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"The Disassembly Line: Balancing and Modeling" -Book Review-

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Title of book: The Disassembly Line: Balancing and Modeling
Authors: Seamus M. McGovern and Surendra M. Gupta
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This book is about the *disassembly* of end-of-life products with particular emphasis on methods and techniques for solving the *Disassembly Line Balancing Problem.*

Disassembly is viewed as "the systematic separation and extracting valuable entities for possible future re-usage". In fact, disassembly is a distinct phase of the product lifecycle. It follows the "before life" phases (such as design and economical evaluation), "useful period" phases (such as manufacturing, distribution, usage and maintenance) and "end of life" phases (such as collecting, sorting). Disassembly might represent the essential first phase of the future activities, such as re-use and re-manufacturing and recycle. Due to the ever higher public awareness, the more and more strict regulations concerning environment quality preservation and increasing economic effectiveness and attractiveness for industry, the activities of recovering valuable parts and subassemblies have become a desirable alternative to the old fashioned disposal processes of end-of-life products.

The authors state, in the preface of the book, that the "disassembly line seems to be the most efficient way to disassemble a product". Consequently, the primary concern of the book is "the complete disassembly of [end-of-life] products on a paced disassembly line for component/material recovery purposes". The authors aim at investigating "the qualitative and quantitative aspects of multi-criteria solution sequences using the various combinatorial optimization techniques" (page 16) to solve the Disassembly Line Balancing Problem (DLPB). The DLBP consists in finding a disassembly feasible solution sequence which preserves precedence constraints and aims at attaining several objectives, such as minimizing the number of work stations and total idle time, ensuring similar idle time at each work station, while attempting to remove hazardous parts and materials and extracting highly demanded product components at the earliest moments possible and minimizing the number of direction changes required for disassembly (removing parts with similar part removal directions together), (page 102).

The book is composed of 29 chapters grouped into three parts entitled "Disassembly Background", "Disassembly-Line Balancing" and "Further Disassembly-Line Considerations" which address general aspects concerning disassembly processes, variations of methods and techniques to solve the DLBP, and other problems related to the disassembly line, respectively.

Part I comprises six chapters which are meant to set the stage for the subsequent chapters. Various information concerning disassembly processes, assembly lines, disassembly lines, other related researches, graphical representations and computational complexity of combinatorial problems are provided.

Part II is made up of 20 chapters and addresses the statement and analysis of the DLBP and several specific variations of methods and techniques which were adapted for solving the problem, tested on four application cases exprimental instances and compared. The objectives of this part of the book are: stating the mathematical model of DLBP, establishing the difficulty of the problem by using the complexity theory and determining the data sets and evaluation criteria to be used in analyzing the problem and solving techniques which are selected (page 99).

It is demonstrated (in chapter 9) that the DLBP is a complex NP complete problem in the strong sense and necessitates specialized solution techniques. Accordingly, authors plea for combinatorial optimization approaches and select several algorithms to solve the problem. The techniques to be utilized to solve the DLBP are introduced in chapter 10 and their usage and performances in solving the problem are presented in chapters 12 through 19. There are seven techniques which are adapted, tested and compared. The *exhaustive search* is used to provide the optimal solution. Two *metaheuristic* approaches (genetic algorithms and ant colony optimization) are next studied. Two *purely deterministic searches* (the greedy algorithm and the "hunter-killer" search) and two *2-phase hybrid* methods are adapted and tested.

The four *experimental instances* (the eight-part personal computer, the enhanced 10-part DLBP case, the 25-part cellular instance, and the size independent "a priori" benchmark with a known optimal solution) are described in chapter 11. Chapter 20 contains a detailed comparison of the six heuristic and metaheuristic techniques as applied to the DLBP with respect to several performance measures. Several complementary research results are reviewed in chapter 21 together with future research directions.

Disassembly processes interact with other "before life", "useful", and "after life" periods of product usage and recovery. As a result, to make the picture complete, **Part III** addresses other areas of disassembly research such as product planning, line and facility design, operations scheduling and sequencing, inventory, "just-in-time", revenue and unbalanced lines (chapter 22 through 29).

The authors of the book form a team who may be viewed as a fine and synergic combination of two complementary experiences and backgrounds from academia and industry. Seamus McGovern, an Electronics Engineer at the Volpe National Transportation System Center, holds a commission in the US Navy as an aerospace duty engineer as well as a part-time industrial engineering faculty appointment at the Northeastern University. Surendra M. Gupta is a professor of Mechanical and Industrial Engineering and a director of the Laboratory for Responsible Manufacturing at the Northeastern University. He has authored/co-authored over 400 technical papers and is a pioneer in the domain of the book.

This book represents a very valuable work in a rather young research domain, which may be viewed as opened by the pioneering paper of Güngör and Gupta entitled "Disassembly Line in product Recovery (*International Journal of Production Recovery*, 40 (11), 2002). The volume mainly reflects the original studies of authors and their colleagues. It also makes an exhaustive and systematic review of the results which are reported in the domain scientific literature and are due to other scientists. The organization of the document is well thought and the presentation style is rigorous and clear. Subsequently, though information content is very dense and diverse, the book is accessible and its study is scientifically rewarding. Special remarks can be made to the uniform and coherent notation which is used throughout the book and to graphical illustrations. A final remark of appreciation is to be made to the excellent quality of editing and printing of the book due to the staff of McGraw-Hill Companies.

In conclusion, the book is a timely work which contains relevant, inspiring and challenging information. Therefore, this reviewer warmly recommends it to the readers of academia and industry as well who are interested in modern manufacturing issues and combinatorial optimization methods and software.

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