PRODUCT DISASSEMBLY PLANNING USING DESIGN FOR DISASSEMBLY AND GENETIC ALGORITHM

A thesis submitted to the Graduate School in partial fulfilment of the requirements

for the degree Master of Science (Intelligent System)

Universiti Utara Malaysia

By

LAU LEE LYN

(Metric No: 86421)

PUSAT PENGAJIAN SISWAZAH
(*Centre For Graduate Studies*)
Universiti Utara Malaysia

PERAKUAN KERJA KERTAS PROJEK
(Certificate of Project Paper)

Saya, yang bertandatangan, memperakukan bahawa
(I, the undersigned, certify that)

LAU LEE LYN

calon untuk Ijazah
(candidate for the degree of) **MSc. (Int. Sys.)**

telah mengemukakan kertas projek yang bertajuk
(has presented his/her project paper of the following title)

PRODUCT DISASSEMBLY PLANNING USING DESIGN FOR DISASSEMBLY AND GENETIC ALGORITHM

seperti yang tercatat di muka surat tajuk dan kulit kertas projek
(as it appears on the title page and front cover of project paper)

bahawa kertas projek tersebut boleh diterima dari segi bentuk serta kandungan dan meliputi bidang ilmu dengan memuaskan.
(that the project paper acceptable in form and content, and that a satisfactory knowledge of the field is covered by the project paper).

Nama Penyelia Utama
(Name of Main Supervisor): **MR. RUSLIZAM DAUD**

Tandatangan
(Signature) : _____

Tarikh
(Date) : 17/5/07

PERMISSION TO USE

In presenting this thesis in partial fulfilment of the requirements for a postgraduate degree from Universiti Utara Malaysia, I agree that the University Library may make it freely available for inspection. I further agree that permission for copying of this thesis in any manner, in whole or in part, for scholarly purpose may be granted by my supervisor(s) or, in their absence by the Dean of the Graduate School. It is understood that any copying or publication or use of this thesis or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to Universiti Utara Malaysia for any scholarly use which may be made of any material from my thesis.

Requests for permission to copy or to make other use of materials in this thesis, in whole or in part, should be addressed to

Dean of Graduate School

Universiti Utara Malaysia

06010 UUM Sintok

Kedah Darul Aman.

ABSTRAK

Kajian ini memperkenalkan kegunaan teknik Artificial Intelligence (AI) iaitu Algoritma Genetik (GA) untuk mengatasi permasalahan melibatkan turutan nyah-pemasangan product. Generasi turutan nyah-pemasangan dihasilkan berpandukan methodologi Rekabentuk untuk Pemasangan (DFA). Dalam projek ini, prestasi Rekabentuk untuk Nyah-Pemasangan (DFD) dan Algoritma Genetik dalam memilih turutan nyah-pemasangan yang optimimum diuji. Permasalahan kajian melibatkan pencarian masa nyah-pemasangan yang optimum, iaitu merujuk kepada masa yang paling minimum. Objektif kajian ini adalah mencari turutan yang optimum dengan masa nyah-pemasangan yang terpendek. Kajian ini dimulakan dengan nyah-pemasangan secara manual yang mengguna teknik DFD. Pemegangan manual dan pemasukan manual akan dijadikan sebagai panduan dalam mengira masa proses nyah-pemasangan. Akhirnya, teknik Genetik Algoritma akan diguna dalam proses tersebut. Hasil keputusan daripada teknik, Rekabentuk untuk Nyah-Pemasangan (DFD) dan Algoritma Genetik dibandingkan untuk menunjukkan prestasi teknik Algoritma Genetik yang dicadangkan.

ABSTRACT

This paper introduces the use of an Artificial-Intelligence (AI) based technique, Genetic Algorithm (GA), to solve single model product disassembly sequence problems. The generation of disassembly sequence is modeled using Design for Assembly (DfA) working principles. In this paper, the performances of Design for Disassembly (DfD) and GA in selecting optimum disassembly sequence were tested. The problem is involves minimizing the total disassembly time by proper feeder allocation and component sequencing. The objective is to find out the optimum disassembly sequence with minimum disassembly time. The study started by manual disassembly using DfD which involves manual handling and manual insertion guideline in estimating time to search for optimum sequence. Finally, GA technique is applied to search for the optimum sequence. The results were compared between DfD and GA to show the efficiency of the proposed GA approach.

ACKNOWLEDGEMENT

Praise and glory to the Father in heaven who had interceded my prayer, guide me and gave me the courage to complete my master programme.

This project is study about disassembly process which in the engineering field that merely strange to me. I had to study how far does AI techniques would helped in such process. Mr. Ruslizam Daud, my supervisor in this project, had guided me all the way long. I would like to express my appreciation to him for his creativity encouraging guidance.

Last but not least, I wish to thank my precious and sweet family who gave me fully support during the study. Without them, I would not able to complete my project.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AI	Artificial Intelligent
GA	Genetic Algorithm
DFD	Design for Disassembly
DFA	Design for Assembly

CHAPTER 1

INTRODUCTION

This chapter briefly explains the background of the study that mainly involves the disassembly process, Genetic Algorithm as AI technique to select the optimum disassembly sequence. The problem statement, objectives, significance of the study and scopes will also be introduced.

1.1 Research Background

Environmental issues are becoming increasingly important to product manufacturers as well as to municipal and governmental authorities. This trend is most apparent when the environmental impact of worn-out products is considered. The shortage of landfill and waste burning facilities constantly remind us that our products do not simply disappear after disposal.

Increasing concern regarding the environmental effects associated with a product's life cycle has propelled the end-of-life (EOL) disassembly to prominence (Viswanathan S. et al. 2004). Disassembly is an important process affecting the product retirement. Once disassemble, the engineer or production department know which part of a product can be reuse, recycled, stored or dispose. Reuse option includes the repair, refurbish and cleaning processes. Recycling is performed in order to regain the material content of the EOL product. Storing the

The contents of the thesis is for internal user only

REFERENCES

Boothroyd, G. (1992). Assembly Automation And Product Design. New York: Marcel Dekker.

Daabub, A.M., & Abdalla, H.S. (1999). A Computer-based Intelligent System for Design for Assembly. *Computers & Industrial Engineering*, 37: 111 – 115.

Deo, S., & Javadpour, R., & Knapp, G.M. (2002). Multiple Setup PCB Assembly Planning Using Genetic Algorithm. *Computers & Industrial Engineering*, 42: 1 – 16.

Chan, V., & Salustri, F.A. (2003). Design for Assembly. Retrieved October 10, 2003, from http://deed.ryerson.ca/~fil/t/dfmdfa.htm

Chapman, C.D., & Saitou, K., & Jakiela, M.J. (1994). Genetic algorithms as an approach configuration and topology design. *Journal of Mechanical Design*, **116/1005**.

Elaoud, A., & Teghem, J., & Bouaziz, B. (2007). Genetic Algorithms to Solve The Cover Printing Problem. *Computers & Operations Research*, 34: 3346 – 3361.

Galantucci, L.M., & Percoco, G., & Spina, R. (2004). Assembly and Disassembly Planning by using Fuzzy Logic & Genetic Algorithm. *International Journal of Advanced Robotic Systems*, **1**(2): 67-74.

Gungor, A., & Gupta, S.M. (1997). An evaluation methodology for disassembly process. *Computers and Industrial Engineering*, **33**(1): 329-32.

Gungor, A., & Gupta, S.M. (1998). Disassembly sequence planning for products with defective parts in product recovery. *Computers and Industrial Engineering*, **35**(1-2): 161-4.

Gungor, A. & Gupta, S.M. (2001). Disassembly sequence generation using a branch and bound algorithm. *International Journal of Production Research*, **39**(3): 481-509.

Ho, W., & Ji, P. (2004). PCB Assembly Line Assignment: A Genetic Algorithm Approach. *Journal of Manufacturing Technology Management*, 16(6): 682 – 692.

Ip, W.H., & Li, Y., & Man, K.F., & Tang, K.S. (2000). Multi-product planning and scheduling using genetic algorithm approach. *Computers and Industrial Engineering*, **38**: 283-296.

Kara, S., & Pornprasitpol, P., & Kaebernick, H. (2005). A Selective Disassembly Methodology for End-Of-Life products. *Emerald Group Publishing Limited*, 25(2): 124 – 134.

Khoo, L.P., & Ng, T.K. (1998). A Genetic Algorithm Based Planning System for PCB Component Placement. *International Journal of production Economics*, 54: 321 – 332.

Lambert, A.J.D. (2005). Optimizing Disassembly Processes Subjected to Sequence Dependent Cost. *Elsevier Ltd.*

Loh T.S., & Bukkapatnam S.T.S., & Medeiros D., & Kwon H. (2001). A Genetic Algorithm for Sequential Part Assignment for PCB Assembly. *Computers & Industrial Engineering*, 40: 293 – 307.

McGovern, S.M., & Gupta S.M. (2007). A Balancing Method and Genetic Algorithm for Disassembly Line Balancing. *European Journal of Operational Research*, 179: 692 – 708.

Perez-Vazquez, M.E., & Gento-Municio, A.M., & Lourenco, H.R. (2007). Solving A Concrete Sleepers Production Scheduling By Genetic Algorithms. *European Journal of Operational Research*, 179: 605 – 620.

Perkgoz, C., & Azaron, A., & Katagiri, H., & Kato, K., & Sakawa, M. (2007). A Multi-Objective Lead Time Control Problem In Multi-Stage Assembly Systems Using Genetic Algorithms. *European Journal of Operational Research*, 180: 292 – 308.

Pongcharoen, P., & Hicks, C., & Braiden, P.M., & Stewardson, D.J. (2002). Determining Optimum Genetic Algorithm Parameters for Scheduling The Manufacturing and Assembly of Complex Products. *International Journal of Production Economics*, 78: 311 – 322.

Ponnambalam, S.G., & Aravindan, P., & Rao, M.S. (2003). Genetic Algorithms for Sequencing Problems in Mixed Model Assembly Lines. *Computers & Industrial Engineering*, 45: 669 – 690.

Ruslizam, D., & Mohd, R.F., & Azwan, A.I. (). A Comparative Study of Pre-Design DFA and Post-Design DFA Method for Product Improvement. *International Conference on Manufacturing Science and Technology*, 269-272.

Vaishnavi & Kuechler (2006). Design Research in information system. Retrieved June 15, 2006, from http://www.isworld.org/Researchdesign/drisISworld.htm

Veerakamolmal, P., & Gupta, S.M., & McLean C.R. (1997). Disassembly process planning. *First International Conference on Engineering Design and Automation.*

Veerakamolmal, P., & Gupta, S.M. (1998). Optimal analysis of lot size balancing for multi products selective disassembly. *International Journal of Flexible Automation and Integrated Manufacturing*, **6**(3/4): 245-69.

Veerakamolmal, P., & Gupta, S.M. (1999). Analysis of design efficiency for the disasembly of modular electronic products. *International Journal of Electronic Manufacturing*, **9**(1): 79-95.

Viswanathan, S., & Allada, D.V. (1999). A Framework For The Flexible Grouping Of Products For Disassembly. *Journal of Electronics Manufacturing*, **9**(1): 53-66.

Viswanathan, S., & Allada, V. (2004). Product Configuration Optimization for Disassembly Planning: A Differential Approach. *The International Journal of Management Science*, 01: 011.

Zussman, E., & Zhou, M. (2000). Design and implementation of a adaptive process planner for disassembly processes. *IEEE Transactions on Robotics and Automation*, **16**(2): 171-9.