



**UNIVERSITI PUTRA MALAYSIA**

***DEVELOPMENT OF A HEURISTIC PROCEDURE FOR BALANCING  
MIXED MODEL PARALLEL ASSEMBLY LINE TYPE II***

**GHOLAMREZA ESMAEILIAN**

**FK 2010 14**



**DEVELOPMENT OF A HEURISTIC PROCEDURE FOR BALANCING  
MIXED-MODEL PARALLEL ASSEMBLY LINE TYPE II**

By

**GHOLAMREZA ESMAELIAN**

**Thesis Submitted to the School of Graduate Studies, Universiti Putra  
Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of  
Philosophy**

**February 2010**

Abstract of thesis presented to the senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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**GHOLAMREZA ESMAEILIAN**

**February 2010**

**Chairman: Assoc. Prof. Datin Napsiah bt Ismail, PhD**

**Faculty: Engineering**

The single-model assembly line is not efficient for today's competitive industry because to respond the customer's expectation, companies need to produce mixed-model products. On the other hand, using the mixed-model products increases the assembly complexity and makes it difficult to assign tasks to workstations because of the variety in model characteristics. As a result, the mixed-model products suffer from delays, limitations in the line workflow and longer lines. Parallel assembly lines as a production system in ALBPs which consists of a number of assembly lines in a parallel status, which by considering the cycle time of each line certain products are manufactured. This thesis takes advantages of the parallel assembly lines to produce mixed-model in order to assemble more than one model in each parallel assembly line and allocating tasks of models to workstations and balancing each parallel line to reduce the cycle times.

To solve these problems, two heuristic algorithms were developed and coded in MATLAB<sup>®</sup>. The first one allocates each model to only one parallel assembly line and achieves the initial arrangement of tasks with the minimum number of

workstations for each line. The second one called Tabu search Mixed-Model Parallel Assembly Line Balancing (TMMPALB), calculates final balancing tasks of different model in parallel lines with optimum cycle time for each line which tasks of each model can be allocated to more than one parallel assembly line through the TMMPALB. The main advantages of employing TS are using a flexible memory structure during the search process, and intensification and diversification strategies, which help to make a comprehensive search in the solution space.

Fourteen data sets create 81 test problems that were solved to validate the performance of the TMMPALB. Each test problem consisted of the number of tasks, process time for each task (time unit), and the precedence relationship, minimum number of station and cycle time for each model. By considering that 80 out of the 81 test problems include three models and the remaining one has four models, 244 cycle times is made, which TMMPALB tries to minimize. The computational results showed that 205 cycle times out of the 244 cycle times have been improved. These results demonstrated that by arranging mixed-model through the parallel assembly lines with minimum number of workstations, the minimum cycle times are achieved in comparing with the single line.

Abstrak tesis dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**PEMBANGUNAN PROSEDUR HEURISTIK UNTUK KESEIMBANGAN  
MODEL-BERCAMPUR DALAM GARIS PEMASANGAN SELARI JENIS II**

Oleh

**GHOLAMREZA ESMAEILIAN**

**Februari 2010**

**Pengerusi: Prof. Madaya Datin Napsiah bt Ismail, PhD**

**Fakulti: Kejuruteraan**

Dalam persaingan industri pada hari ini, garis pemasangan produk tunggal adalah tidak cekap kerana kebanyakan daripada syarikat perlu memenuhi permintaan pelanggan bagi menghasilkan produk model bercampur. Sebaliknya, dengan menggunakan model bercampur, akan mengalami kelewatan, had dalam aliran kerja garis, serta garis lebih panjang. Sebagai satu sistem pengeluaran, pemasangan garis selari adalah satu lagi konsep yang berkaitan dengan ALBPs dimana mengandungi sejumlah pemasangan garis dalam satu taraf selarian dimana produk dikeluarkan dengan mempertimbangkan masa kitaran setiap baris tersebut. Tesis ini mengambil kelebihan pemasangan selari untuk mengeluarkan produk model bercampur dengan tujuan memasang lebih daripada satu produk disetiap barisan pemasangan selari dan memperuntukkan tugas model serta mengimbang garis untuk mengurangkan masa kitaran setiap hasil keluaran.

Untuk menangani masalah ini, dua algoritma heuristik telah dibangunkan dan yang telah dikodkan didalam MATLAB<sup>®</sup>. Pertama adalah diperuntukkan untuk tugas bagi setiap model bagi pemasangan garis selari dan mengira bilangan minimum bagi

stesyen kerja untuk setiap baris. Kedua, yang dipanggil Pencarian Tabu Model Bercampur Pengimbangan Baris Pemasangan Selarian (TMMPALB), mengira satu masa kitar optimum untuk setiap garis pemasangan selari model bercampur melalui pencarian algoritma Tabu (TS). Kelebihan utama menggunakan TS ialah struktur memori yang fleksibel selama proses carian, dan intensifikasi dan kepelbagaian strategi, yang membantu untuk membuat carian yang komprehensif dalam ruangan penyelesaian.

Empat belas set data yang kerap digunakan untuk mewujudkan 81 masalah ujian telah diselesaikan untuk mensahihkan prestasi TMMPALB. Masalah setiap ujian yang terkandung didalam sejumlah tugas, satu masa proses untuk setiap tugas (unit masa), dan hubungan keutamaan dan masa kitaran untuk setiap hasil keluaran. Dengan mempertimbangkan 80 daripada 81 masalah-masalah ujian adalah untuk tiga model dan satu daripadanya mempunyai empat model, dengan jumlah 244 masa kitaran untuk TMMPALB yang perlu diminimumkan. Keputusan menunjukkan bahawa 205 masa kitaran daripada 244 masa kitaran telah. Berkurangan keputusan-keputusan ini menunjukkan dengan menyusun produk model bercampur melalui garis pemasangan selari bilangan stesyen kerja minimum dan masa kitaran minimum dicapai jika dibandingkan dengan garis tunggal.

## ACKNOWLEDGEMENTS

First and foremost, I would like to thank GOD for the countless bounties he has granted me. I thank Him for giving me the ability to deal with my challenges during my research. I thank Him for letting me accomplish this thesis work.

Second, I would like to express my sincerest gratitude to Assoc. Prof. Dr. Napsiah for her valuable supervision and encouragement and special thanks to my committee members: Prof. Dr. Shamsuddin and Prof. Dr. Megat for their interest and helps throughout this study. I would have not achieved this goal without their support. I am also grateful to Dr. Özcan for his patience to answer my questions and his colleagues. In addition, I would like thank Dr. Lusa.

Third, the author wishes to thank University Putra Malaysia for the financial support of our work, Department of Mechanical and Manufacturing to conduct the research and the anonymous referees for their praiseworthy accuracy and readiness in carrying out the reviews, and for their valuable suggestions, which led to an improvement of the quality of the presented work.

Finally, I would like to thank my wife, Maryam; she has been a constant source of inspiration and giving all her love and sacrifice to support me. She has shared the journey of PhD thesis writing from its early beginnings to the last stage and I acknowledge with gratitude and love the importance of her presence in my life.

## DEDICATION

With love and gratitude to my parents and my wife Maryam.







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## APPROVAL

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the Degree of Doctor of Philosophy. The members of Supervisory Committee were as follows:

**Napsiah Ismail, PhD**

Associate Professor  
Faculty of Engineering  
Universiti Putra Malaysia  
(Chairman)

**Shamsuddin Sulaiman, PhD**

Professor  
Faculty of Engineering  
Universiti Putra Malaysia  
(Member)

**Megat Mohammad Hamdan b Megat Ahmad, PhD**

Professor  
Faculty of Engineering  
Universiti Pertahanan Nasional Malaysia  
(Member)

---

**HASANAH MOHD. GHAZALI, PhD**

Professor and Dean  
School of Graduate Studies  
Universiti Putra Malaysia

Date: 13 May 2010

## DECLARATION

I declare that the thesis is my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

*Gholamreza Esmacilian*

Date: 08 April 2010



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