Introduction

Over my 45 years as an engineer, professor, surface scientist and consultant in materials science and corrosion engineering, I have counseled many students that taking a corrosion course is like taking out insurance for their careers. Corrosion is inevitable and can only be hindered. There will always be a demand for improved materials and for more efficient control of corrosion. The knowledge and skills of corrosion engineers will always play a crucial role in every stage of the design and maintenance of manufactured goods.

Today, with billions of dollars per year reinvested in infrastructure and the replacement of technical assemblies damaged by environmental degradations, corrosion engineering offers a measure of a civilization’s ability to properly utilize natural resources, provide structural integrity, and improve quality of life. These complex issues are not easily addressed in a single discipline engineering educational program. However, the corrosion engineering community, which draws from a broad range of physical and chemical sciences, engineering, knowledge of materials, economics, management fundamentals, and their applied practices is expected to perform at a competence level that allows scientific and technical contribution in solving corrosion problems over the course of a full career.

This book reflects some of the changes that have occurred in the field of materials science and corrosion engineering. Contributors come from around the world and from a variety of fields; these selected teams of corrosion teaching faculty, graduate students, and experts in engineering education offer potential approaches to move forward and better prepare graduates to address the corrosion problems of the 21st century. The following chapters are a collection of some possible education approaches as they apply to corrosion engineering. These are based on traditional methodologies but also recognize leading edge technological needs and corrosive environments.

The present practice needs to be modified into a more interdisciplinary program that achieves the needed competence, laboratory and field experience, and promotion of lifelong learning. Present and future corrosion engineering talents need a more comprehensive preparation regarding state-of-the-art developments in material interrogation and analytical practices for assessing corrosion damage. Corrosion education can, and should, address design issues of structures and technical assemblies in the ever-increasing complexity and severity of corrosive environments. This needs to include the topics of structural integrity, corrosion resistant materials and coatings, and more economical practices in mitigation and repair. Also, in the future corrosion engineers must use accurate advanced measurements and analyses, including:

- Electrochemical impedance spectroscopy,
- Both elastic and electronics impedance,
Modeling must be a significant outcome to predict the remaining service life of structural and functional components.

Future corrosion engineering programs will require sound fundamental knowledge, mechanical and analytic preparation at the level of advanced engineering mathematics, and advanced computations methodologies, as well as laboratory preparation and field experience in corrosion inspection, data acquisition, and mitigation practices. The prepared corrosion engineer should be able to pass the engineering fundamentals and professional engineer examinations. He or she should also be computer literate and able to perform at a quantitative modeling level with statistical interpretation.

Corrosion engineering education needs to be more interdisciplinary as well as fundamentally comprehensive. Today in most engineering colleges the corrosion engineering education program is primarily associated with one disciplinary department, which offers its specialty at its set performance level and leaves corrosion topics outside that discipline to other likewise narrowly focused engineering programs, which often marginally explore corrosion as an applied science or engineering topic. An interdisciplinary approach is important to increase the depth of knowledge in the new technologies that can be applied to solving corrosion problems using state-of-the-art tools and more insightful laboratory and field experience. Further, NACE should also be a supportive and guiding leader in these future corrosion engineering education programs because as an association it encompasses a membership of all the levels of education within the corrosion community. A comprehensive curriculum would support a high level of preparedness, preventing scholastic hindrance in the advancement of corrosion science, engineering developments, material selection, corrosion mitigation and material interrogation for corrosion damage and the ability to produce competent service and guarantee integrity.

Most materials science and corrosion programs address scientific principles and their application to processes; it is, of course, critical that engineering education curricula continue to provide students with a solid foundation in these areas. However, there is an additional aspect of education that is often not addressed until the student is a professional in the field: practices. Those working on the diverse applications of materials science and corrosion engineering need to have been prepared to address practical concerns so that professionals can determine:

- How do I apply fundamental principles to novel and sometimes fluid situations?
- How do I make use of improved data, new technologies, and advanced tools?
- How do I reach across disciplines to find a solution?
- How do I develop a solution that is economically sound and environmentally sustainable?
- How do I work on a team?
- How do I create collaboration across research, industrial and cultural institutions?
- How do I communicate most effectively with, and between, all stakeholders?
- How do I manage my own career?
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This book will introduce the reader to some applications of pedagogy to better interface the teaching priorities to the engineer. Among other things, the chapters reveal successes and new ideas in curriculum development, instructional strategies, project-based learning, and collaboration with industry, information technology, interdisciplinary outreach, and career development.

Dating far back into prehistory, people have sought to create more useful materials and to slow the natural deterioration of products. Many of these developments not only influenced immediate manufacture but also had long reaching economic and cultural impact. This is ever more true today. So while the study of materials science and corrosion has always been about resources, environments, and change, it has become clear that these areas should be more broadly defined because the field has expanded in both depth and breadth. While economic resources remain an important factor in the field, new technologies open the door to using materials in new ways. Further, we have come to understand that people are important resources, too. Working environments include the growing number of physical and cultural situations in which the engineering fundamentals can be applied and the interdependence of disciplines and institutions. Moving forward we should be creating new solutions, not only across materials but across disciplines.

With the advancing and broadening of necessary skill sets and the discovery of a growing range of applications, new concepts of corrosion engineering education must be developed to efficiently meet present and future needs. An interdisciplinary graduate degree program with a preplanned curriculum including laboratory and field experience can produce the talent to achieve even greater improvements in the critical field of corrosion engineering.

It is with a sense of responsibility that I recognize that a constructive change in corrosion engineering education is necessary. This book is meaningful and timely because it begins the much-needed conversation about the thoughtful growth and change needed in the education of materials and corrosion engineers so that this important and comprehensive field can continue to offer the world its benefits. Let the evolution—and revolution—of materials and corrosion engineering education begin!

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