1.0 Introduction

Design is to formulate a plan for the satisfaction of a human need. In the beginning, the particular need to be satisfied may be quite well defined. On the other hand, the particular need to be satisfied may be so nebulous and ill-defined that a considerable amount of thought and effort is necessary in order to solve the problem.

The formulation of plans for the physical realization of machines, devices, and systems is a study in decision-making processes. It involves an understanding of the decision-making process and applying it to practical situations. However, to make the decisions applicable to the particular situation requires a set of circumstances.

The design of machine elements is an integral part of the larger and more general field of mechanical design. To design any mechanical system, the designer must be competent in the design of the individual machine elements that comprise the system. The design of any machine element follows the same procedure fundamental to any design process. Figure 1.1 represents the complete process [Shig83].

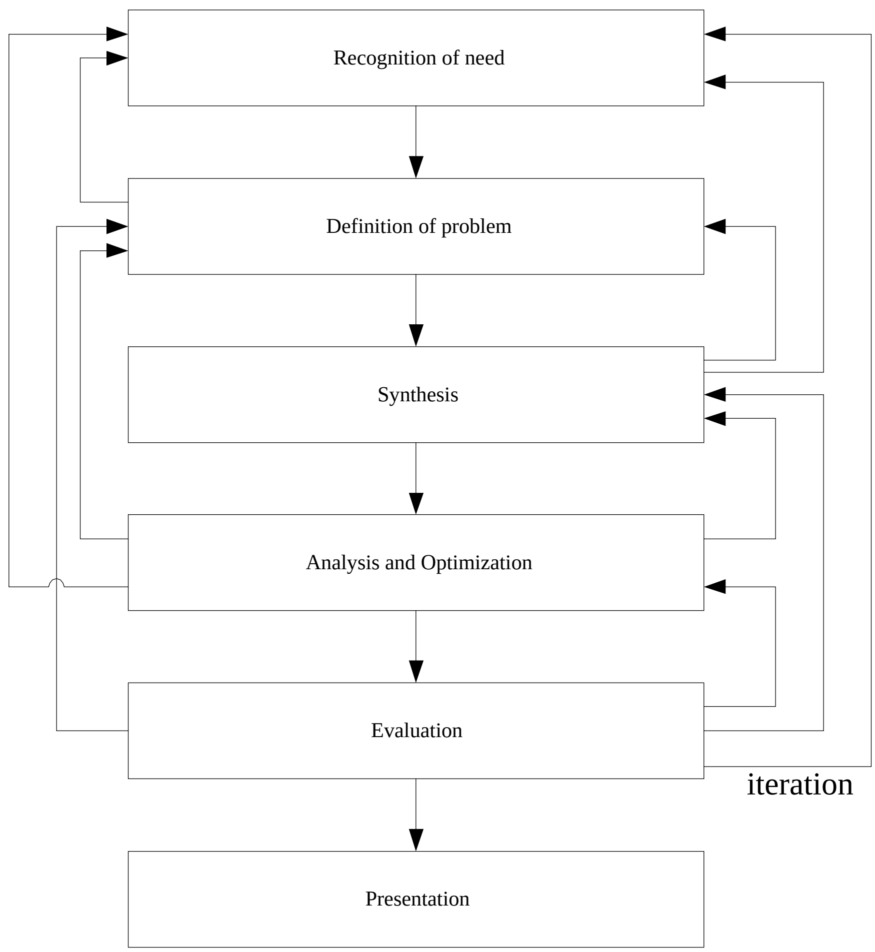

Figure 1.1: The phases of design

Recognition of the need is a highly creative act and triggered by a set of circumstances that arise almost simultaneously.

Definition of the problem must include all specifications for the element to be designed. The specifications include the input and output quantities, the characteristics and dimensions of the space the machine element must occupy and all limitations on these quantities. We can consider the machine element to be designed as a black box. In this case, the designer must specify the inputs and outputs of the box, together with the characteristics and the limitations. There are many implied specifications that result either from the designer's particular environment or from the nature of the problem itself.

After the problem has been defined and a set of written and implied specifications has been obtained, the next step in design is the *synthesis* of the optimum solution. The synthesis requires both analysis and optimization to take place because the mechanical element under design must be analyzed to determine whether the performance complies with the specifications. The analysis may reveal that the system is not an optimum one. If the design fails either or both of these tests, the synthesis procedure must begin again.

Thus, it is evident that design is an iterative process in which we proceed through several steps, evaluate the results, and then return to an earlier phase in the procedure. A designer will synthesize several components of a system, analyze, and optimize them and return to synthesis to see what effect this has on the remaining part of the system. It is also to be noted that design problems have no unique answers and a "good" answer today may turn out to be a "poor" answer tomorrow. The design of machine elements frequently involves many steps and calculations. Also, it is often desirable to generate several trial designs before specifying one to approach an optimal design.

The use of computers is increasing daily as a result of the greater productivity associated with their use. Engineering problems that were unsolvable, or to which only approximate solutions could be found are now being solved with ever increasing accuracy [Mott85].

A less spectacular but significant benefit has been the increase in accuracy when doing long, tedious and repetitive calculations. Many of the decisions normally made by the designer can be performed by the computer, such as looking up a standard sheave size for a belt in the table, calculating the length of the belt or determining the number of belts required for a specific design. The designer, however, must remain in control and be involved in the design process. Turning many of the mechanical elements of design over to CAE/CAD tools, more of the designer's energy is freed for design creativity [Esau90].

Earlier computer programs required a fair amount of knowledge about the computer and the program being used to get successful results. Nowadays, the trend has shifted to the interactive type of programs. The benefits are manifold as it requires no prior knowledge of the computer or the program, answers are supplied quickly, and the user is given the opportunity to correct mistakes as soon as they are made. This allows the designer and the computer to work as a team; the designer provides the decision-making capability and the computer, the rapid computation ability. Whenever the computer encounters a decision point, the necessary information is requested from the designer (and previous computations and information are made available, if necessary, to assist the designer in the decision process). The process maybe continued and repeated until satisfactory results are obtained.

Visual programming languages make software design accessible even to the untrained programmers, but basic software engineering practices must still be followed to create a usable product [Spar99]. However, considerable time needs to be spent in analyzing requirements, software design, and documentation of the product. In addition, effective interface design is essential in a highly technical software environment, especially in the case of the design of machine elements where the user is presented with many inputs and outputs.

The complexity of mechanical design is reflected in the complexity of the design equations, which relate functional requirements to design parameters [Watt90b]. The design is, in theory, complete when all of the design equations are satisfied, however, it is often difficult to find a solution because of the coupling that exists among design equations. The designer, often, has to refer back and forth to the appropriate tables and graphs to select suitable design parameter values and to appropriate standards to make the final design selection. Providing a means of computing design parameters and documenting the design can reduce the design time. The difficulties imposed by the non-linear and heuristic nature of design could be eased by a suitable arrangement of all design resources on the desktop.

The objective of this research has been to aid the designer in the design of machine elements. The author has developed a system that helps catalogue all the design resources regarding a machine element on the desktop. The designer will be also able to store the web resources available on the design of a particular machine element. In addition, the designer can keep track of the limitations imposed on the design, and the computations can be performed using various formulae by extracting data from various tables, standards, and graphs. A means of recording the optimal values to document the design has also been incorporated.