



**Tribhuvan University**  
**Institute of Science and Technology**

# **Study of Different Sequencing Approaches for Mixed-Model Just-in-Time Production System**

**A Project work Submitted To:**

Tribhuvan University  
Central Department of Computer Science and Information Technology  
(CDCSIT)  
Kirtipur, Kathmandu, Nepal

In partial fulfillment of the requirements for  
The Master's Degree in Computer Science and Information  
Technology

**Submitted By:**

Bharat Raj Pokharel

January 2012



**Tribhuvan University**  
**Institute of Science and Technology**  
**Central Department of Computer Science and Information Technology**

### **Supervisor's Recommendation**

I hereby recommend that the project work prepared under my supervision by **Mr. Bharat Raj Pokharel** entitled **Study of Different Sequencing Approaches for Mixed-Model Just-in-Time Production System** in partial fulfillment of the requirements for the degree of M. Sc. in Computer Science and information Technology be processed for the evaluation.

.....  
**Prof. Dr. Shashidhar Ram Joshi**  
Department of Computer Engineering,  
**Pulchowk Campus IOE, Pulchowk,**



**Tribhuvan University  
Institute of Science and Technology  
Central Department of Computer Science and Information Technology**

**LETTER OF APPROVAL**

We certify that we have read this project work and in our opinion it is satisfactory in the scope and quality as a dissertation in the partial fulfillment for the requirement of Masters Degree in Computer Science and Information Technology.

**Evaluation Committee**

.....  
**Asst. Prof. Dr. Tanka Nath Dhamala**  
Head,  
Center Department of Computer  
Science and Information Technology,  
Tribhuvan University, Kathmandu,  
Nepal

.....  
**Prof. Dr. Shashidhar Ram Joshi**  
Department of Computer  
Engineering,  
Pulchowk Campus IOE,  
Pulchowk, Kathmandu, Nepal.  
**(Supervisor)**

.....  
**External Examiner**

.....  
**Internal Examiner**

## ACKNOWLEDGEMENT

I really give me a great pleasure to write the acknowledgement on the completion of this project work at the Center Department of Computer Science and Information Technology, Tribhuvan University. I am deeply indebted to number of valuable guidance, constructive comments, encouragement and suggestion of my respected supervisor Prof. Dr. Sashidhar Ram Joshi, Head, Department of Computer Engineering, Pulchowk Campus IOE, Pulchowk, Kathmandu, Nepal. His kindly help and scholarly guidance have become the greatest property of this dissertation, without his supervision, this would never have been appeared in the form. To whom I express my extreme gratitude. Meanwhile, I am very much grateful to the research committee members of Tribhuvan University who conclude positive decision on my proposal.

I express my appreciation to all my teachers, Dr. Onkar Prasad Sharma, Marist College, USA, Asso. Prof. Dr. Subarna Sakya (IOE-TU), Dr. Tanks Nath Dhanala (CDCSIT-TU), Prof. Sudarsan Karanjit (NCIT), Ast. Prof. Min Bahadur Khati (CDCSIT-TU), Mr. Hementa G.C. (CDCSIT-TU), Mr Samujjwal Bhandari (CDCSIT-TU), Mr. Bishnu Gautam (CDCSIT-TU), Mr. Dinesh Bajracharya (CDCSIT-TU), Mr. Arjun Saud (CDCSIT-TU), Mr. Jagdish Bhatta (CDCSIT-TU) and other for granting me broad knowledge and inspirations within the time period of two years.

During this work I have collaborated with many colleagues for whom I have great regards, and I wish to extend my warmest thanks to all those who have helped me with my work in the department.

Finally, I want to express my love and appreciation to Mr. Tribhuwan Pokharel for his patience and encouragement throughout this research time. I would like to thanks my family and my friend **Ganesh Prasad Chataut** for their continuous help and encouragements, likewise, I thanks all those relatives and other who wish to success.

Bharat Raj Pokharel  
CDCSIT T.U.

## **ABSTRACT**

### **Study of Different Sequencing Approaches for Mixed-Model Just-in-Time Production System**

Mixed Model Just-in-Time production systems have been developed in recent years in order to reduce costs of diversified small-lot production, which involves producing only the necessary products in the necessary quantities at necessary times. This problem minimizes both the earliness and the tardiness penalties that respond to the customer demands for a variety of models without holding large inventories or incurring shortages. The problem of sequencing flexible transfer lines or mixed-model assembly lines according to the JIT philosophy can be formulated as a non-linear integer programming problem.

In this project work , we focused on the concept of penalizing jobs both for being early and for being tardy because not only of modern competitive industrial challenges of providing a variety of products at a very low cost by smoothing productions but also of its increasing and exciting computer applications. Here, sequencing approaches of the mixed-model just-in-time production systems is reviewed. In this project work, realizing a need of critical review, a survey on the elegant mathematical models, methods and complexity of the mixed-model just-in-time sequencing problem with an insight into the existing analytical literature is given. The established research results together with open problems and possible extensions are presented.

## DEDICATION

To My Mother Santa Pokharel

And

My Father Bishnu Prasad Sharma

Who spend their whole life

For

My Study

## **LIST OF ABBREVIATIONS**

AP	:	Assignment Problem
DP	:	Dynamic Programming
EDD	:	Earliest Due Date
FCFS	:	First Come First Serve
JIT	:	Just In Time
JITPS	:	Just In Time Sequencing Problem
MDJIT	:	Mixed Model Just In Time
MMJITSP	:	Mixed Model Just In Time Sequencing Problem
ORV	:	Output Rate Variation
ORVP	:	Output Rate Variation Problem
OS	:	Operating System
PRV	:	Production Rate Variation
PRV-MD	:	Production Rate Variation Maximum Deviation
PRV-MM	:	Production Rate Variation Mixed Model
PRVP	:	Production Rate Variation Problem
SJF	:	Shortest Job First
SRTN	:	Shortest Remaining Time Next

# TABLE OF CONTENTS

## Chapter 1

<b>1. Introduction:</b> .....	<b>1</b>
1.1 Background: .....	1
1.2 Objective of the Study:.....	2
1.3 Organization of the Thesis:.....	3
1.4 Methodology: .....	3

## Chapter 2

<b>2. Computational Complexity</b> .....	<b>4</b>
2.1 Turing Machine: .....	4
2.2 Functions .....	5
2.3 Graph Theoretical Denotations .....	6
2.4 Algorithms .....	6
2.5 Heuristics Programming .....	9
2.6 Dynamic Programming .....	10
2.7 Complexity Classes .....	11
2.8 Combinatorial Optimization .....	13

## Chapter 3

<b>3. Scheduling Problems: Complexity</b> .....	<b>21</b>
3.1 Schedules and their representation .....	21
3.2 Some application area of scheduling.....	22
3.3 Earliest Due Date (EDD) Algorithm .....	25
3.4 Benefit of Just-in-Time Production System .....	25
3.5 Applications of Just-in-Time Production System .....	26

## Chapter 4

<b>4. Mathematical Mode Formulation:</b> .....	<b>28</b>
4.1 The ORV Problem Formulation:.....	28
4.2 Product Rate Variation Problem:.....	28
4.3 Pegged ORV Problem:.....	31



## Chapter 5

<b>5. Solution Procedure for PRV Problem:</b> .....	<b>32</b>
5.1 Heuristic Approach .....	32
5.2 Dynamic Programming .....	33
5.3 Assignment Method .....	35
5.4 Perfect Matching Method .....	38
5.5 Simultaneous Optimality .....	43

## Chapter 6

<b>6. Solution Procedure for ORV Problem:</b> .....	<b>45</b>
5.6 Heuristic nearest integer point:.....	45
5.7 Miltenburg and Sinnamon Heurist Approach:.....	46
5.8 Dynamic Programming Algorithm: .....	48

## Chapter 7

<b>7. Conclusion:</b> .....	<b>52</b>
<b>References:</b> .....	<b>53</b>
<b>Appendix</b> .....	<b>56</b>

**List of Figure:**

Figure 1: Graphical notation of $f(n) = O(g(n))$ .....	7
Figure 2: Machine Oriented Gantt Chart .....	22
Figure 3: Job Oriented Gantt Chart .....	22
Figure 4: Mixed-Model Multi-Level Production System .....	28
Figure 5: Input Demand for ORVP.....	47

**List of Table:**

Table1: Schedule generated for demand vector using Heuristic Nearest integer point .....	47
Table2: Assembly and Demand Data .....	48
Table3: Schedule generated by dynamic programming .....	50