

Chapter 1

Introduction

Design is a process of creating a solution or a set of solutions viable for addressing a need through exploring science and physical principles. Knowledge from science, mathematics, and engineering practice along with creativity is employed to transform resources to meet the design objective with efficacy and measurable performance. The operation of designing artifacts and the construction of the designed artifacts have long been considered inseparable. However, designing of products and their fabrication in industrialized societies are separately pursued to better address increasing complexity and the cost associated with it. The process of building a design is initiated when the process of designing it is complete. Significant amounts of efforts have been devoted to understanding the design process and the ability to design in an innovative manner. This ability to apply knowledge to generate novel design solutions that satisfy specific goals and requirements has broad-ranging implications for the well-being of the entire human race.

Of the many rationales for needing to understand the design process, the first is driven by the increasing complexity of modern designs. The availability of novel materials and new technologies, the rapidly increasing knowledge base available for conceiving innovative solutions, and the ever-growing demand for shorter product turnaround time all present a daunting challenge to designers. Responding to these demands calls for a systematic approach that help enable creative design thinking and foster innovation as a fundamental attribute. In addition, the complexity of products and the short bringing a product to market time mandate that a team of designers work on multiple design tasks. A well-defined, structured approach to design is essential to organizing and coordinating team efforts in attending to satisfying all the requirements and avoiding making costly mistake and delay.

These needs have resulted in a plethora of design methodologies, procedures, techniques, aids, and virtual tools for dealing with activities that designers may use at different stages of the overall design process. They include rational procedures that formalize time-proven design practices and adaptations of methods from unrelated domains such as operations research and decision theory. All the design methodologies have the following two features in common—externalizing design

thinking and formalizing design processes into structured procedures. The former feature involves extracting the thought and thinking process out of the mind of the designer and organizing them using charts, tables, and diagrams. Externalizing design thinking is arguably very powerful when dealing with wicked problems and problem-solving requiring multiple of individuals working in teams, freeing the mind of the designer to pursue creative thinking. (See Chap. 4 for a discussion about problems with wicked properties.) The latter feature aids to avoid oversights when developing a design. Formalization also helps widen the search for appropriate design solutions. Research over the last several decades shows that engineering design process practiced by experts can be formalized in ways that can be easily learned by people who are inexperienced and less skilled. Research that increases our understanding of design process also makes the process explicit and accessible to anyone who is interested in learning it.

In the design process, design thinking is the thought process all great innovators practice for generating and implementing the basic notions that characterize a solution as being viable and innovative. It is a process for approaching design solution and innovation that center on addressing the true needs and the users for whom the solution is developed. The process can be explored to foster creative problem-solving in a systematic and structured way. It is particularly powerful in addressing difficult problems that are ill-defined and difficult to be solved using standard methods and approaches by re-framing the problems and through questioning assumptions and implications. The process can have a significant impact on the novelty, quality, implementation, value, and cost of the solution. The chapter provides an overview of the framework for the design thinking as well as engineering design process. It concludes with a brief section on the arrangement of the book.