MIXED INTEGER PROGRAMMING (MIP) MODEL FOR PRODUCTION SCHEDULING IN AN AUTOMOTIVE PART COMPANY

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Thanks to

My beloved parents

Kamaruddin bin Hashim and Roslina binti Nik Mohd. Amin

My supportive fiancée

Mohd.Khairul Rijal bin Ab.Rahman

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ABSTRACT

Scheduling is defined as the allocation of resources to task over time in such a way that a predefined performance measure is optimized. Scheduling is a decision making function that plays an important role in manufacturing industries. In this research, a model of Mixed Integer Programming is proposed based on the scheduling problems in an automotive part production company. This mathematical method provides a theoretical framework for the formulation and solution of the models which involve the translation of the real problem into a model. This model targets to optimize the scheduling production in order to increase productivity. All standard constraints encountered in the production scheduling are included in the model (machine capacity, material balances, manpower restrictions and inventory limitations). Machine setup time changeover and cost changeover for the different product will influence the arrangement of scheduling process. The objective function that is minimized considers all major sources of variable cost that depend on the production schedule, such as changeover cost between products, inventory cost and labor cost. The result from this study are presented and discussed based on the optimal production schedule.

ABSTRAK

Penjadualan ditakrifkan sebagai peruntukan sumber daya untuk tugas dari masa ke masa sedemikian rupa sehingga saiz prestasi yang telah ditetapkan dioptimumkan. Penjadualan adalah proses membuat keputusan yang memainkan peranan penting dalam industri perkilangan. Dalam kajian ini, model 'Mixed Integer Programming' dibentuk berdasarkan kepada masalah penjadualan yang timbul di bahagian pengeluaran automotif di syarikat. Kaedah matematik memberikan kerangka teori untuk formulasi dan penyelesaian model yang diterjemahkan dari masalah nyata ke dalam bentuk model. Model ini mensasarkan untuk mengoptimumkan penjadualan pengeluaran dengan tujuan meningkatkan produktiviti. Semua rintangan yang wujud dalam penjadualan pengeluaran akan diserapkan ke dalam model (mesin kapasiti, keseimbangan bahan mentah, sekatan tenaga kerja dan keterbatasan inventori). Pertukaran masa persediaan mesin dan pertukaran kos untuk produk yang berbeza akan mempengaruhi tatacara proses penjadualan. Fungsi objektif yang diminimalkan mempertimbangkan semua sumber utama dari kos pembolehubah yang bergantung pada jadual pengeluaran, seperti kos pertukaran di antara produk, kos persediaan dan kos tenaga kerja. Hasil dari kajian ini disajikan dan dibahas mengikut penjadualan pengeluaran yang optimum.

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CHAPTER 1

INTRODUCTION

1.1 Background of the Study

Scheduling can be broadly defined as the allocation of resources to tasks over time in such a way that a predefined performance measure is optimized. From the view point of production scheduling, the resources and tasks are commonly referred to as machines and job and the commonly used performance measure is the completion time of jobs [1]. In manufacturing, there are many types of scheduling such as job shop, flow shop, sequencing, parallel and etc. Problems arise in scheduling when the process of the production has many products to be produced. Therefore, scheduling can be said as a strategy to determine what product will be produced in a certain day based the certain limitations that need to be considered.

In order to have a good scheduling planning, a technique can be applied in this problem is Mixed Integer Programming (MIP). Mixed integer programming is known as a guiding quantitative decision in business, industrial engineering and to the social and physical sciences. In World War II, this technique used to deal with transportation, scheduling and allocations of resources under constraints like cost and priority gave subject an impetus that carried it into the postwar era. This means that, this technique can be used in order to help in solving scheduling problem. In this study, MIP is used to model the real life situations in scheduling of automotive parts production process.

1.2 Problem Statement

Scheduling is a complicated problem where there is a variety of products needs to be scheduled in a certain period of time. In one day, production only can produce a certain amount of product. This issue is further complicated where a decision needs to be made in order to schedule the production process for all of the products. This decision must take into consideration about the limitations that may present during the scheduling process. Limitations that present in the scheduling problem are machine capability, labor hour, changeover time for transition between two products, change over cost for transition between two products and cycle time for each product. Each type of product may have a different cycle time process where it will restrict the amount of production due to the machine capacity. Besides, in one day, there is possibility to have more than one product to be manufactured which involve the changeover time and cost between those products. Therefore, a good scheduling planning is needed to overcome all the restriction so that an optimal production can be achieved.

1.3 Objective

In order to complete this project within the time frame and the scope given, several objectives for this research have been identified and listed such as below:

a) To formulate a model based on Mixed Integer Programming (MIP) method which can solve scheduling problem in an automotive part company.

b) To determine the optimum schedule for the automotive part production process.

1.4 Scope of the Study

In this research, the data used were taken from a company named company I which is located at Pasir Gudang, Johor. This study focused only on the production department where automotive component part is produced. The scope is narrow down by only selecting a single production line as the subject in this study which is capable to produce 8 different types of product. A complete data for a month duration will be used in the study.

1.5 Significance of the Study

The significance of this study is to create a Mixed Integer Programming model based on the company scheduling problem. This model will be used to solve the scheduling problem in order to help the company to have a better planning in the scheduling production process. Through this model, an effective scheduling planning for the production process in a month period can be created as a guide to the company so that an optimal production can be obtained.

1.6 Outline of the Report

The structure of the report can be summarized as shown in Table 1.1. The description of each chapter in the report is as follow:

1) Chapter 1: Introduction

   This chapter gives a broad idea about the whole study. The main topics included in this chapter are background of scheduling and mixed integer programming (MIP) technique, problem statement, objective, scope, significance of study and the outline of the project report.

2) Chapter 2: Scheduling

   This chapter summarized all the theories, information and previous research that related to the scheduling problem and mixed integer programming technique. Discussion based on the finding from journals, books, internet, articles and etc are done in this chapter. Topics included in this chapter are production planning, scheduling, mixed integer programming (MIP) and previous research related to scheduling problem.

3) Chapter 3: Methodology

   This chapter describes research methods used in this study. It gives information on how the study are done and conducted through the whole period in completing the study. Data will be collected from the company's information during the case study. Once data have been completed, an analysis of the data will be done by using AIMMS software in order to produce optimal production schedule.

4) Chapter 4: Formulation Model

A mixed integer programming model formulation will be created and discuss in this chapter. Information about the model is explained in details here.

5) Chapter 5: Optimal Production Schedule

This chapter presents all the results of this study which was solved by using AIMMS software. The solution of the problem will be proposed once it satisfied all the restrictions in production process.

6) Chapter 6: Conclusion

This chapter summarizes the report. Recommendations for future works will be suggested in this chapter also.

Table 1.1: Structure of the report

CHAPTER	CONTENTS
Chapter 1 Introduction	This chapter examines the overall perspective for the research, such as:- - Background of the study - Problem statement of the study - Objectives of the study - Scope of the study - Significant of the study - Outlines of the report
Chapter 2 Scheduling	This chapter focuses on the following topics: - Production planning - Scheduling - Mixed integer programming - Previous research
Chapter 3 Research Methodology	This chapter introduces the research methodology structure and research process which consists of:- - Research methodology - Data collected
Chapter 4 Formulation Model	This chapter discuss about the data used in the process of created a MIP formulation model based on the company's scheduling problem which consists of: - Problem structure - Problem definition - Model formulation

Chapter 5 Results and Discussion	This chapter discuss about the data analyses, findings and the proposed solution. Topics included are: - Result - Findings - Discussion
Chapter 6 Conclusion	This chapter is the last chapter of the thesis which is the concluding and recommendation part. - Conclusion of the study - Recommendation for future works

1.7 Conclusion

As the conclusion, scheduling problem is a big issue to the manufacturer. A good manufacturer will identify the problem of the company's scheduling planning so that the problem can be solved by using certain suitable method. This study was done in order to help in improving the company scheduling planning by using application of the mathematical formulation. In the next chapter, further discussion about the problem in scheduling and Mixed Integer Programming technique will be discussed for more understanding on this research.

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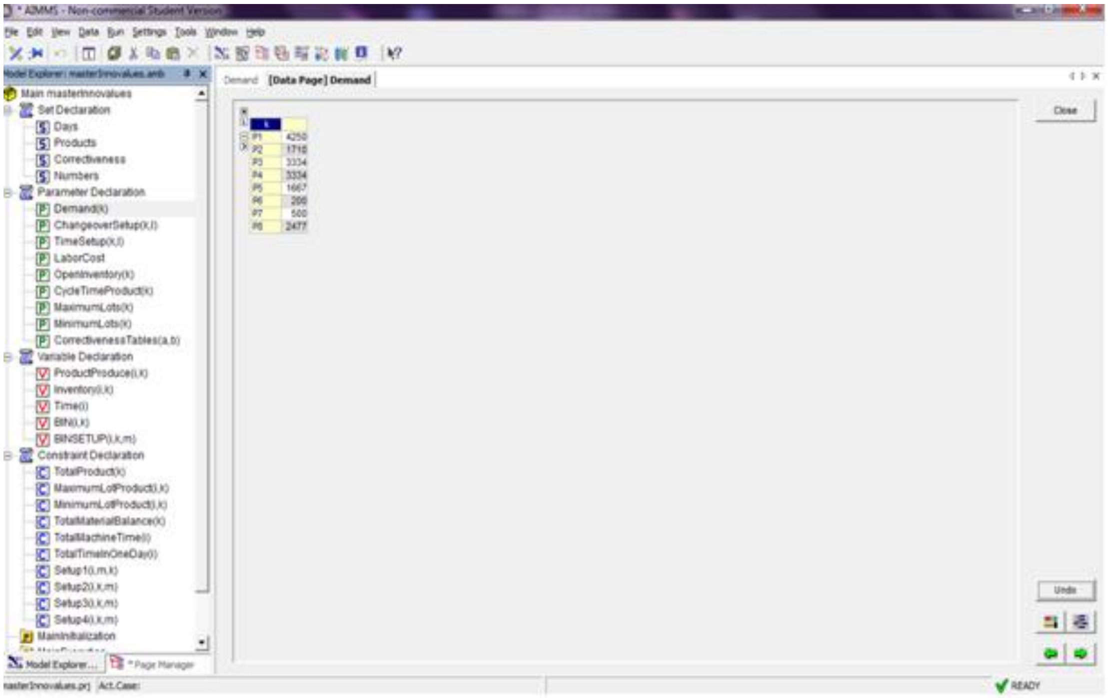
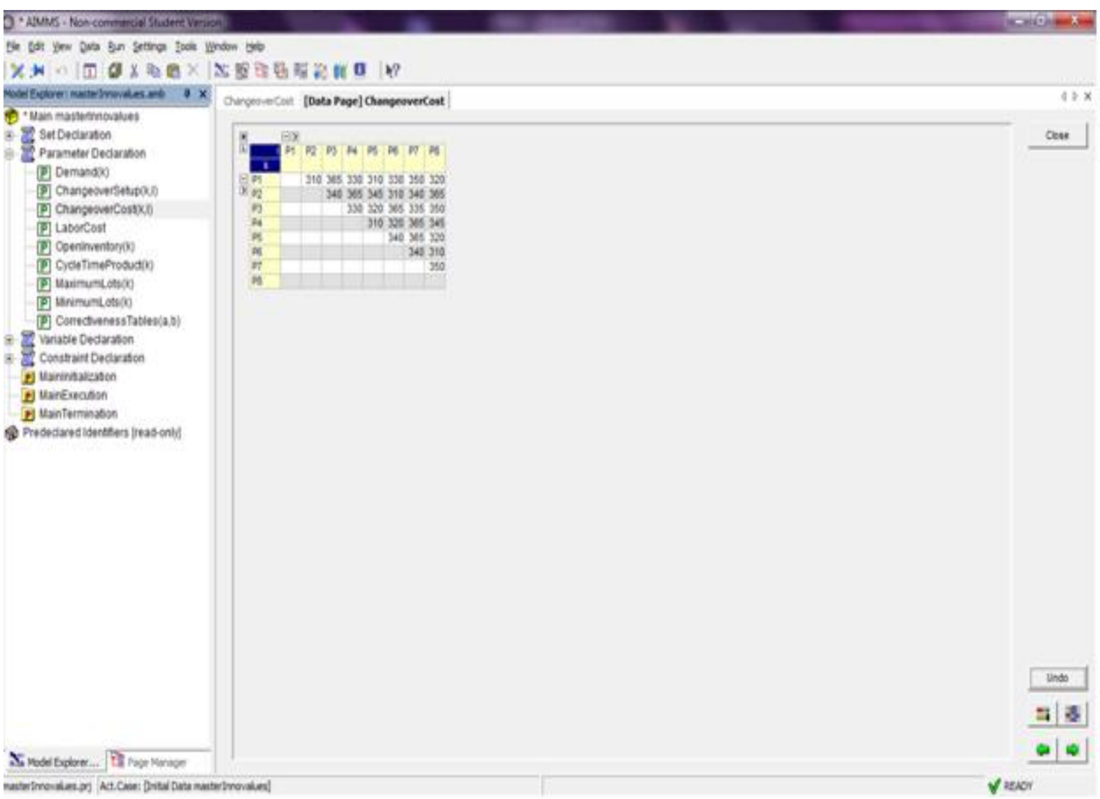
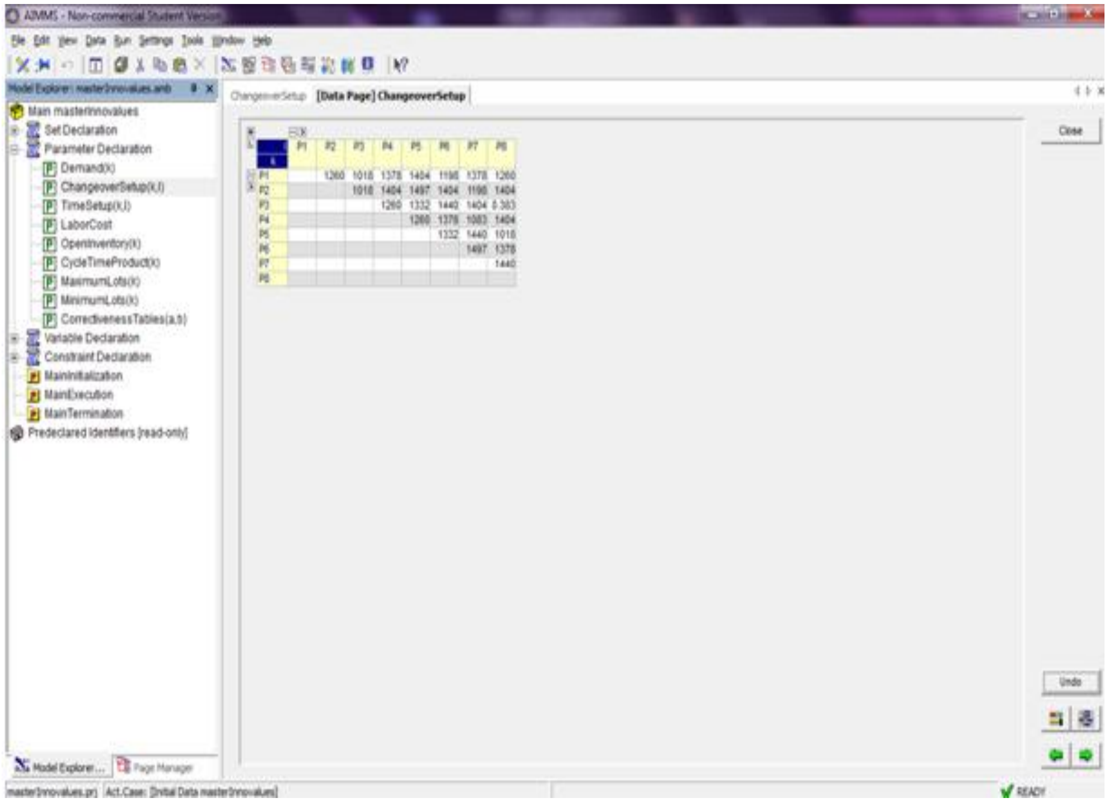
DATA : DEMAND FOR ONE MONTH



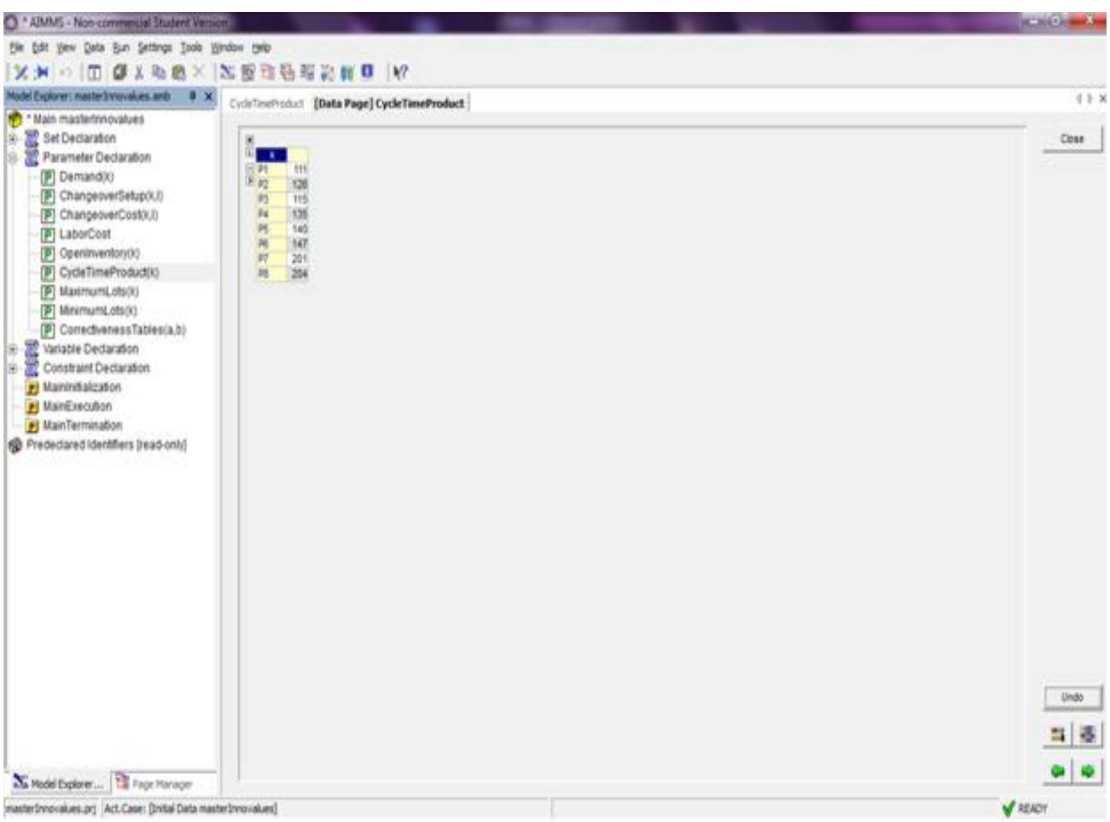
DATA : CHANGEOVER COST



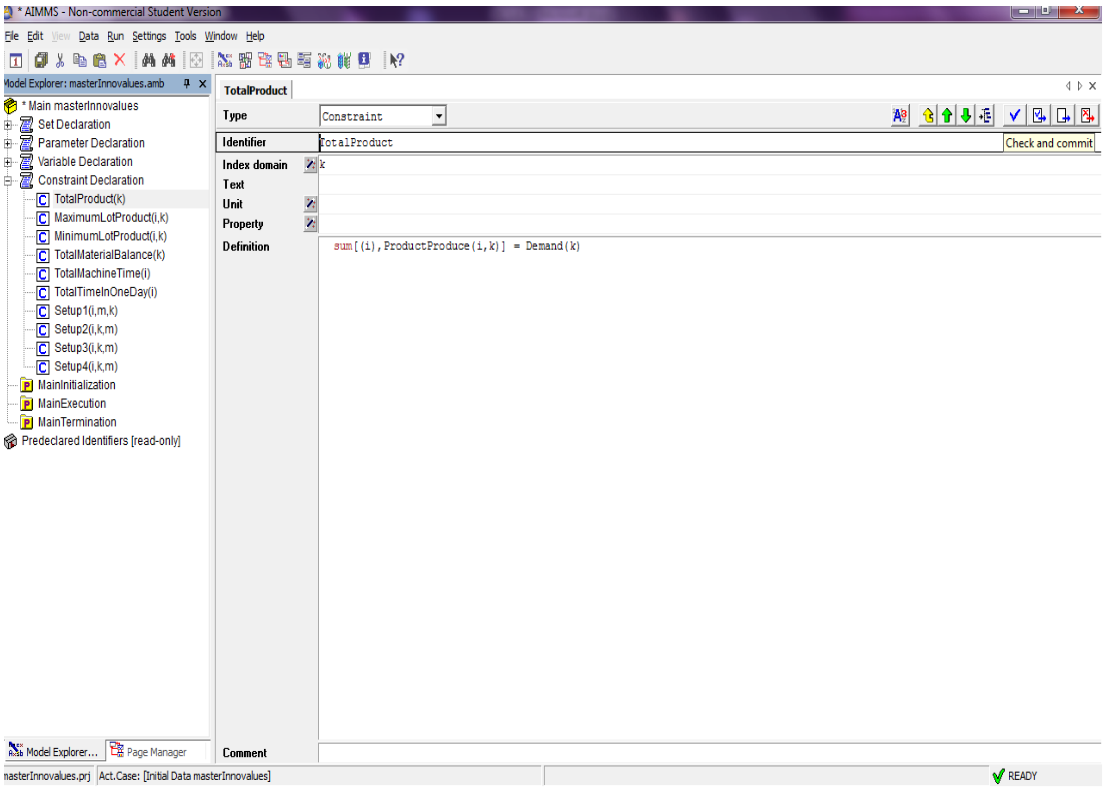
DATA : CHANGEOVER TIME (IN SECOND)



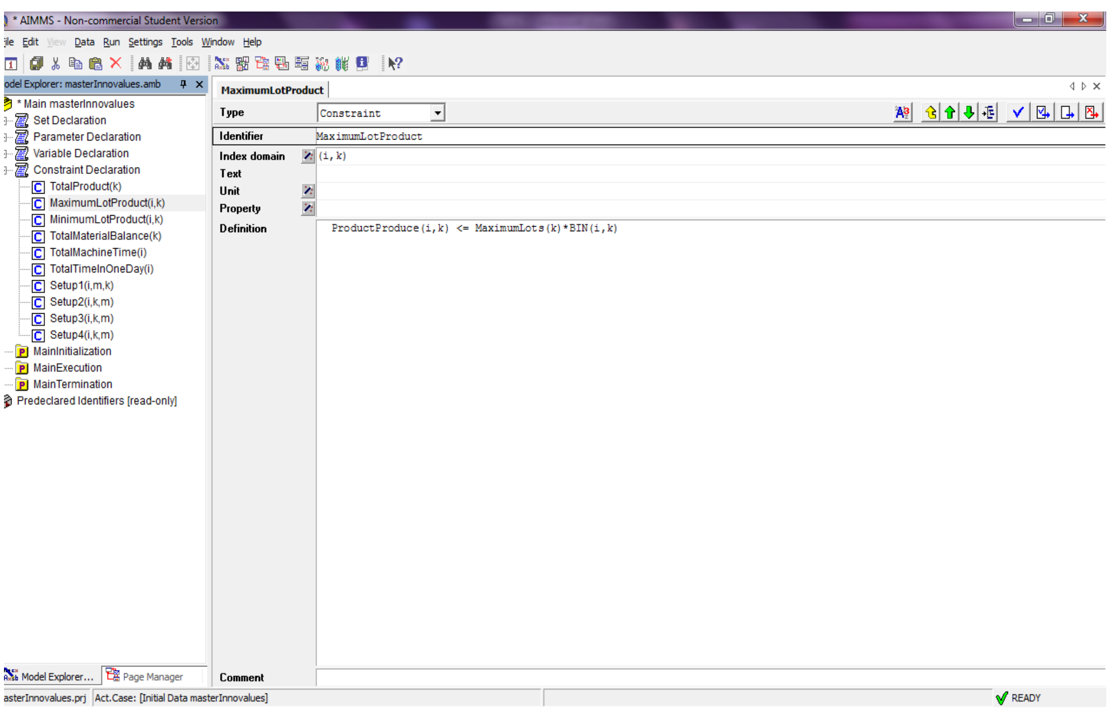
DATA : CYCLE TIME FOR EACH PRODUCT



CONSTRAINT : TOTAL PRODUCT



CONSTRAINT : MAXIMUM LOT



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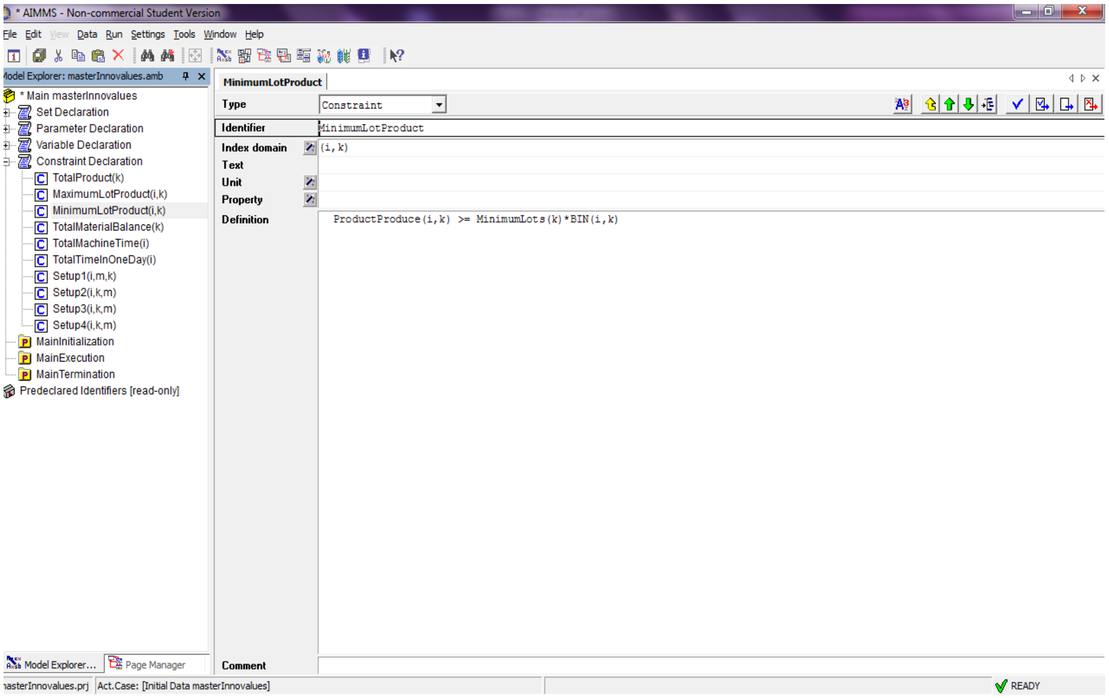

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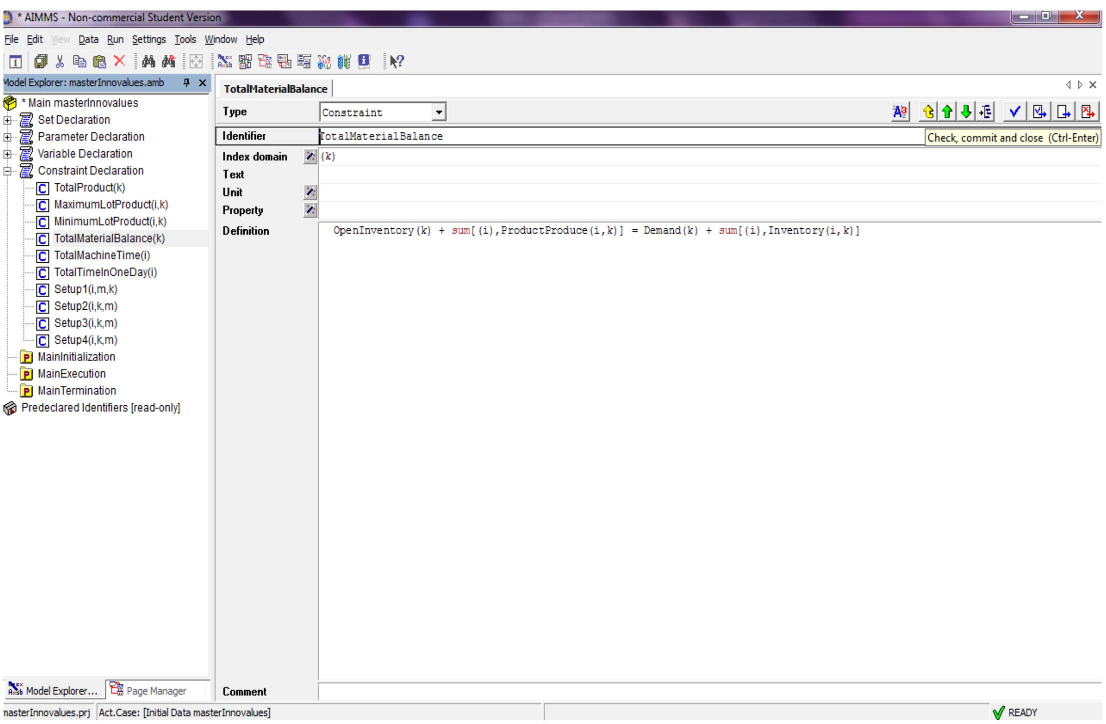
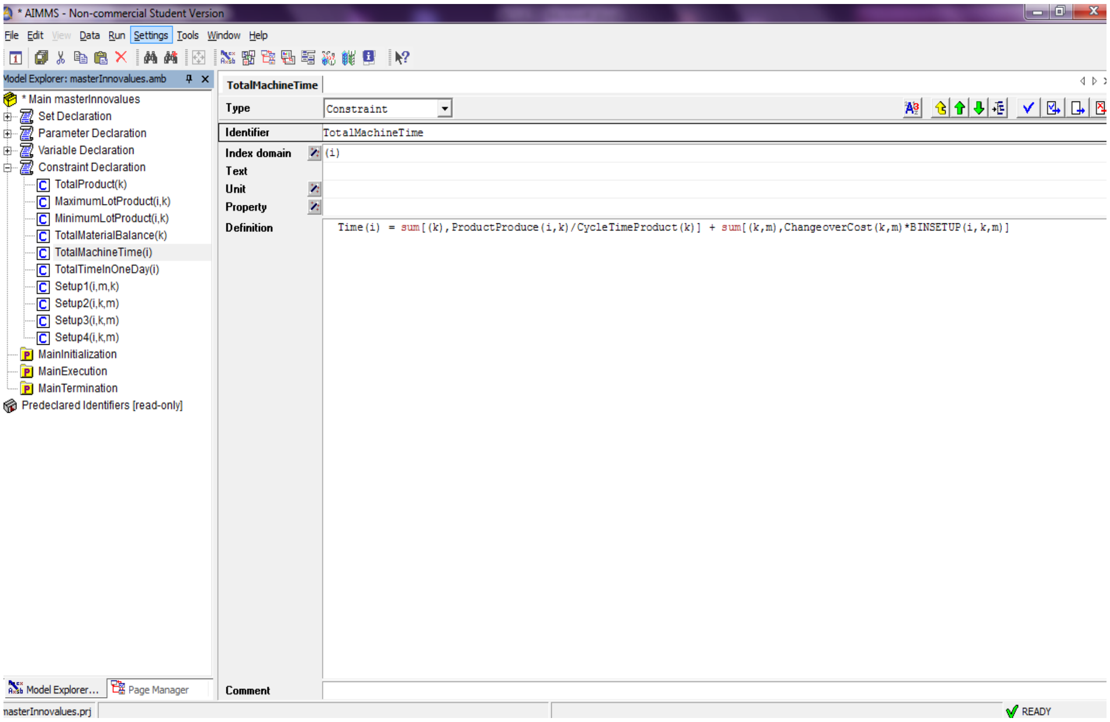
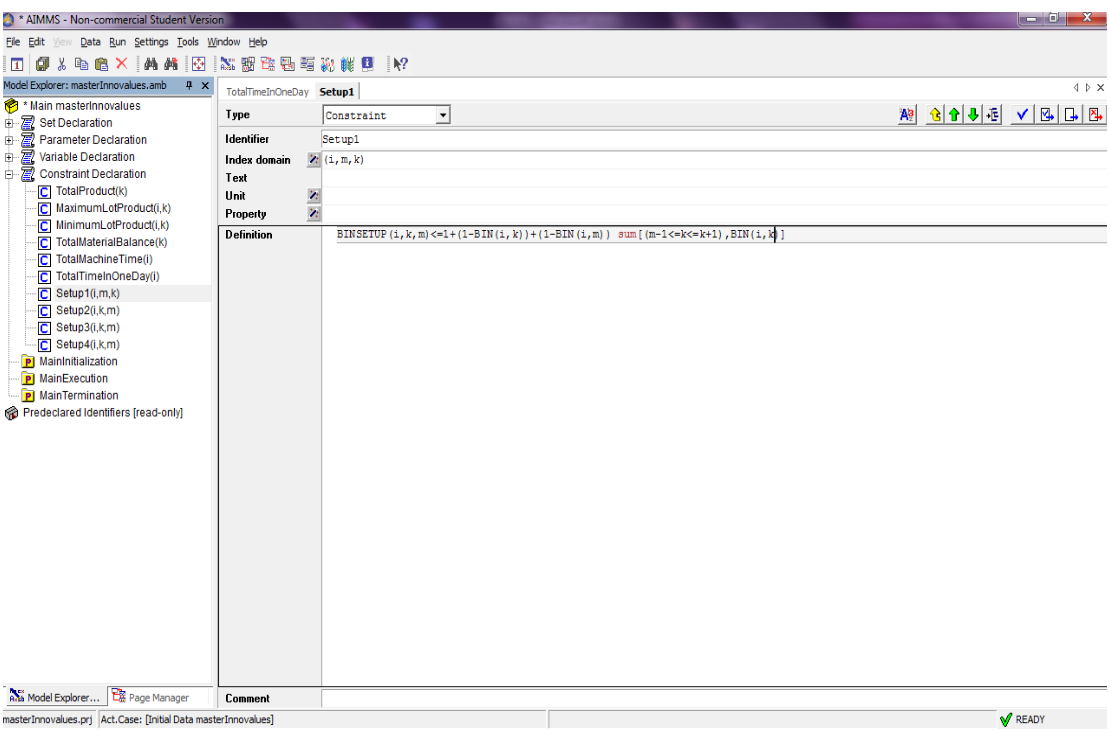


CONSTRAINT : TOTAL MACHINE TIME



CONSTRAINT : SETUP 1



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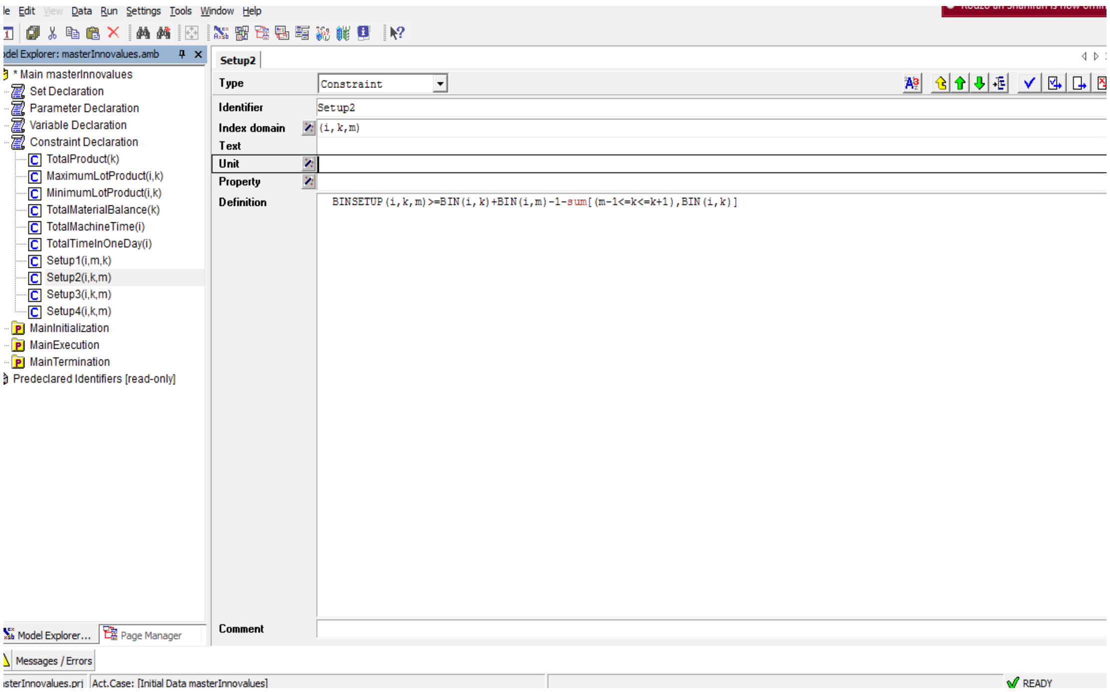

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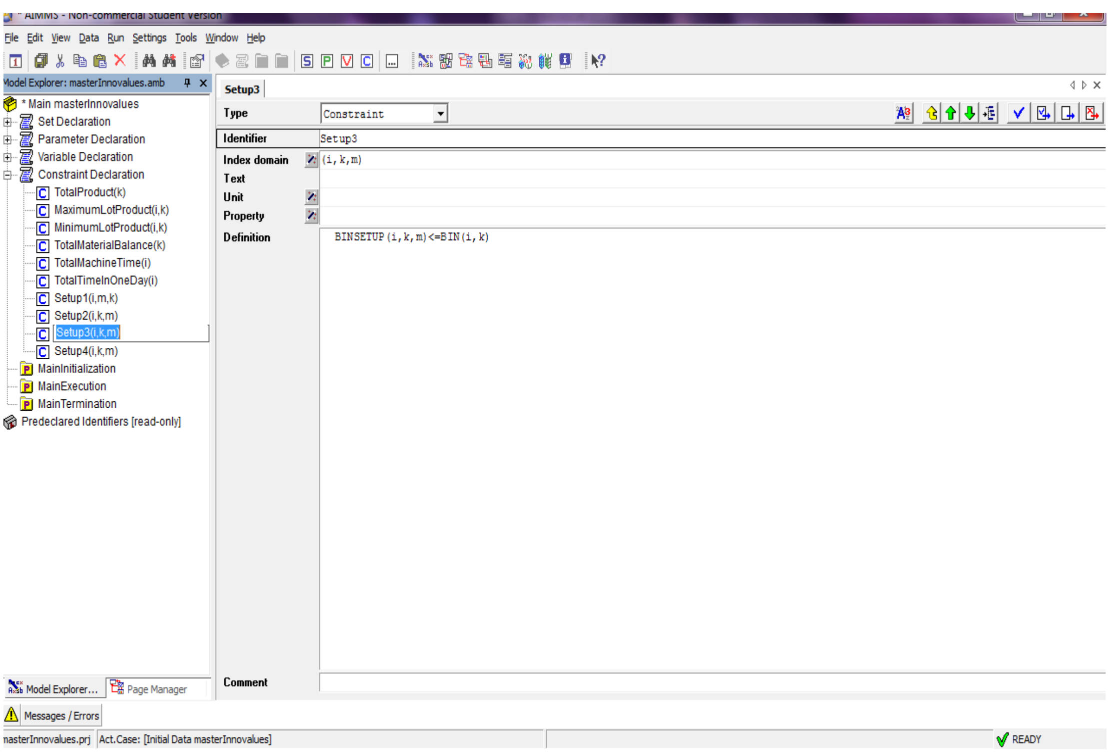

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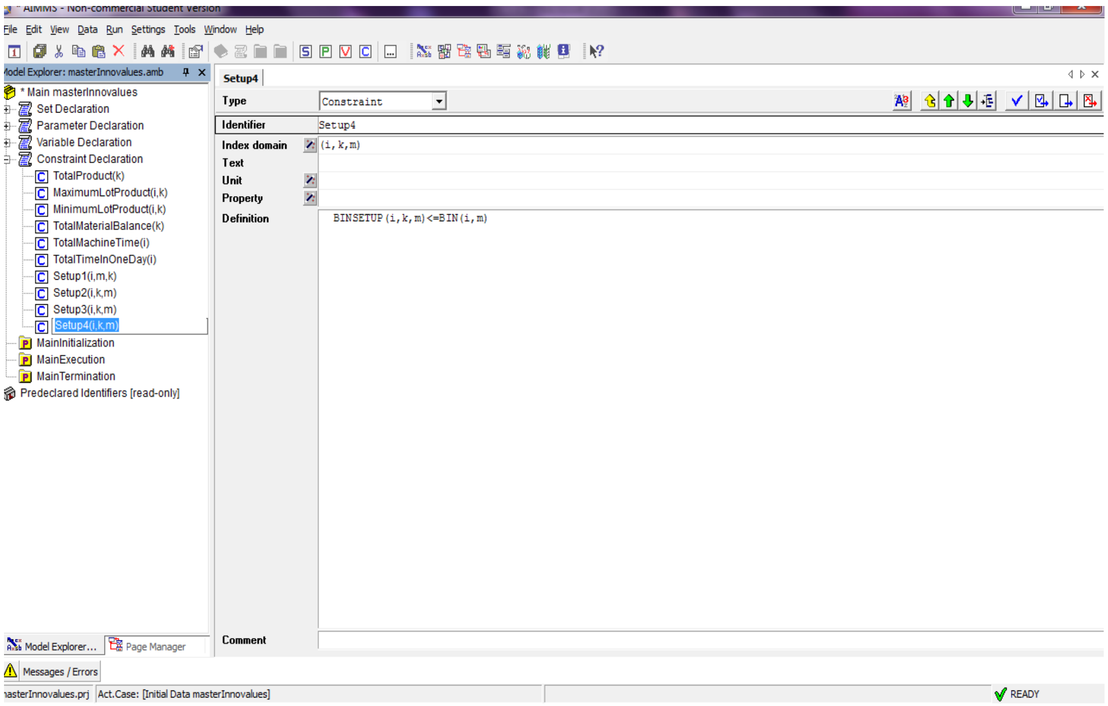
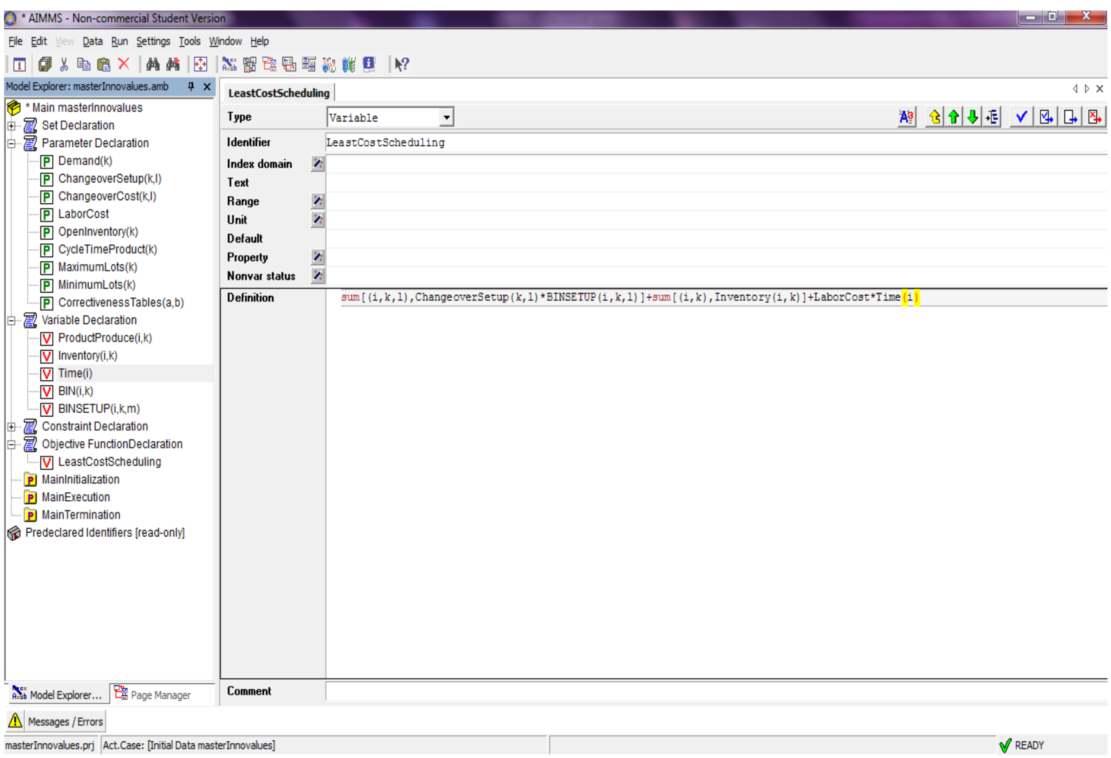
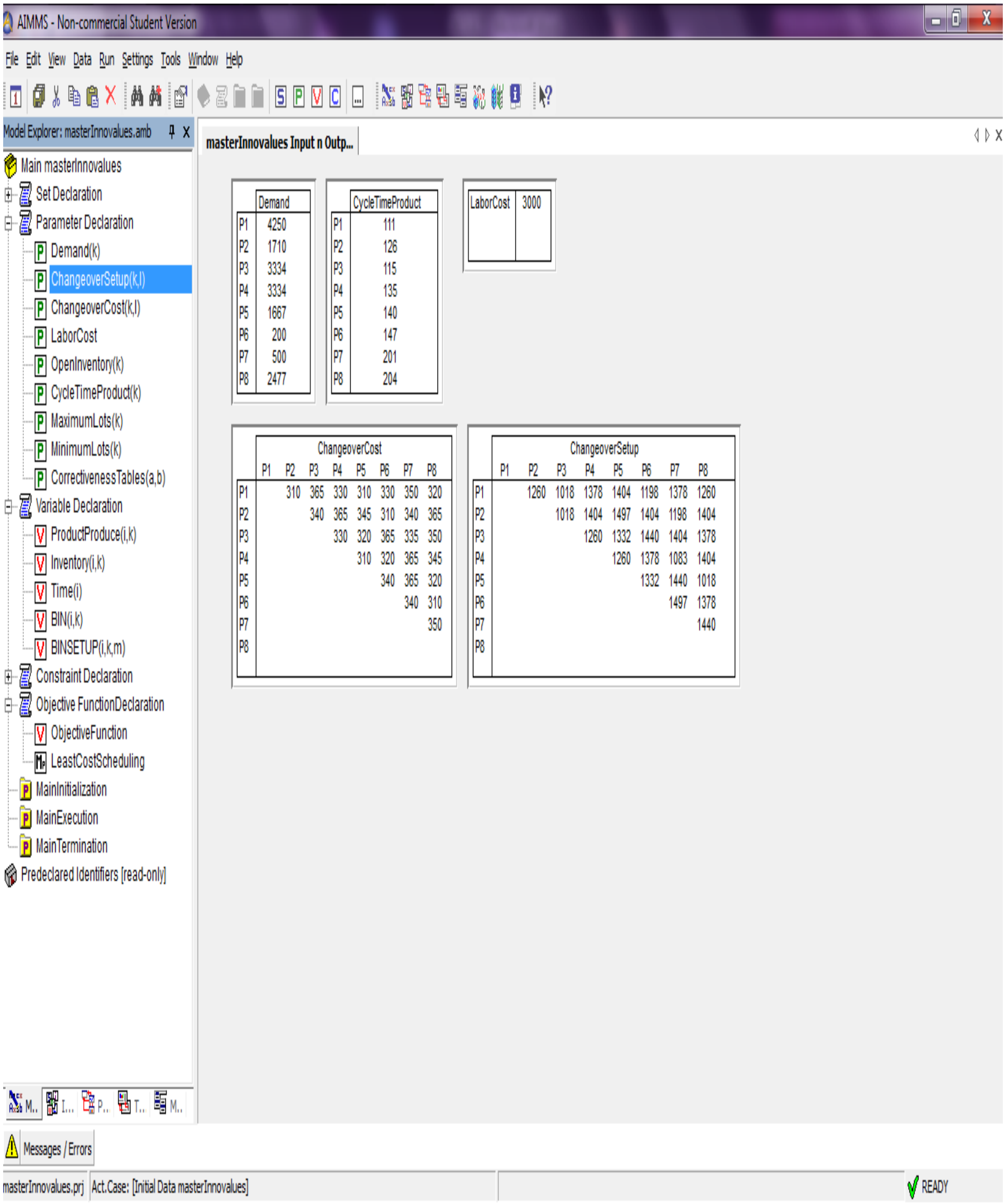


OBJECTIVE FUNCTION



DATA USED IN THE PROJECT



	Demand
P1	4250
P2	1710
P3	3334
P4	3334
P5	1667
P6	200
P7	500
P8	2477

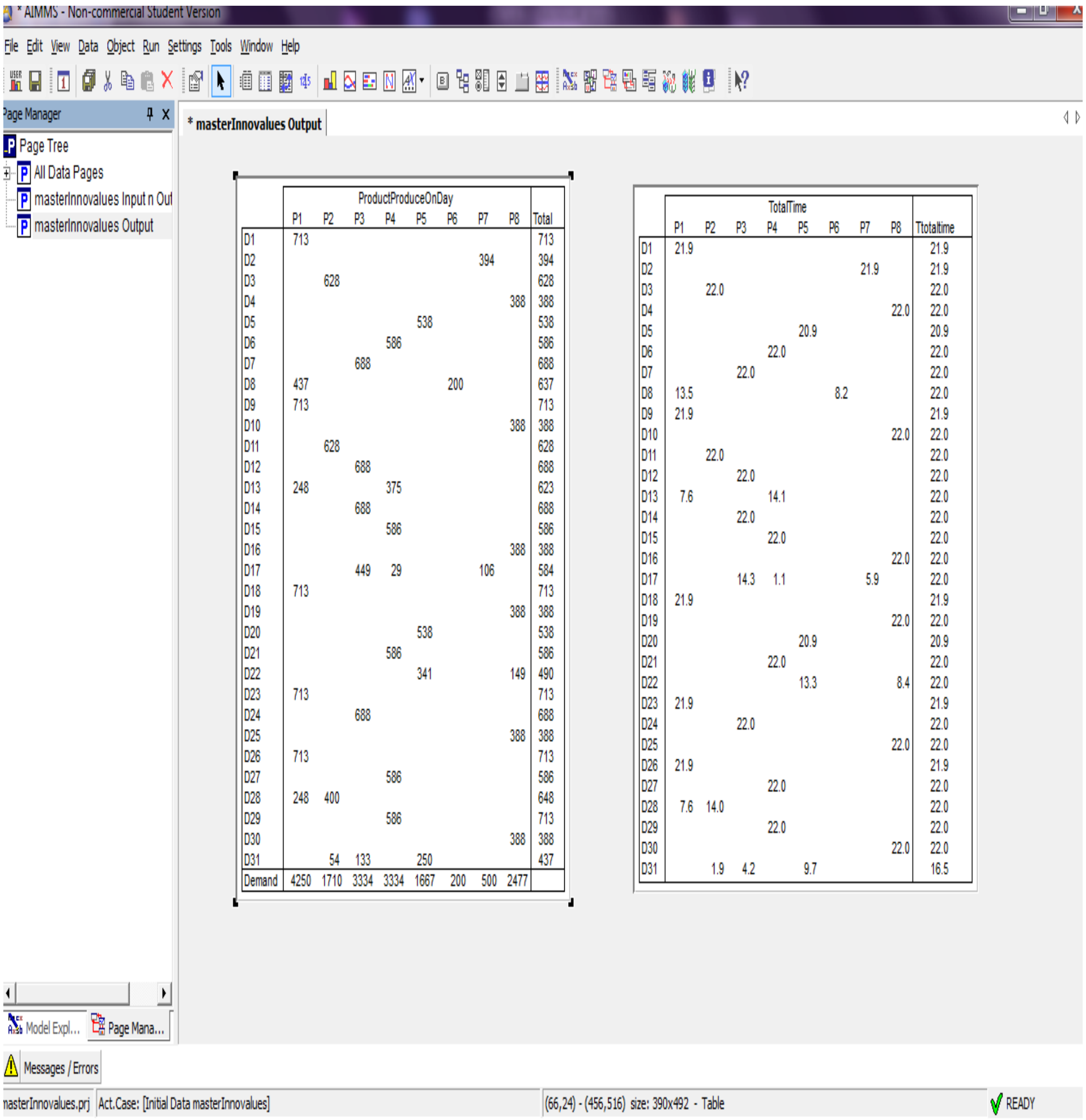
	CycleTimeProduct
P1	111
P2	126
P3	115
P4	135
P5	140
P6	147
P7	201
P8	204

LaborCost	3000

ChangeoverCost	P1	P2	P3	P4	P5	P6	P7	P8
P1		310	365	330	310	330	350	320
P2			340	365	345	310	340	365
P3				330	320	365	335	350
P4					310	320	365	345
P5						340	365	320
P6							340	310
P7								350
P8								

ChangeoverSetup	P1	P2	P3	P4	P5	P6	P7	P8
P1		1260	1018	1378	1404	1198	1378	1260
P2			1018	1404	1497	1404	1198	1404
P3				1260	1332	1440	1404	1378
P4					1260	1378	1083	1404
P5						1332	1440	1018
P6							1497	1378
P7								1440
P8								

RESULT OBTAIN FROM AIMMS SOFTWARE



	ProductProduceOnDay								
	P1	P2	P3	P4	P5	P6	P7	P8	Total
D1	713								713
D2							394		394
D3		628							628
D4								388	388
D5					538				538
D6				586					586
D7			688						688
D8	437					200			637
D9	713								713
D10								388	388
D11		628							628
D12			688						688
D13	248			375					623
D14			688						688
D15				586					586
D16								388	388
D17			449	29			106		584
D18	713								713
D19								388	388
D20					538				538
D21				586					586
D22					341			149	490
D23	713								713
D24			688						688
D25								388	388
D26	713								713
D27				586					586
D28	248	400							648
D29				586					713
D30								388	388
D31		54	133		250				437
Demand	4250	1710	3334	3334	1667	200	500	2477	

	TotalTime								
	P1	P2	P3	P4	P5	P6	P7	P8	Ttotaltime
D1	21.9								21.9
D2							21.9		21.9
D3		22.0							22.0
D4								22.0	22.0
D5					20.9				20.9
D6				22.0					22.0
D7			22.0						22.0
D8	13.5					8.2			22.0
D9	21.9								21.9
D10								22.0	22.0
D11		22.0							22.0
D12			22.0						22.0
D13	7.6			14.1					22.0
D14			22.0						22.0
D15				22.0					22.0
D16								22.0	22.0
D17			14.3	1.1			5.9		22.0
D18	21.9								21.9
D19								22.0	22.0
D20					20.9				20.9
D21				22.0					22.0
D22					13.3			8.4	22.0
D23	21.9								21.9
D24			22.0						22.0
D25								22.0	22.0
D26	21.9								21.9
D27				22.0					22.0
D28	7.6	14.0							22.0
D29				22.0					22.0
D30								22.0	22.0
D31		1.9	4.2		9.7				16.5