plex process of quantitative risk assessment and limits of this approach.

- Chapter 4: Planning frameworks for sustainable development
  The planning section of this book offers a range of planning frameworks, from an elaboration on the elements to consider in planning for sustainability and steps to take, to broader conceptual frameworks regarding the systems in which business operates, what constitutes their unsustainability and how to make the systems as well as the companies operating within them more sustainable.
- Chapter 5: Designing for sustainable development
  This chapter provides an overview of approaches to designing for sustainability, details cradle-to-cradle materials assessment and product design, and highlights aspects of more sustainable process design strategies.
- Chapter 6: Implementing sustainable development; decision-support approaches and tools
  This chapter describes some of the approaches and tools that companies use to demonstrate their commitment to sustainability and support decision-making.
- Chapter 7: Future directions of the chemical industry
  The transition to a sustainable chemicals industry requires a thorough reconceptualization of the industry and its products. New directions for this industry are emerging. This chapter takes a broad, futuristic, and macro-view of the chemical industry.
- Chapter 8: The business case for sustainable development
  This chapter is divided into four parts: (1) results from the 2004 Chemical Industry Sustainability Survey and related Focus Groups, developed in a collaboration between the Bridges to Sustainability, PricewaterhouseCooper (PwC), and AIChE, and conducted by PwC for this book; (2) an overview of sustainability and performance, linking the intangibles of sustainability to marked performance; (3) five business cases presented by sustainability managers at companies with significant chemical operations and a major customer of chemicals (Shell, BASF, DuPont, GlaxoSmithKline and 3M); and (4) various other provocative perspectives on the business case for the industry.

It is a daunting, virtually impossible task to do credit to the wide-ranging discussions in this book. There is just too much material on numerous topics going in many directions, authored by a diverse group of authors with a wide range of backgrounds. But, taken together, the contributors give an excellent description of the state of the chemical industry with regard to sustainability and provide the rationale, direction and goals to encourage chemical companies to include sustainability in their goals. One phrase says it all: "The challenge of achieving a sustainable world is huge and daunting, but there is no alternative".

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J.W. Talley (Ed.), Bioremediation of Recalcitrant Compounds, Taylor & Francis/CRC Press, Boca Raton, FL, 2006 (324 pages, US$ 139.95, ISBN 1-56670-656-4).

The scope of sites contaminated with industrial, potentially toxic chemicals is vast. For example, the U.S. Department of Defense has more than 21,000 sites that may require some form of remediation. The contaminants on these sites are wide ranging in chemical structure and in hazard potential. Examples of potentially dangerous chemicals found at these sites include TNT, chlorinated solvents, PAHs, and PCBs. Conventional methods of site remediation that have been used in the past include incineration, air stripping, and activated carbon adsorption. Frequently, however, these methods are not cost-effective. Biotreatment, which offers a possible alternative cleanup process, is the theme of this book.

To define the problem facing remediation engineers, Talley writes the following in Chapter 1:

> "Bioremediation is defined by the U.S. Environmental Protection Agency (EPA) as a managed or spontaneous process in which microbiological processes are used to degrade or transform contaminants to less toxic or nontoxic forms, thereby remedying or eliminating environmental contamination (EPA, 1994). These microbiological processes may reduce hydrocarbon concentrations in various types of solids and sediments to levels that no longer pose an unacceptable risk to the environment or human health (Linz and Nakles, 1997). However, hydrocarbons that remain in treated soils and sediments still might not meet stringent regulatory levels, even if they represent site-specific, environmentally acceptable endpoints (NRC, 1997). This unresolved issue of the availability of residual hydrocarbon contaminants is the focus of this work."

Given the complexity of the problem, Talley has assembled several key investigators to write chapters for this book that "... provides an authoritative state-of-the-art biotreatment review for three key contaminant groups: chlorinated solvents, polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs). Issues such as availability, toxicity, and treatability are discussed along with a summary of the latest bioremediation technologies. Special innovative research and development projects are presented for each contaminant group". The projects described in this book resulted from the U.S. Government's Strategic Environmental Research Development Program (SERDP) Federal Integrated Biotreatment Research Consortium funded by three U.S. federal agencies.

The results of this research effort are reported in the following eight chapters:

- Introduction to recalcitrant compounds.
- Toxicological exposure of bound recalcitrant compounds.
- Roadblocks to the implementation of biotreatment strategies.
- The federal integrated biotreatment research consortium (flask to field).
- Chlorinated solvent contaminated soils and groundwater: field application of the solvent extraction residual biotreatment technology.
- Enhancing PCB bioremediation.
- Polycyclic aromatic hydrocarbons (PAHs): improved land treatment with bioaugmentation.
- Future needs for research and development.

I was particularly in the chapter entitled "Enhancing PCB bioremediation" because I had met the senior author (James M. Tiedje) on several occasions, some of his work having been sponsored by the U.S. EPA's Hazardous Materials Research Program. I was a member of the Science Advisory Group of one of the centers that funded some of Dr. Tiedje's work whose objectives were to:

- Develop genetically engineered organisms that will grow on PCBs.
- Evaluate surfactants and $FeSO_4$ to enhance PCB dechlorination.
- Implement and test PCB bioremediation in pilot-scale reactors.

Conclusions drawn by Tiedje in his work are as follows:

> "Bioremediation can potentially result in dechlorination of PCBs and possibly even in mineralization of the contaminant. Energy costs are lower than other forms of treatment. Slurry phase treatment usually requires less time than solid phase biological treatment due to increased rates of contaminant mass transfer. Furthermore, it is relatively simple to maintain either aerobic or anaerobic conditions in the reactor and to switch between these two conditions .... Although results of the currently ongoing pilot test are yet to be determined, flask- and laboratory-scale soil remediation experiments indicate that the designed two-phase enhanced anaerobic dechlorination of aroclor coupled with GEM-based enhanced aerobic degradation/mineralization of lower-chlorinated PCBs could be very beneficial as a remediation technology."

The book ends with a chapter entitled "Future needs for research and development." In this chapter, Talley discusses a number of research and development issues that were identified as worthy of being followed up but were not pursued due to a desire to move the technology with the most potential to the pilot or field scale.

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D.A. Vaccari, P.F. Strom, J.E. Alleman, Environmental Biology for Engineers and Scientists, John Wiley & Sons, Inc., Hoboken, NJ, 2006 (953 pages, 7-in. × 10-in. format, US$ 115.00, ISBN 0-471-72239-1).

Today's graduating environmental engineers must be familiar with a greatly expanded body of knowledge of environmental science. If, in my opinion, they utilize the material in this book to the fullest, these new engineers will have a solid basis for their professional careers.

The book was written to serve as a text for a graduate level environmental engineering course. It was designed to familiarize students with a broad range of biological topics. The first 10 chapters (see below) cover a wide range of biological topics (the range of these topics is much wider, I might note, than what I was exposed to in my teaching career). The book contains much more material than the narrow range of microbiology topics which have been (to date) the substance of most microbiology courses for engineers.

Chapters in the first section of the book by title are:

- Perspectives on biology
- Biology as a whole
- The substances of life
- The cell: the common denominator of living things
- Energy and metabolism
- Genetics
- The plants
- The animals
- The human animal
- Microbial groups
- Quantifying microorganisms and their activity

The succeeding chapters deal with more conventional material taught in environmental engineering classes. Those chapter titles are listed below:

- Effect of microbes on human health
- Microbial transformations
- Ecology: the global view of life
- Ecosystems and applications
- Biological applications for environmental control
- The science of poisons
- Fate and transport of toxins
- Dose–response relationships
- Field and laboratory toxicology
- Toxicity of specific substances
- Applications of toxicology