

CHAPTER TEN

HISTORICAL ACCOUNTS OF ENGINEERING EDUCATION

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INTRODUCTION

When engaging in the reform of engineering education, it is important to understand its historical context. For over 150 years, educational institutions have played a major role in shaping the skills and professional identities of engineers. During this period, the appropriate approach to engineering education has been the subject of constant discussions and controversy. Major changes have occurred both in the way engineering education is organized and in its relation to science education. Radical changes have also occurred in the technologies and technical specialties within engineering. Despite this history, and particularly in view of the controversies surrounding the role of engineering education since the late 1960s, engineering schools have been surprisingly stable in their basic philosophy regarding the structure and core content of the engineering curriculum. Only modest reforms have been implemented in the curriculum and pedagogy of engineering education in several decades. Most of these reforms have been focused on increasing the number of technical engineering topics, and solving the resulting problems of disciplinary congestion.

By the 1990s, organized efforts in both the United States and Europe raised basic questions about the relevance of engineering education as it had developed since World War II. The problems included a lack of practical skills in modern engineering training, the lack of relevance for industry of the science being taught, and the kind of analytical qualifications being awarded in engineering education compared with visions of engineers as creative designers and innovators of future technologies. With its emphasis on science and knowledge structured around technical disciplines, engineering education developed into an education of technically skilled cooperative workers. However, many feel that the knowledge and broad innovative capacity needed to produce creative design engineers able to cope with contemporary technological change seem to be lacking in engineering education.

Several educational initiatives have addressed these issues, and attempted to outline plans to reform engineering education. Some focus on engineering curriculum or pedagogy; some develop completely new engineering programs based on new technologies. Other initiatives combine business, management,

and organizational understanding with engineering, or alternatively emphasize the creative and design aspects of engineering. Some reform initiatives have been supported by grants from government agencies, such as the National Science Foundation (NSF) in the United States; others have arisen from the Bologna Process that attempts to promote a unified system of education across Europe. While most initiatives focus on local, regional, or national experiments and reform, the CDIO Initiative is multinational, with open-source resources, and a broad, comprehensive methodology.

Contemporary tensions in engineering education may be deeply rooted in the diversity of modern technologies. The applications of these diverse technologies throughout society require increasing differentiation in the education of engineers. This diversity has already presented new challenges to the definition of engineering competence. The diversity of technologies presents new challenges to an engineering institution's sense of unity, identity, and standardization of professional preparation. Despite the complexity and multiplicity of technologies, institutional unity and its manifestation in a common engineering core curriculum have so far been successfully maintained by the engineering profession and by elite engineering universities. Nevertheless, the policies of identity formation and the creation of a homogeneous image of engineering are issues that need to be taken seriously, both in historical accounts and in contemporary reform initiatives. Engineering identity plays a vital part in educational reform and negotiations for change.

Critical accounts by observers close to the situation point to the need for reform in engineering education [1]–[2]. Other critics seem more confident in the achievements of engineers in society, and argue for the continuation of a traditional science-based engineering curriculum [3]. From their perspective, technology and the natural sciences are two distinctly separate approaches to knowledge [4]. Their studies contradict the popular misleading notion that engineering science is *applied science*. However, they do not raise critical issues related to the social and institutional dependencies of technology. Unfortunately, even engineering schools and professional institutions have supported the idea of a close relationship between science and technology by asserting that natural sciences are the core foundation of engineering. Contemporary developments in the natural sciences and engineering sciences have blurred the boundaries. New approaches of *techno-science* seem to be gaining ground as the characterization of the ties between modern science and technology, leaving neither one in a subsidiary role [5]. These new approaches recognize the role of technology as a contributor to scientific achievements, and change the basic idea of nature and technology.

The basic question is whether the critics are pointing to problems that will require radical reforms and transformations, or to a crisis in engineering education that will go away, as has happened so often before when technology and engineering have been criticized. The view that technology drives change and innovation seems to be less criticized today compared with the 1970s. At