Engineering Within Ecological Constraints

Edited by Peter C. Schulze

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PREFACE

Advances in engineering and technology have historically been crucial to solving important societal problems, including those that result from the environmental impacts of humans. This pattern will undoubtedly continue into the future. Unfortunately, however, the application of some innovations has had undesirable, sometimes unanticipated, environmental consequences. Therefore, a primary challenge for the future is to maximize the benefits of technological innovation and use while minimizing undesirable environmental effects.

One response to this challenge is the recent efforts in business and industry that emphasize preventing environmental damage, a practice based on industrial ecology. Like traditional ecology, which is the study of natural and managed ecosystems, industrial ecology is the study of industrial systems and their relationships to natural and managed ecosystems. The foundation of industrial ecology is a systems approach to environmental design and management based on an understanding of the flows of materials and energy in industrial and consumer activities, the effects of these flows on the environment, and the influences of economic, political, regulatory, and social factors on the flow, use, and transformation of resources. These efforts have made substantial progress in reducing pollution and the consumption of raw materials per unit of production. However, inefficiencies are only part of the problem.

Gains in efficiency can be overshadowed by concurrent increases in the scale of production that result from population growth or increased per capita consumption. For example, efficiency improvements in fishing technology have led to overfishing and the collapse of several fisheries. Fishing quotas designed to address this problem ideally are based on economic theory and on ecological data

and reasoning. In fisheries as in other areas of economic activity, averting problems of overuse will require that insights from ecology, engineering, economics, and other fields be better integrated in devising technological and policy solutions.

The papers in this volume are the products of a National Academy of Engineering (NAE) meeting intended to take a small step toward promoting the necessary multidisciplinary approach.

They were contributed by engineers, ecologists, and social scientists. They provide a variety of perspectives on the challenges faced in efforts to engineer within ecological constraints. We hope these papers will contribute to efforts to find paths toward sustainability and will stimulate further cross-disciplinary interaction.

This volume originates from an April 1994 meeting we chaired based on a concept originated by Peter Schulze. Both the publication and the meeting are components of an ongoing NAE initiative exploring issues of technology and the environment. We are indebted to the authors for their excellent contributions, to a group of external reviewers of those contributions, and to an editorial team composed of Peter Schulze, Dale Langford, Jessica Blake, and Penny Gibbs. On behalf of Peter Schulze, thanks also go to Austin College for supporting his work on this volume. In addition, we thank Deanna Richards, who heads up the NAE's technology and the environment effort, and Bruce Guile, who directs the NAE Program Office, for excellent advice and assistance throughout the project.

Special appreciation also goes to the Andrew W. Mellon Foundation for supporting this project and related elements of the NAE's Technology and Environment Program. Finally, we would like to acknowledge the leadership at the NAE for the foresight to initiate and sustain the NAE's program that continues to play a catalytic role in examining the intimate connection between technology and the environment.

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