

Introduction

The primary objective of the introductory engineering projects course is to provide an overview of engineering careers, primarily through open-ended, hands-on design experiences. This text and reference book is designed to support those experiences by providing guidance on course activities and information about the principles, methods and professional skills that are essential to engineering design.

In introductory engineering projects courses, the full cycle of engineering design is experienced. It begins with specification of design objectives and constraints, continues through development, documentation and analysis of design ideas, and ends with the process of building and testing the solution. Throughout the cycle, engineering design follows a logical process involving careful documentation and quantitative analysis using mathematical tools and scientific principles.

During the design process, experience will be gained in developing and working in interdisciplinary teams. Written and oral communication skills will be honed, both through formal communications with classmates, instructors and clients, and through informal communication within teams. Because engineering communication utilizes graphics, in addition to words, proficiency with engineering drawing and graphical presentation of data is developed.

The first few chapters of this book cover three course activities: the Mystery Artifact Challenge, the Design Loop and Reverse Engineering, which are intended to emphasize various critical skills or elements of the design process. Each of these chapters provide information on the skills or elements addressed by the activity and gives guidance on how to successfully complete it.

Chapter 2 provides guidance on completing the Mystery Artifact Challenge. This activity is designed to cultivate investigative skills and resourcefulness, as well as to begin the process of evolving work groups into effective teams. The investigative skills required for the Mystery Artifact Challenge are in fact vital to all engineers, and include the ability to make detailed observations, to formulate and test hypotheses based on observations, and to assess how characteristics and properties of an artifact correlate to its function.

Chapter 3 describes the Design Loop, a design exercise that emphasizes the iterative nature of the design process. The Design Loop introduces the role of measurements and testing in the design process and provides experience with measurements, spreadsheets and engineering drawing.

Reverse Engineering is covered in Chapter 4. This activity provides an opportunity to learn about how engineering products are designed and manufactured by carefully dissecting an existing product. Reverse Engineering emphasizes analysis and quantitative testing, and challenges participants to make product improvements in function, appearance, manufacturability, environmental impact and universal accessibility.

The remaining chapters of the book explore professional skills essential to design courses; these will be further developed throughout subsequent college coursework and used throughout an engineering career. These skills include the ability to make ethical judgments; to work effectively in teams; to communicate technical information using words and graphics; and to apply the fundamentals of engineering mechanics, measurements and instrumentation to engineering design.

One of the defining characteristics of the engineering profession is its code of ethics, which consists of standards of conduct that are necessary because of society's reliance on engineering expertise. The introduction to engineering ethics presented in Chapter 5 is intended to assist with the recognition of ethical conflicts when they arise and provide practice in making ethical judgments. Moving from societal interactions to interpersonal dynamics, Chapter 6 deals with teamwork. Teams, not individuals, are now widely recognized as the fundamental unit in most engineering organizations. Chapter 6 outlines practical tools for effective team building and maintenance.

Chapter 7 describes the design process, detailing the essential stages of the process and describing tools and concepts that are useful for negotiating each stage. The chapter presents tools for scheduling, project management, ideation, analysis and evaluation of engineering designs. The chapter also provides background information for all engineering design courses. Chapter 8 provides suggestions and guidance for the creation of products that are aesthetically pleasing as well as functional.

Chapters 9-13 deal with effective communication of technical information. Data presentation and engineering drawing are covered in Chapters 9 and 10, respectively. Modes of communication—written reports, oral reports and poster presentations—are discussed in turn in Chapters 11, 12 and 13. Each of these chapters begins with the principles of effective communication in the respective mode and provides straightforward guidance on organization, format and delivery.

Chapter 14 presents fundamental concepts of engineering mechanics. In future courses, students in aerospace, civil and mechanical engineering will study this topic in more depth. However, a basic understanding is valuable for all engineers engaged in design of physical artifacts, because strength and stiffness are factors in the design of most objects. Chapter 15 introduces techniques and instrumentation for making measurements that are commonly required for analysis and testing of design projects. As with engineering mechanics, most students will learn more about measurements and instrumentation in future courses, building on the basic information presented here.

Since analysis is the essence of engineering, Chapter 16 provides a review of engineering analysis to engender appreciation of the role analytical assessment plays in the design process.

Chapter 17 introduces electronics and circuits and provides enough information to recognize electronic components and their role in a simple circuit, read an electronic schematic circuit design, and make basic calculations to create a safe functioning circuit.