Environment
Conscious
Manufacturing
Dedicated to Our Families

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Contents

Preface ........................................................................................................................................... ix
Editors ......................................................................................................................................... xiii
Contributors ............................................................................................................................. xv

Chapter 1  Industrial Metabolism: Roots and Basic Principles ......................... 1
A.J.D. Lambert

Chapter 2  Product Design for the Environment: The Life Cycle
Perspective and a Methodological Framework
for the Design Process ................................................................. 33
Fabio Giudice

Chapter 3  Product Life Cycle Monitoring via Embedded Sensors .......... 91
Srikanth Vadde, Sagar V. Kamarthi, Surendra M. Gupta,
and Ibrahim Zeid

Chapter 4  Quantitative Decision-Making Techniques for Reverse/
Closed-Loop Supply Chain Design .......................................... 105
Kishore K. Pochampally, Satish Nukala, and Surendra M. Gupta

Chapter 5  Proactive Yesterday, Responsive Today: Use of Information
to Enhance Planning in Closed-Loop Supply Chains .......... 215
Muhammad N. Jalil, Rob A. Zuidwijk, and Harold Krikke

Chapter 6  Disassembly Line Balancing ................................................. 235
Seamus M. McGovern and Surendra M. Gupta

Chapter 7  Multikanban System for Disassembly Line ....................... 311
Gun Udomsawat and Surendra M. Gupta

Chapter 8  Disassembly Sequencing Problem: Resolving
the Complexity by Random Search Techniques ..................... 331
Mukul Tripathi, Shubham Agrawal, and M. K. Tiwari
Chapter 9 Human-in-the-Loop Disassembly Modeling and Planning ................................................. 363
Ying Tang and Meng-Chu Zhou

Chapter 10 Planning Disassembly for Remanufacture-to-Order Systems ..................................... 387
Karl Inderfurth and Ian M. Langella

Chapter 11 Facility and Storage Space Design Issues in Remanufacturing .................................. 413
Aysegul Topcu, James C. Benneyan, and Thomas P. Cullinane

Chapter 12 Some Studies on Remanufacturing Activities in India ......................................... 445
Kampan Mukherjee and Sandeep Mondal

Chapter 13 Optimal Control Policy for Environment-Conscious Manufacturing Systems ............ 473
Kenichi Nakashima

Chapter 14 Disassembly and Reverse Logistics: The Case of the Computer Industry ................. 491
K. Kathy Dhanda and Adrian Peters

Chapter 15 Evaluating Environment-Conscious Manufacturing Barriers with Interpretive Structural Modeling ....................... 509
Joseph Sarkis, Mohd. Asif Hasan, and Ravi Shankar

Index ................................................................................................................................................. 525
Preface

Environment conscious manufacturing (ECM) is an emerging discipline that is concerned with developing methods for manufacturing new products from conceptual design to final delivery, and ultimately to end-of-life disposal, that satisfy environmental standards and requirements.

The environment and global warming are receiving increasing attention these days. The Academy Award winning documentary, “An Inconvenient Truth,”* released in 2006 and presented by former U.S. Vice President Al Gore, has sent a warning signal to the masses to sharpen their awareness about global warming. At the same time, most industrialized nations are facing serious repercussions from the rapid technological development that has taken place in the past few decades. In recent years, environmental awareness and recycling regulations have been putting pressure on many manufacturers and consumers, forcing them to produce and dispose of products in an environmentally responsible manner. Government regulations are becoming more persuasive, and thus many manufacturers are under pressure to use recycled materials whenever possible. Occasionally, manufacturers are even required to take care of the products at the ends of their useful lives. This regulation has created a need to design products that are environment friendly, as well as easy to disassemble and recycle. Hence, there is more than ever a need to develop algorithms, models, heuristics, and software for addressing designing, recycling, and other issues (such as the economic viability, logistics, disassembly, recycling, and remanufacturing) for an ever-increasing number of products produced and discarded.

This text provides a comprehensive coverage of this discipline, exploring topics such as industrial metabolism, product design for the environment, design of reverse and closed-loop supply chains, disassembly modeling, and case studies in ECM. Students, academicians, scholars, consultants, and practitioners worldwide would benefit from this text. It is our hope that this book will inspire further research in ECM and motivate new researchers to get interested in this all too important field of study.

The book is organized into 15 chapters. The first chapter, by Lambert, presents an introduction to the basic concepts of industrial ecology including its historical roots. The author discusses the concepts of industrial metabolism and integrates them with the concepts of reverse logistics. The second chapter by Giudice, takes the life cycle approach to designing the product for the environment, considering all phases of the life cycle, from definition of product requirements to its disposal. In the third chapter, Vadde et al. describe sensor-embedded products in the context of product life cycle management.

The effectiveness of the embedded sensors is modeled using simulation and measured in terms of the average downtime, average maintenance cost, average disassembly cost, and average life cycle cost. It is shown that embedding sensors in computers provides a beneficial result.

The fourth chapter by Pochampally et al. illustrates how various quantitative techniques can be employed in the design phase of reverse and closed-loop supply chains to address a variety of decision-making problems. The decision-making problems addressed include the selection of economically used products, collection centers, recovery facilities, production facilities, second-hand markets, and new products; the optimal transportation of goods; the evaluation of marketing strategy; and the futurity of used products. In the subsequent chapter (Chapter 5), Jalil et al. assert that, in closed-loop supply chains, uncertainty could be managed by using information. The authors illustrate their point by considering the case of CopyMagic.

Chapters 6 through 10 address various issues associated with disassembly, which is the first step in product recovery. Product recovery seeks to obtain materials and parts from old or outdated products through reuse, remanufacturing, or recycling to minimize the amount of waste sent to landfills. Disassembly is defined as the methodical extraction of valuable parts or subassemblies and materials from discarded products through a series of operations. Chapter 6, by McGovern and Gupta, deals with disassembly line balancing. Since a disassembly line is the best choice for automated disassembly, it is essential that the disassembly line is designed and balanced to work efficiently. The disassembly line balancing problem seeks a disassembly sequence that is feasible, minimizes the number of workstations, minimizes total idle time, and ensures similar idle times at each workstation as well as addresses other disassembly-specific concerns. As finding the optimal balance is computationally prohibitive due to exponential growth, the chapter presents several metaheuristics algorithms that are easy to implement to solve the problem. Chapter 7, by Udomsawat and Gupta, presents a variant of the Toyota Production System (known as the multikanban system) that is implemented in a disassembly line. The authors’ investigation reveals that the multikanban system is effective in controlling the system’s inventory while providing a decent customer service level. In Chapter 8, Tripathi et al. suggest several random search techniques that can be used to solve a disassembly sequencing problem. Chapter 9, by Tang and Zhou, presents an overview of two models for uncertainty management in disassembly process planning, owing to human intervention. The first model mathematically represents the influence of human factors on disassembly, while the second incorporates fuzzy learning strategy into the disassembly process. In Chapter 10, Inderfurth and Langella discuss the planning of disassembly for the remanufacture-to-order systems. The authors argue that linear programming models can be used to plan disassembly for simple situations when yields are known. Their model, first discussed in the context of a single period, is subsequently relaxed to accommodate multiple periods, which necessitate the use of heuristic methodologies. The authors suggest the use of
Preface

Chapter 11, by Topcu et al., highlights the issues arising from the design of facility and storage space in the context of remanufacturing. The authors argue that the number of usable parts or candidates for remanufacture retrieved from returned products varies significantly, causing fluctuations in inventory capacity and configuration requirements. Therefore, remanufacturing requires storage designs that not only minimize warehousing space and inventory-holding costs but also facilitate effective coordination of facilities planning and remanufacturing decisions. The authors use two mathematical models to illustrate their views. In Chapter 12, Mukherjee and Mondal highlight the current status of Indian remanufacturing. They point to the lack of such economic activities in the country and examine the reasons for such absence through empirical investigation. Chapter 13, by Nakashima, proposes a Markov model to evaluate and optimize environment-conscious manufacturing systems with stochastic variability stemming from customer demand, recovery rate, and disposal rate. The model can be used to calculate the total expected cost per period. In Chapter 14, Dhanda and Peters report that while the developed countries are guilty of discarding a majority of electronic products in the waste stream, most of the waste is actually shipped overseas to Asian countries. The authors analyze the reasons for such behavior and suggest some solutions to this problem. In the final chapter, Sarkis et al. point out that the adoption of environment-conscious manufacturing practices needs to overcome a variety of barriers. The authors propose the use of interpretive structural modeling to help investigate, analyze, and overcome these barriers. The chapter provides an overview of the major barriers and an illustrative example with initial insights.

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Editors

generation, energy systems modeling, process integration, materials flow modeling, and, more recently, on disassembly sequencing. He has published more than 40 research papers in various scientific journals and has contributed to numerous books, conference proceedings, and professional papers. Dr. Lambert teaches undergraduate students energy efficiency and the managerial aspects of reuse and recycling; he supervises group projects on industrial ecology–related topics. He coaches graduate students on topics such as energy and waste management in industry, and sustainable energy resources. His recent activities can be viewed at http://w3.tm.tue.nl/en/subdepartments/aw/ (technology studies). Dr. Lambert can be reached by e-mail at A.J.D.Lambert@tue.nl.
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