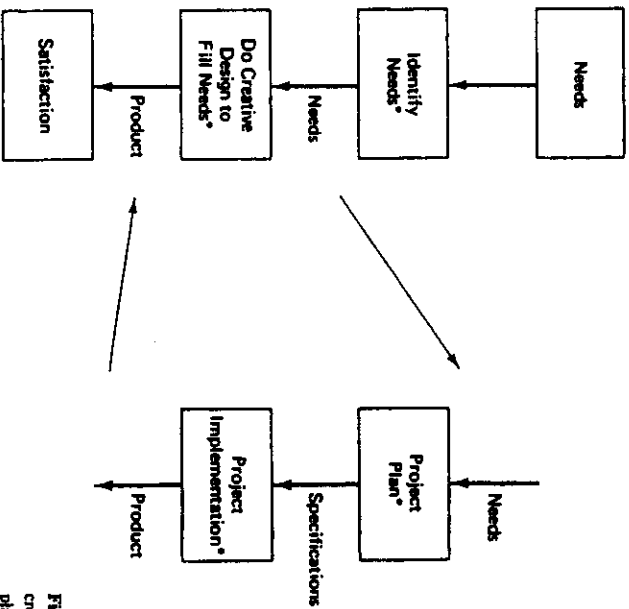


*Use problem-solving techniques.

Figure 1.1 Engineering design is the central activity in meeting needs. It involves identifying the needs and then creating a design to fill them; both require problem-solving techniques.

Figure 1.2 shows two parts of the creative design process. The first part of the process is making a project plan—outlining the various needs and reducing them to a set of specifications. The project plan is an administrative tool used for identifying the various tasks and indicating when to do them. The second part of the process, the project implementation, is designing and developing the final product. Both the project plan and the project implementation are necessary for an orderly product development.

In the context of engineering design, the project plan leads to a set of specifications and tasks. In a sense, you can consider it a nontechnical document, because it includes more concepts than technical detail. But this is no reason for overlooking it. For one thing, the project plan may be easily summarized and put into the form of a proposal, which is used to communicate the design plan to others, perhaps to management or to a potential customer. For another, the project plan is an outline of intended work for the complete project. It functions as a road map for the entire creative design effort, making the difference between project success and failure.



* Use problem-solving techniques.

Figure 1.2. The essential first part of a creative design is to complete the project plan. The project plan produces the specifications that describe what is needed so it can be designed and built.

The project implementation, on the other hand, involves the technical activity you would expect in a design project: specifications, hardware and software design and development, documentation, prototype construction, and testing. You can see that the hobbyist technique is only a small part of this implementation and consequently overlooks many essential aspects of the project. Because of these many details, the next chapter is devoted to doing the project implementation.

Both parts of the creative design process require problem solving. Determining the information that you need to set the design specifications is a problem. Likewise, it is an equally substantial problem to design the product. Both can be addressed by the same problem-solving techniques.

1.2 PROBLEM SOLVING

Problem solving is the process of determining the best possible action to take in a given situation. This process requires identification of the problem and a description of its causes. It then makes a systematic evaluation of various alternative solutions until one

can be selected as the best. Although you have used problem-solving techniques in one form or another for years, you probably have not looked at them closely. An outline of a problem-solving method suitable for engineering design is shown in Figure 1.3. It is important to note that this method is not limited to identifying the needs of a customer. It 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.

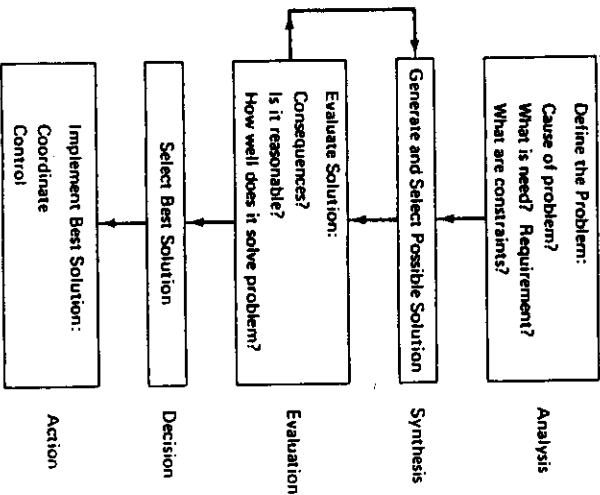


Figure 1.3 General problem-solving steps. The engineer must define a problem and evaluate a number of possibilities until the best solution can be selected. The best solution is never perfectly satisfactory, because it is a balance between needs and constraints.

How can you apply the problem-solving steps in Figure 1.3? Assume for a moment that you have a customer or client with a particular technical difficulty. Before you can even hope to solve the problem or offer any advice, you need to define the problem: ask when it first appeared, and then find out what caused it. When you try to define the problem better, be sure to separate the causes of the problem from its effects. Next consider possible solutions, and select the one that appears most likely to resolve the difficulty. Finally, put your solution into action, but be sure to stay in control to ensure its success. A more specific example would be the following. Suppose that the owner of a local metal-working shop has asked you for your advice on buying a computer. You would begin by asking questions to determine what he wants a computer to do. Does he want a computer to simplify his job scheduling and inventory management so that he has more free time to plan his future business? Does he want to put all of his accounting on a computer so that he can have quick monthly reports? Has a friend told him that :