CHAPTER ONE
INTRODUCTION

RATIONALE

The purpose of engineering education is to provide the learning required by students to become successful engineers—technical expertise, social awareness, and a bias toward innovation. This combined set of knowledge, skills, and attitudes is essential to strengthening productivity, entrepreneurship, and excellence in an environment that is increasingly based on technologically complex and sustainable products, processes, and systems. It is imperative that we improve the quality and nature of undergraduate engineering education.

In the last two decades, leaders in academia, industry, and government began to address the necessity for reform by developing views of the desired attributes of engineers. Through this endeavor, we identified an underlying critical need—to educate students who are able to Conceive-Design-Implement-Operate complex, value-added engineering products, processes and systems in a modern, team-based environment. It is from this emphasis on the product, process, or system lifecycle that the initiative derives its name–CDIO.

Within these pages, we demonstrate how conceiving, designing, implementing, and operating products, processes, and systems is the appropriate context for engineering education. The CDIO approach builds on stakeholder input to identify the learning needs of the students in a program, and construct a sequence of integrated learning experiences to meet those needs. We incorporate a comprehensive and broadly applicable approach to improving curriculum, teaching and learning, and workspaces that is supported by robust assessment and change processes. By these means, we seek to significantly improve the quality and nature of undergraduate engineering education.

BACKGROUND

In the 1980s and 1990s, engineers in industry and government, along with university program leaders, began to discuss improvements in the state of engineering education. In this process, they considered the proficiencies of

engineering graduates of recent years and developed lists of the desired attributes of engineers. Common among these lists was an implicit criticism of current engineering education for prioritizing the teaching of theory, including mathematics, science, and technical disciplines, while not placing enough emphasis on laying the foundation for practice, which emphasizes skills such as design, teamwork, and communications.

This criticism reveals the tension between two key objectives within contemporary engineering education: the need to educate students as *specialists* in a range of technologies—each with increasing levels of knowledge required for professional mastery—while at the same time teaching students to develop as *generalists* in a range of personal, interpersonal, and product, process, and system building skills.

Engineering programs in many parts of the world that exemplify this tension are the products of the evolution of engineering education in the last half century. Through those years, programs moved from a practice-based curriculum to an engineering science-based model. The intended consequence of this change was to offer students a rigorous, scientific foundation that would equip them to address unknown future technical challenges. The unintended consequence of this change was a shift in the culture of engineering education that diminished the perceived value of key skills and attitudes that had been the hallmark of engineering education until that time. Thus evolved the tension between theory and practice.

The challenge that remains is that of introducing change to relieve this tension, to respond to the needs of our external stakeholders, to reform our programs and educational approaches, and in fact, to transform the culture of education.

THE CDIO INITIATIVE

The CDIO Initiative meets this challenge by educating students as well-rounded engineers who understand how to Conceive-Design-Implement-Operate complex, value-added engineering products, processes, and systems in a moderny, team-based environment. The Initiative has three overall goals: *To educate students who are able to:*

- *Master a deeper working knowledge of technical fundamentals.*
- *Lead in the creation and operation of new products, processes, and systems.*
- *Understand the importance and strategic impact of research and technological development on society.*

This education stresses the fundamentals, and is set in the *context* of conceiving, designing, implementing, and operating products, processes, and systems. We seek to develop programs that are educationally effective *and* more exciting to students, attracting them to engineering, retaining them in the program and in the profession.