UNIVERSITI PUTRA MALAYSIA

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

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By

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

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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®. 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

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Februari 2010

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

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Dalam persaingan industri pada hari ini, garis pemasangan produk tunggal adalah tidak cekap kerana kebanyakkan 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®. 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 tugasan (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.

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DEDICATION

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

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:

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