UNIVERSITI PUTRA MALAYSIA

PRODUCTION SCHEDULING OF RECONFIGURABLE MANUFACTURING SYSTEMS USING FUZZY LOGIC TECHNIQUES

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By

TARVATSADAT NEHZATI

**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in
Fulfillment of the Requirements for the Degree of Master of Science**

May 2012

DEDICATION

For all your advice and encouragement, this thesis is gratefully dedicated to:

My Beloved Father and Mother

Seyed Behrooz Nehzati

Maryam Bokharaiean Khorasani

Thank you very much for your continuous support and effort towards the

publication of this thesis.

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Master of Science

PRODUCTION SCHEDULING OF RECONFIGURABLE MANUFACTURING SYSTEMS USING FUZZY LOGIC TECHNIQUES

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TARAVATSADAT NEHZATI

May 2012

Chairman: **Professor Napsiah Ismail, PhD**

Faculty: **Engineering**

Evolution of manufacturing systems passed through different environment to full fill a need for optimal operating system. This led dynamic environment of manufacturing to Reconfigurable Manufacturing Systems (RMSs), which characterized by shorter product life cycle and changes in demand. To implement a successful RMS, effective process plan and production schedule is essential. However, little is known about applicability and effectiveness of intelligent techniques in reconfigurable manufacturing. On the other hand, investigation on the influence of intelligent production scheduling techniques on RMS performance is not negligible.

This research proposed fuzzy model is subject to evaluate thedefined performance measures, such as; Machine utilization, Scalability, Product completion time and Lateness. To verify the methodology, the obtained result brought to comparison with

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those results acquired in conventional manufacturing systems. In addition a recursive mathematical model is developed to enhance the research validation.

In this study, fuzzy logic model usedfour suitable fuzzy input variables, namely machine allocated processing time, machine priority, due date priority and machine structure, to solve production scheduling problem in selecting machine for each job operation and determining the processing sequence for each machine,simultaneously. The proposed fuzzy model used a fuzzy rule based inference system to determine job priority as a fuzzy output variable for the production scheduling purpose.

The production schedule showed that is able to improve performance criteria in machine utilization, machine completion time, and also in product completion time as well as scalability. Experimental and comparative test indicates superiority of RMS environment over Flexible Manufacturing System environment (FMS)on using the same fuzzy based production scheduling model in terms of machine utilization (increased by 6.6%), machine completion time (increased by 63.3%), lateness (decreaseddeistically) and product completion time (increased by 22.13), as well as throughput (increased by 20%). Employing mathematical programming showed that the fuzzy scheduling is the most successful approach to solve RMS scheduling problem. However, investigating on the effect of changing manufacturing environment and fuzzy production scheduling model on a conventional production scheduling demonstrated slight increment in machine utilization, machine completion time and product completion time increased by 0.82%, 9.1%, and 2.4% respectively while lateness decreased by 35%, however the through put reduced by -2.5%.Although the obtained results are discussable based on

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assumptions and input data, however the positive impact of fuzzy technique in RMS environment is easily interpretable.

The performance in fuzzy based production scheduling of RMS is superior to that of conventional manufacturing systems.The results would motivates researches to continue with evaluating different performance measures and assumptions and evaluating the effect of fuzzy logic techniques in order to come up with utilized production scheduling model for future manufacturing environment.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazahMaster Sians

PENJADUALAN PENGELUARAN SISTEM PEMBUATAN BERKONFIGURASI MENGGUNAKAN KAEDAH FUZZY LOGIK

Oleh

TARAVATSADAT NEHZATI

Mei 2012

Pengerusi: **Profesor Napsiah Ismail, PhD**

Fakulti: **Kejuruteraan**

Untuk mendapatkan system operasi yang optima, sistem pembuatan telah melalui pelbagai persekitaran dan suasana yang berbeza. Perbezaan itu telah membawa persekitaran yang dinamik kepada sistem pembuatan yang berkonfigurasi (RMSs) yang menjurus kepada kitaran hayat produk yang lebih pendek serta perubahan permintaan. Proses rancangan yang berkesan disusuli dengan jadual pengeluaran adalah sangat penting dalam menjayakan sistem pembuatan berkonfigurasi ini. Walau bagaimanapun, terdapat maklumat yang terhad tentang kebolehsaknaan dan keberkesanan kaedah pintar yang digunakan dalam sistem pembuatan berkonfigurasi ini. Sebaliknya, melihat kepada peranan yang besar yang dimainkan oleh RMS ini pada masa hadapan di dalam bidang pembuatan, sewajarnya, kajian terhadap impak kepada kaedah penjadualan pintar RMS tidak boleh diabaikan.

Kajian ini ialah untuk mengaplikasikan model penjadualan pengeluaran fuzzy di dalam RMS, yang bertujuan untuk menyelesaikan masalah berkaitan kedudukan operasi

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(laluan) dan penjadualan (turutan) di dalam persekitaran RMS. Pelaksanaan model fuzzy yang dicadangkan adalah tertakluk kepada penilaian terhadap ukuran prestasi yang telah ditentukan seperti penggunaan mesin, kebolehukuran, masa siap setiap produk serta kelewatan. Dalam mengesahkan metodologi, hasil/keputusan daripada keedah ini dibandingkan dengan keputusan yang dihasilkan dari kaedah system pembuatan yang konvensional.

Dalam kajian ini, secara serentak, model fuzzy menggunakan empat input pembolehubah fuzzy iaitu masa pemprosesan mesin, keutamaan mesin, keutamaan tarikh akhir dan struktur mesin, masalah penjadualan pemilihan mesin untuk setiap operasi dan menentukan turutan proses untuk setiap mesin. Model fuzzy yang dicadangkan menggunakan sistem kesimpulan berasaskan peraturan fuzzy dalam menentukan keutamaan tugasan atau hasil pembolehubah untuk tujuan penjadualan.

Penjadual yang dicadangkan menunjukkan ia boleh meningkatkan prestasi penggunaan mesin, masa siap untuk setiap mesin, masa siap untuk setiap produk serta kebolehukuran. Ujian secara eksperimen dan perbandingan menunjukkan sistem pembuatan berkonfigurasi adalah lebih baik berbanding sistem pembuatan fleksibel (FMS) dengan menggunakan model penjadualan berasaskan fuzzy yang sama, seperti penggunaan mesin (peningkatan 6.6%), masa siap untuk setiap mesin (peningkatan 63.3%), kelewatan (peningkatan 103%), masa siap untuk setiap produk (peningkatan 22.13%) dan pengeluaran (peningkatan 20%). Namun, kajian terhadap kesan perubahan persekitaran pembuatan dan model penjadualan fuzzy ke atas kaedah penjadualan konvensional menunjukkan peningkatan yang sedikit pada penggunaan mesin, masa siap

untuk setiap mesin, kelawatan, dan masa siap untuk setiap produk , masing-masing dengan peningkatan 0.82%, 9.1%, 35% dan 2.4%, manakala, pengeluaran berkurang sebanyak 2.5%. Walaupun hasil yang dibincangkan adalah berdasarkan kepada andaian dan data input, kesan penggunaan kaedah fuzzy dalam persekitaran RMS amat mudah dijelaskan.

Prestasi kaedah penjadualan secara fuzzy di dalam RMS adalah sangat baik berbanding kaedah sistem pembuatan yang lain. Hasil daripada kajian ini akan menggalakkan kajian seterusnya dengan mengkaji ukuran prestasi yang berbeza, membuat andaian dan menilai kesan daripada kaedah fuzzy dengan tujuan untuk menghasilkan model penjadualan yang boleh digunakan di dalam bidang pembuatan di masa hadapan.

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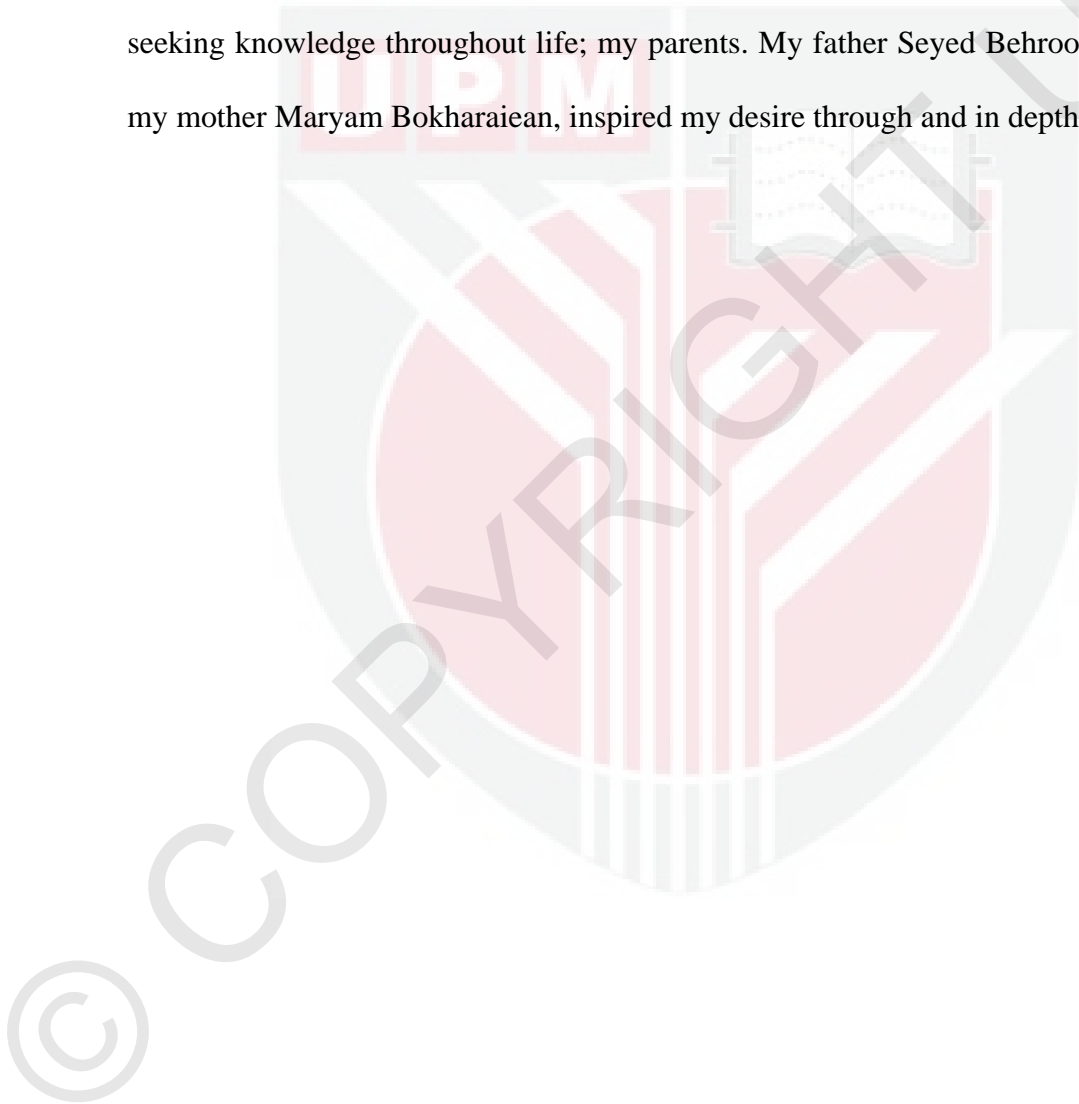
I certify that a Thesis Examination Committee has met on 11th of May, 2012 to conduct the final examination of Taravatsadat Nehzati on her thesis entitled **"Production scheduling ofReconfigurable Manufacturing System Using Fuzzy Logic Technique"** in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Science.

Members of the Thesis Examination Committee were as follows:

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

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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.

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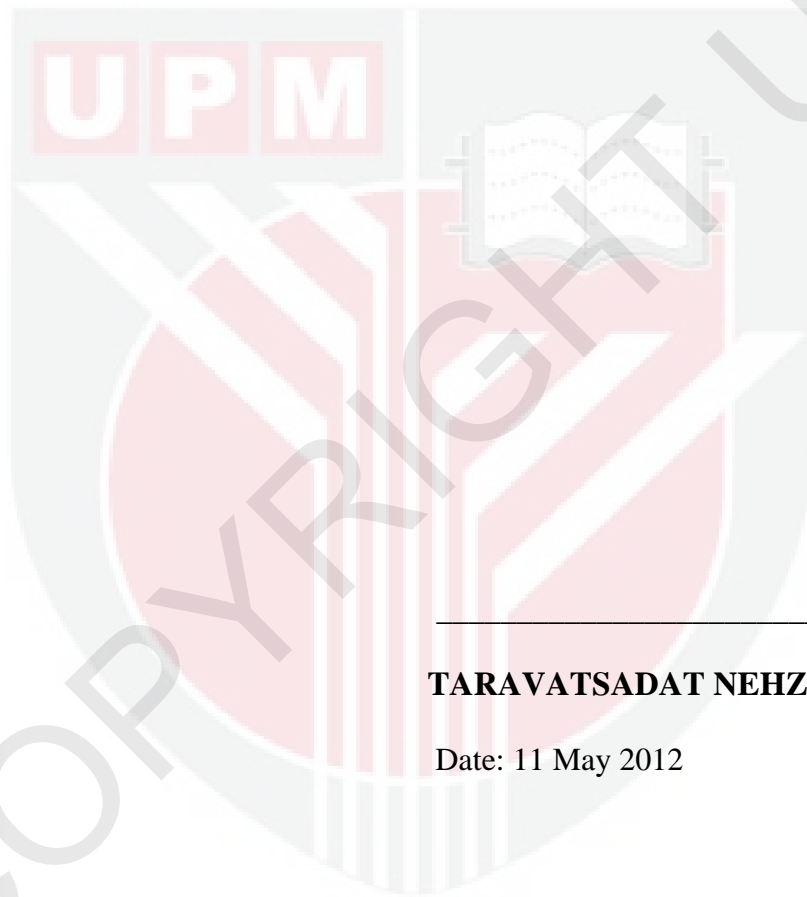
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Date: 11 May 2012

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