Chapter 4

Developing an Information System for PAC in the Case Study

4.1 Introduction

From previous chapters, the causes of problems in the existing production control and sequential processes are identified. The lack of data collection and information system to communicate with the planning process that cause the unsuitable planning. Thus, the objective of this study is developing an information system for Production Activity Control (PAC) to improve the quality of data and information in term of correction completeness, and relevancy as follows;

1. Some processes cause repetitive data
2. Some processes do not have enough information to make decisions
3. Many data items in each activity are not standardized

These cause of problems are analyzed from the decomposition diagram of IDEF0 model. All topics focus on some repetitive and obstructive processes, which are separated responsibilities and determine the limit of process by holding on the objective of the Production Control and sequential processes.

These cause of problems not only focus on some repetitive and obstructive processes but also on data communication problem, because the structure of the existing processes categorizes duties and the responsibilities of activity according to each section. The standardization of each data item relies on the specification of each section. Thus, the system provides an uncertainty of data exchange between sections, which is common when referring to the main body and other items.

This information system is applied with by many concepts and techniques that are involved. These concepts and techniques consists of the following.

- Conceptual design : This phase is applied to determine the structure of information system for PAC, which is developed by IDEF0 modeling technique and the concept of PAC. This phase is a big picture of information system to illustrate the system structure and to categorize each variable into the information system.

- Implementing design : This phase describes about the detail of each module from the conceptual design, the input/output user interface and workflow of each module, that define the job description of production control and sequential processes to match with the developed information system. This phase also includes the comparison table between the existing system and the developed system that can indicate the improving workflow.

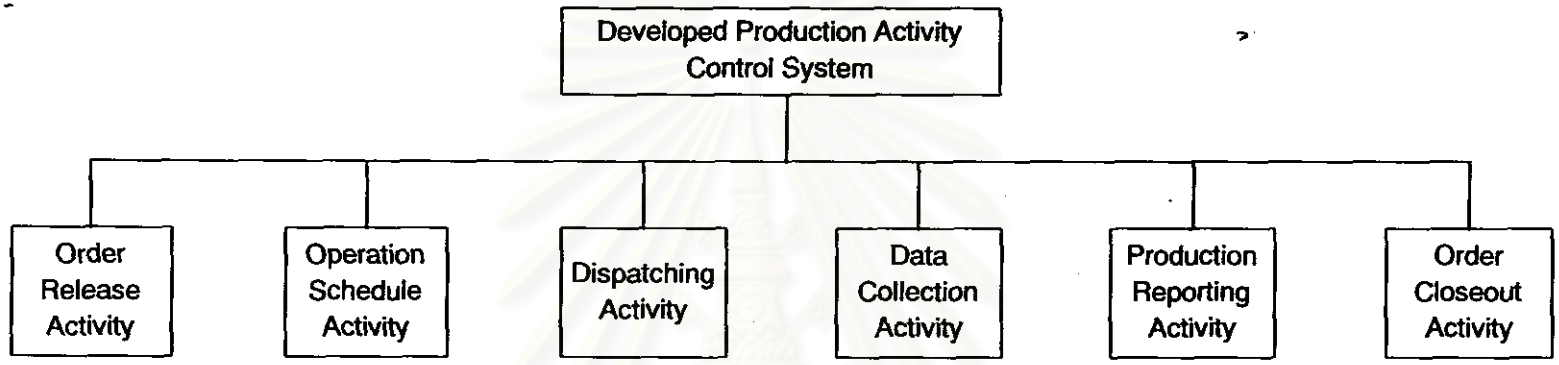
- Physical design : This phase composes of software and hardware configuration to support the information system. This information system is developed on personal computer (PC) platform, which uses Microsoft Window environment and Microsoft FoxPro developing tool to prepare user interface and database system. This phase also include the hardware configuration that can describe the hardware specification and networking configuration.

4.2 Conceptual Design

A conceptual design of PAC information system is designed to serve the major functions of production control and sequential processes and to minimize the impact of unexpected events such as absence of worker, machine failure, and shortage of part. This study is applied the concept of PAC to improve an efficient sequential processes data collection and information system that can be communicated with the Final Assembly Schedule (FAS) and Work Order Schedule (WOS) in each sequential processes.

The IDEF0 model technique also use to analyze each process in order to illustrate the functional processes inter-relationships between each activity in the PAC information system. The decomposition diagram of IDEF0 model can represent the system structure design with a hierarchical structure and provide the activity model independent of both organization and time. A node tree diagram of PAC information system is shown in Table 4-1 and a decomposition diagram is illustrated in appendix B-1.

Table 4-1 : A node tree diagram of PAC information system



Responsibility :	- Production Control	- Production Dept. - Assembly - Machine - Die-Casting	- Production Control - Assembly - Machine - Die-Casting	- Production Dept. - Assembly - Machine - Die-Casting	- Production Dept.	- Production Control
Document No. :	PAC 02	PAC 03	PAC 04	PAC 05	PAC 06	PAC 07

Remark : "Production Control" means the Production Control Process.

"Assembly" means a final process of production.

"Machine" means an intermediate process of production.

"Die-Casting" means a primary process of production.

An information system uses the standard format of each data item to communicate and exchange data between activities This system applied the concept of Bill of Materials (BOM) to refer a group of data items in production control and sequential processes and the concept of data dictionary/directory to store and manage all metadata (data about each data item. A summary of variable list in this system is shown in table 4-2.

Table 4-2 : A summary of variable list of PAC information system

- Master Files :- compose of BOM information and general information, which are manual input from the Production Control Section.
  - BOM Information : consists of BOM Index, Item Master Files, and End Item File.

Entity/Table Name: BOM Index

Objective : To refer the relationship of product structure.

Primary Key	Data Attribute Name	Format	Description
X	Item_Number	XX9999X	Foreign Key Link Table : Item Master File
X	Parent_Number	XX9999X	Unique number for identifying the parent item
	Quantity_Per_Pare	9999	Number of item per parent

Entity/Table Name: Item Master Files

Objective : To collect the information of each item.

Primary Key	Data Attribute Name	Format	Description
X	Item_Number	XX9999X	Unique number for identifying the item
	Item_Name	X(30)	Specific name for item
	Engine_Model	X(5)	Specific engine_model for item
	Item_Category	X(8)	Category set of item
	Drawing_Number	X(15)	Specific drawing number for item
	Original_Number	X(15)	Specific original number for item
	Unit_Type	X(8)	Measuring unit for item
	ENG_Changed_Number	9999	Specific code of ENG-Changed Number

Table 4-2 (Conts.)

Entity/Table Name: End Item File

Objective : To refer the relationship of each product.

Primary Key	Data Attribute Name	Format	Description
X	Item_Number	XX9999X	Foreign Key Link Table from BOM index
X	Parent_Number	XX9999X	Unique number for the specific product
	Quantity_Per_Pare	9999	Number of item per parent (specific product)
	Level_Code	9	Level of item in the specific product

- General Information : consists of Customer, Supplier and Resource Master File.

Entity/Table Name: Customer

Objective : To collect the information of each customer.

Primary Key	Data Attribute Name	Format	Description
X	Customer_Code	X(8)	Unique character set to define customer
	Customer_Category	X(8)	Category set of each customer
	Customer_Name_T	X(50)	Customer name in Thai language
	Customer_Name_E	X(50)	Customer name in English language
	Customer_Address_T	X(50)	Customer address in Thai language
	Customer_Address_E	X(50)	Customer address in English language
	Customer_Contact_1	X(50)	Customer contacted person #1
	Customer_Contact_2	X(50)	Customer contacted person #2
	Customer_Phone	X(14)	Customer telephone number
	Customer_Fax	X(14)	Customer fax number
	Customer_Email	X(30)	Customer email address
	Customer_Vat	99.9	Tax charged rate to customer
	Customer_Payment	X(3)	Term of payment
	Remark	-	Special contacting conditions

Table 4-2 (Conts.)

Entity/Table Name : Supplier

Objective : To collect the information of each supplier.

Primary Key	Data Attribute Name	Format	Description
X	Supplier_Code	X(8)	Unique character set to define supplier
	Supplier_Category	X(8)	Category set of each supplier
	Supplier_Name_T	X(50)	Supplier name in Thai language
	Supplier_Name_E	X(50)	Supplier name in English language
	Supplier_Address_T	X(50)	Supplier address in Thai language
	Supplier_Address_E	X(50)	Supplier address in English language
	Supplier_Contact_1	X(50)	Supplier contacted person #1
	Supplier_Contact_2	X(50)	Supplier contacted person #2
	Supplier_Phone	X(14)	Supplier telephone number
	Supplier_Fax	X(14)	Supplier fax number
	Supplier_Email	X(20)	Supplier email address
	Supplier_Vat	99.9	Tax charged rate from supplier
	Supplier_Payment	X(3)	Term of payment
	Remark	-	Special purchasing conditions

Entity/Table Name : Resource Master File

Objective : To collect the information of each sequential process.

Primary Key	Data Attribute Name	Format	Description
X	Resource_Number	X(6)	Unique character set to define the production resource requirement
	OS_Number	X(6)	Specific operation standard number
	Default_Manpower	9999	Default manpower usage
	Default_Pro_Capability	99.9	Default production capability
	Default_Mat_Availability	9999	Default material availability
	Default_Cycletime	99.9	Default cycletime per pieces
	Default_Setuptime	99.9	Default setup time
	Toolset_Number	X(6)	Specific number for tooling set

Table 4-2 (Conts.)

- Transaction Files :- compose of order release, operation scheduling, data collection, order closeout, and problem status.

Entity/Table Name : Order Release
Objective : To store the planning result of Final Assembly Schedule (FAS)
Verification : Manual check by the Production Control Section
Input method : Manual input from the Production Control Section

Primary Key	Data Attribute Name	Format	Description
X	Lot_Number	9999	Unique number for setting up the FAS
	Item_Number	XX9999X	Foreign Key Link Table from BOM Index
	Customer_Code	X(8)	Foreign Key Link Table from Customer
	PO_Number	X(20)	Specific character set to refer purchasing order
	Delivery_Type	X(10)	Type of delivery
	Delivery_Quantity	9999	Number of delivery in the FAS
	Delivery_Date	DD/MM/YY	Delivery date in the FAS

Entity/Table Name : Operation Scheduling
Objective : To store the planning result of Work Order Schedule (WOS) in each sequential process.
Verification : The Assembly Section (WOS for final process)
The Machining Section (WOS for intermediate process)
The Die-Casting Section (WOS for primary process)
The Production Control Section (Purchasing plan for supplier)
Input Method : Manual input by the Production Department

Primary Key	Data Attribute Name	Format	Description
X	Job_Number	X(4)	Unique number for setting up the WOS
	Item_Number	XX9999X	Foreign Key Link Table from BOM Index
	Resource_Number	X(6)	Foreign Key Link Table from Resource Master
	Supplier_Code	X(8)	Foreign Key Link Table from Supplier
	Ref_Lot_Number	X(20)	Foreign Key Link Table from Order Release
	Process_Number	X99	Specific number to define the production line
	Planning_Date	DD/MM/YY	Planning date for production
	Job_Quantity	9999	Number of item in each job number

Table 4-2 (Conts.)

Entity/Table Name : Data Collection
Objective : To store the actual production result of Work Order Report (WOR) in each sequential process.
Verification : The Assembly Section (WOR for final process)
The Machining Section (WOR for intermediate process)
The Die-Casting Section (WOR for Primary process)
Input Method : Manual input by the Production Department

Primary Key	Data Attribute Name	Format	Description
X	Job_Number	X(4)	Foreign Key Link Table from Operation Scheduling
X	Item_Number	XX9999X	Foreign Key Link Table from BOM index
	Production_Date	DD/MM/YY	Actual production date
	Accept_Quantity	9999	Number of acceptant item
	Scrap_Quantity	9999	Number of scraped item (from process)
	Reject_Quantity	9999	Number of rejected item (from material)
	Usage_Setuptime	99.9	Total setup time usage per day
	Usage_Breakdowntime	99.9	Total breakdown time usage per day
	Usage_Stoptime	99.9	Total stop time usage per day

Entity/Table Name : Order Closeout
Objective : To record the actual delivery and the revised order from customer.
Verification : The Production Department (Approved revised delivery order (DO_number)
The Production Control Section (Each data item from revised delivery order)
Input method : Manual input by the Production Control Section
Approval input by the Production Department

Primary Key	Data Attribute Name	Format	Description
X	DO_Number	X(4)	Unique number for actual delivery order
	Lot_Number	X(4)	Foreign Key Link Talbe from Order Release
	Item_Number	XX9999X	Foreign Key Link Talbe from BOM Index
	Revise_TAG_Number	X(7)	Specific number to revise tag card (Approved)
	Revise_Quantity	9999	Number of revised item (Approved)
	Revise_Date	DD/MM/YY	Date of revised delivery order
	Approved_Code	X(3)	Specific code name from authorized staff in the Production Department

Table 4-2 (Conts.)

Entity/Table Name : Problem Status

Objective : To monitor and control the unmatching record between WOS and WOR in each sequential process.

Verification : The Assembly Section (for final process)
The Machining Section (for intermediate process)
The Die-Casting Section (for primary process)

Input Method : Automatic generated by comparing the data item of WOS and WOR in the Production Department

Primary Key	Data Attribute Name	Format	Description
X	Problem_Number	X(4)	Unique number to refer problem status record
	Job_Number	X(4)	Foreign Key Link Table from Operation Scheduling
	Item_Number	XX9999X	Foreign Key Link Table form BOM Index
	Problem_Quantity	9999	Number of unmatched item
	Record_Date	DD/MM/YY	Date of unmatched result
	Description	Memo	Short message to describe problem
	Recorder	X(3)	Specific code name from authorized staff in the Production Department

4.3 Implementing Design

4.3.1 Order Release Activity Module (A1)

This module is the first activity of PAC information system, which prepares the Final Assembly Schedule (FAS). The objective of this module is to formalize the standard item number by BOM and to match the planned order with the actual production resources. The BOM information, this module can be checked and followed up the actual production resources and outside supplier that can improve the completeness of the FAS. The component of order release activity module shows in table 4-3.

Table 4-3 : The component of order release activity module

The Developed Production Activity Control System	Responsibility	Form No.	Input	Output
A1 : Order Release Activity				
A11 Preparing the Order Release tasks	Production Control Section			
A12 Checking production resource and outside supplier	Production Control Section			
A13 Planning the Final Assembly Schedule (FAS)	Production Control Section	OR-01	X	
		OR-02		X

Input/Output of this module is handled by the Production Control Section. The part number from each customer is adjusted to the standard item number by implementing a concept of BOM in "Preparing the order release tasks (A11)". Each data item has to check production resources and outside supplier before input in "Planning the final Assembly Schedule (FAS)" to release the FAS report, which is an output of this module. A design screen of Input/Output of this module is shown in figure 4-1.

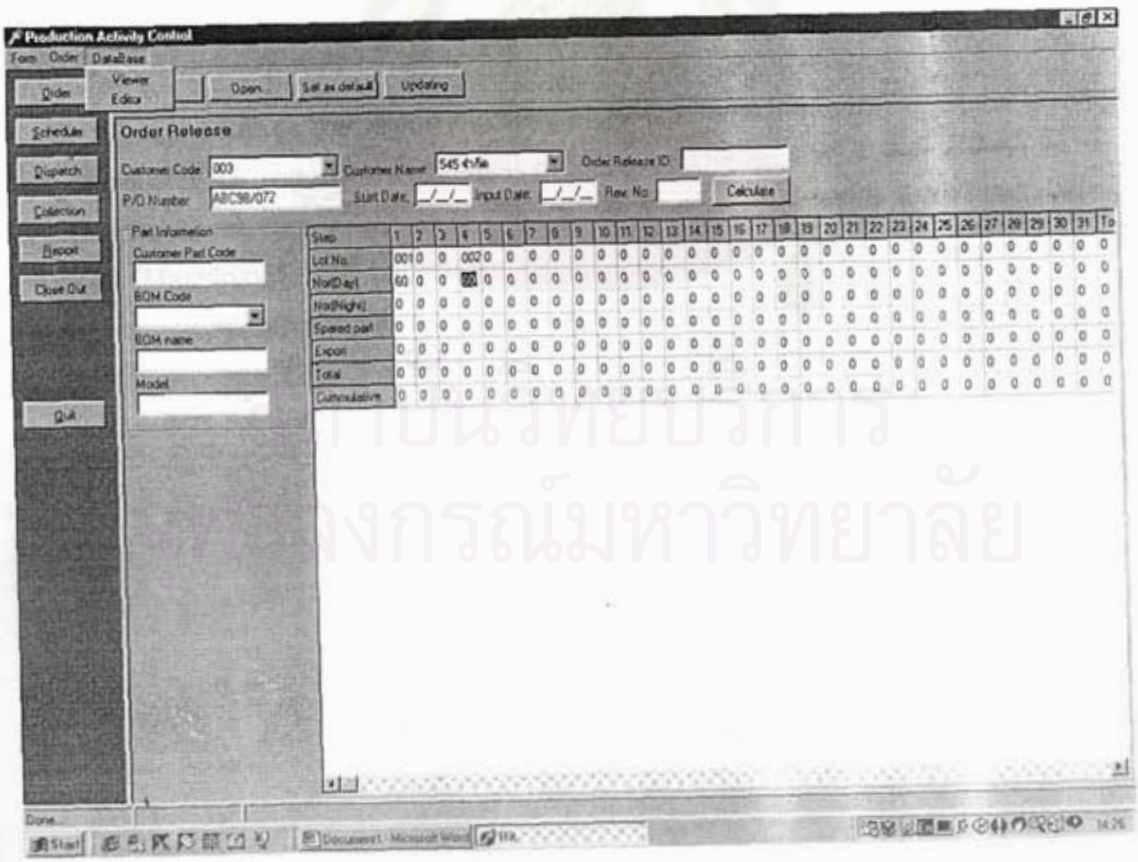


Figure 4-1 : A design screen of Input/Output of order release activity module

With this module, is improved the quality of Information in the FAS report in term of completeness and relevancy by using the standard item number (BOM) and comparing with the actual production resources. The compared workflow for this module is shown in table 4-4.

Table 4-4 : The comparison workflow for order release activity.

The Existing Production Activity Control System	The Developed Production Activity Control System	unchanged	Addition	Improvement	Remove
A1 Order Planning Activity	*A1 Order Release Activity*				
A11 Collecting the Customer Order Plan	A11 Preparing the Order Release tasks			X	
	A12 Checking production resource and outside supplier		X		
A12 Planning process	A13 Planning the Final Assembly Schedule (FAS)	X			
A13 Collecting the Component List					X
A14 Planning process for Components					X

4.3.2 Operation Scheduling Activity Module

This module is the second activity of PAC information system, which arranges the detail of FAS report to sequential processes. The objective of this module is to prepare the Work Order Schedule (WOS) for final process (Assembly), intermediate process (Machining), and primary process (Die-Casting). With BOM information, the related components of standard item number can be identified and assigned to each sequential process. before start the operation. The component of operation scheduling activity module is shown in table 4-5.

Table 4-5 : The component of operation scheduling module

The Developed Production Activity Control System	Responsibility	Form No.	Input	Output
A2 : Operation Scheduling Activity				
A21 Planning the Work Order Schedule for Assembly Section		PAC 03-1		
A211 Assigning the Work Order tasks in Assembly Section	Production Department			
A212 Verifying the Work Order tasks	Assembly Section			
A213 Planning the Work Order Schedule	Production Department	OS-01	X	
		OS-02		X
A22 Planning the Work Order Schedule for Machining Section		PAC 03-2		
A221 Assigning the Work Order tasks in Machining Section	Production Department			
A222 Verifying the Work Order tasks	Machining Section			
A223 Planning the Work Order Schedule	Production Department	OS-03	X	
		OS-04		X
A23 Planning the Work Order Schedule for Die-Casting Section		PAC 03-3		
A231 Assigning the Work Order tasks in Die-Casting Section	Production Department			
A232 Verifying the Work Order tasks	Die Casting Section			
A233 Planning the Work Order Schedule	Production Department	OS-05	X	
		OS-06		X

Production department use the BOM information to assign the work order tasks with the standard item number to each sequential process. Supervisor in each sequential process verify the work order tasks and informs the actual status of production. With the communication of sequential processes, the quality of data, which is an input of the planning process, has more corrective than the existing process.

Then, those verified data is input to "planning the work order schedule" in each sub-module. The output of this module is the WOS report for final process, intermediate process, and primary process as follows;

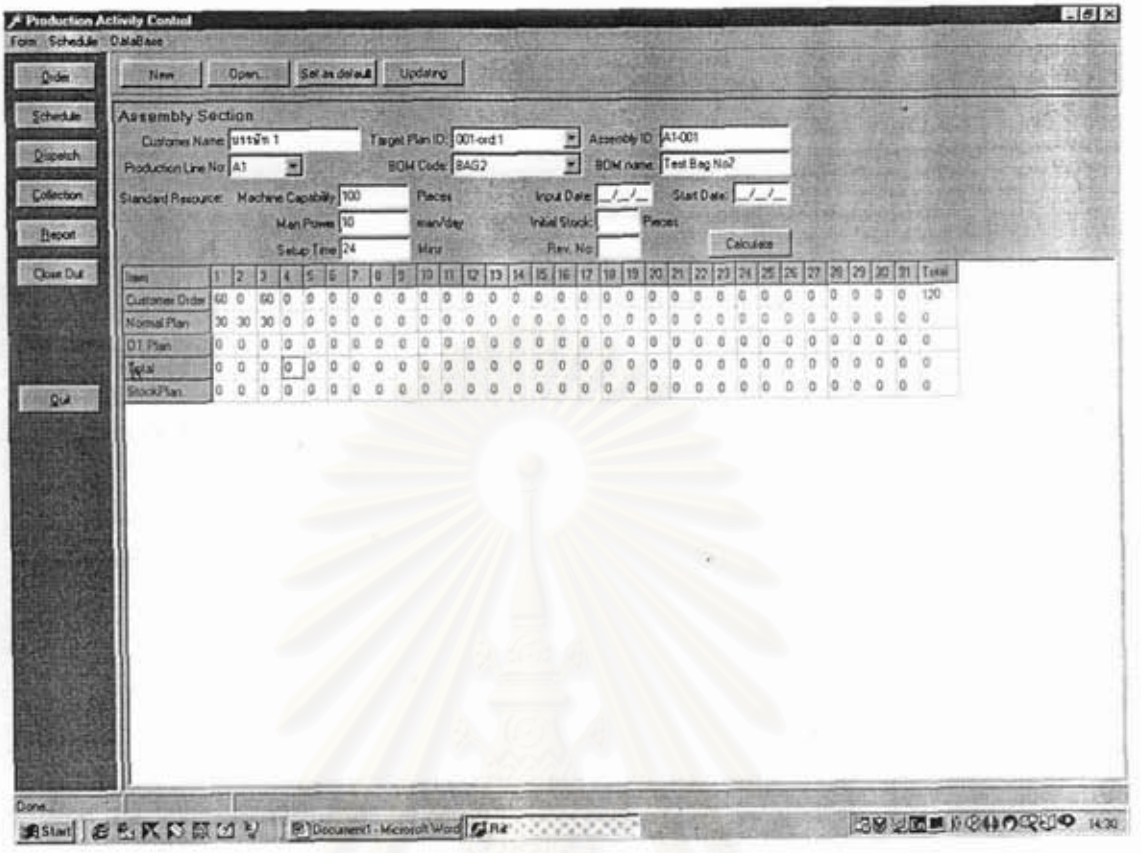


Figure 4-2 : A sample of design screen of Input/Output of operation scheduling activity module.

The benefit of BOM information reduce the repetitive process in "matching the component list" by using the standard item number to identify the related components and the database system to communicate with each supervisor. Thus, the quality of data and process the suitable WOS report for each sequential process can be improved. The comparison workflow for this module is shown in table 4-6.

Table 4-6 : The comparison workflow for operation scheduling activity

The Existing Production Activity Control System	The Developed Production Activity Control System	unchanged	Addition	Improvement	Remove
A2 Operation Scheduling Activity	*A2 Operation Scheduling Activity*				
A21 Operation Scheduling for Assembly	*A21 Planning the Work Order Schedule for Assembly Section*				
A211 Matching the Component List	A211 Assigning the Work Order tasks in Assembly Section			X	
	A212 Verifying the Work Order tasks		X		
A212 Planning Process	A213 Planning the Work Order Schedule	X			
A22 Operation Scheduling for Machining	*A22 Planning the Work Order Schedule for Machining Section*				
A221 Matching the Component List	A221 Assigning the Work Order tasks in Machining Section			X	
	A222 Verifying the Work Order tasks		X		
A222 Planning Process	A223 Planning the Work Order Schedule	X			
A23 Operation Scheduling for Die-Casting	*A23 Planning the Work Order Schedule for Die-Casting Section*				
A231 Matching the Component List	A231 Assigning the Work Order tasks in Die-Casting Section			X	
	A232 Verifying the Work Order tasks		X		
A232 Planning Process	A233 Planning the Work Order Schedule	X			

4.3.3 Dispatching Activity Module

This module is the third activity of PAC information system, which works out the detail of WOS report in each sequential process and prepares the purchasing plan for outside supplier. The aim of the module is to minimize the part shortage problem in final process (Assembly) by matching and assigning the purchasing plan task with the WOS report for sequential processes. This module also use BOM information to identify the standard item number of each supplier. Thus, the items from supplier and sequential processes can be compromised to reduce the part shortage problem in daily operation. The component of dispatching activity module shows in table 4-7.

Table 4-7 : The component of dispatching activity module

The Developed Production Activity Control System	Responsibility	Form No.	Input	Output
A3 Dispatching Activity				
A31 Preparing the purchasing plan for outside supplier		PAC 04-1		
A311 Matching and assigning the purchasing tasks	Production Control Section			
A312 Verifying the Inventory	Production Control Section			
A313 Planning the purchasing plan	Production Control Section	DL-01	X	
		DL-02		X
A32 Preparing and producting the parts	Assembly Section	DL-03	X	
		DL-04		X
	Machining Section	DL-05	X	
		DL-06		X
	Die Casting Section	DL-07	X	
		DL-08		X

Input/Output of this module is separated into two part. The first part is preparing the purchasing plan for outside supplier and the other part is preparing and producing the parts. A source of input data is the WOS report for sequential processes. With the first part, the Production Control section use BOM information to match the standard item number and to assign the purchasing plan tasks for verifying the inventory and editing the tasks until the result is suitable to order. Then, this result is an input data for planning. An output of the first part is the purchasing plan for outside supplier. A design screen and output format is shown in figure 4-3.

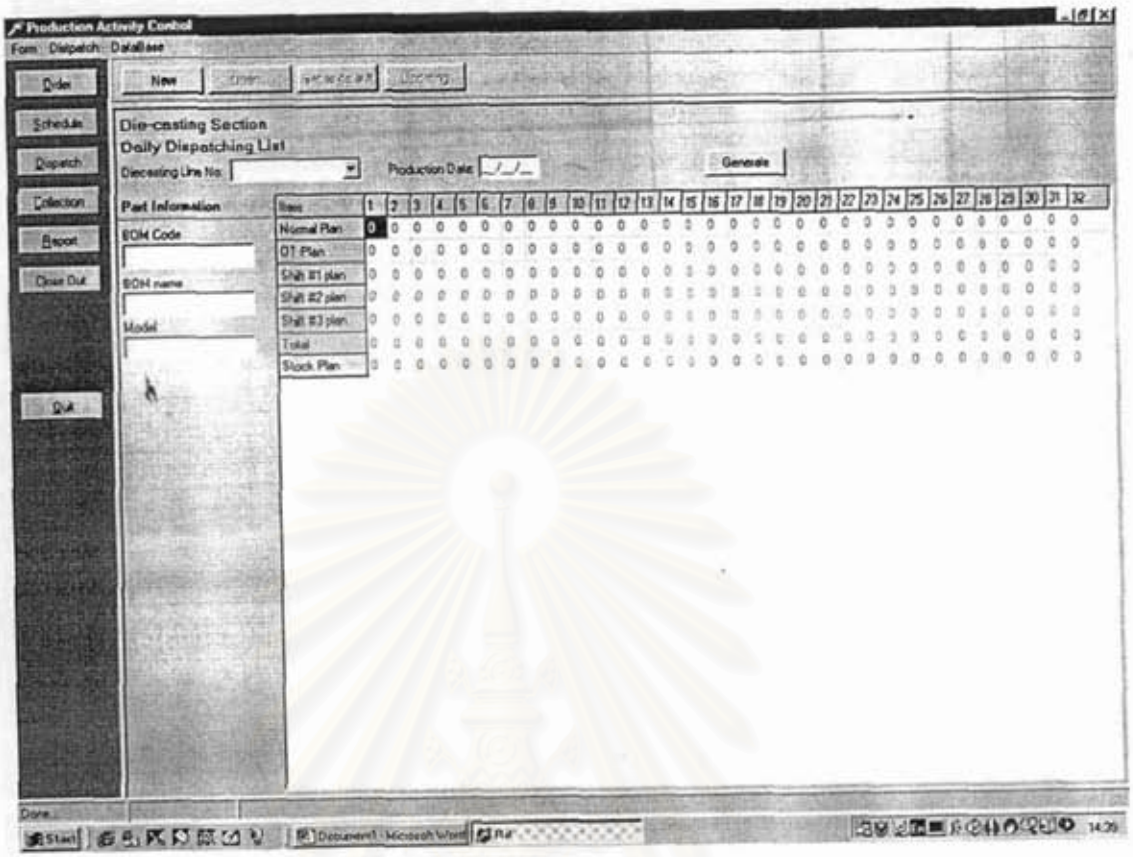


Figure 4-3 : A sample of design screen and output format

The other part of this module is preparing and producing the parts. A source of input data is the WOS report for sequential processes same as the first part. Supervisor in each sequential process prepares production resources and controls the process. After finish the daily operation, supervisor summarizes the results of production with the Work Order Report (WOR) in each sequential process by manual that is the output of this part. A summary of screen design and output format is shown in figure 4-4.

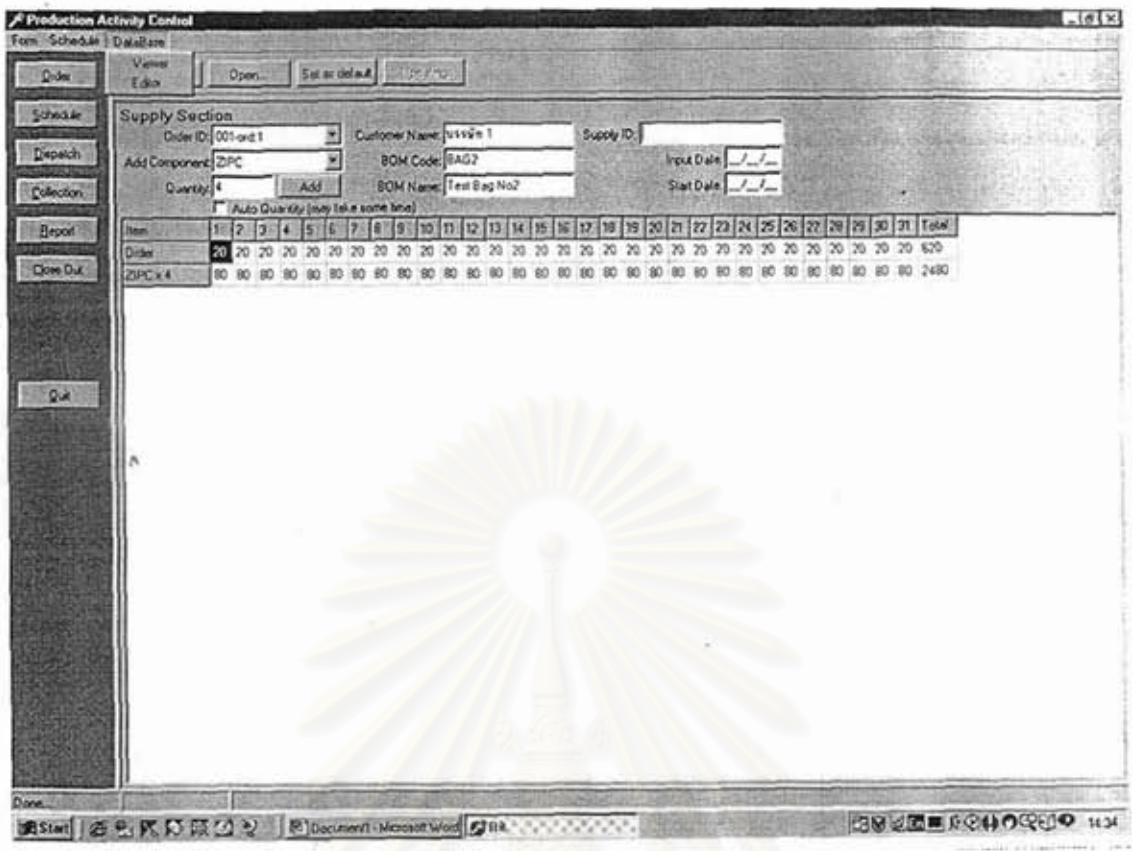


Figure 4-4 : A summary of screen design and output format for the preparing and producing process

This module can arrange the detail of planned schedule to a standard form and balance each items from supplier and sequential processes. Each data item in this module is based on BOM information to identify the standard item number that can reduce the error from repetitive input and output. The compared workflow of this module is described in table 4-8.

Table 4-8 : The comparison workflow for dispatching activity module

The Existing Production Activity Control System	The Developed Production Activity Control System	unchanged	Addition	Improvement	Remove
A3 Production Reporting Activity	*A3 Dispatching Activity*				
	A31 Preparing the purchasing plan for outside supplier				
	A311 Matching and assigning the purchasing tasks		X		
	A312 Verifying the inventory		X		
	A313 Planning the purchasing plan		X		
A31 Preparing the Production Resource	A32 Preparing and producting the parts			X	
A32 Production Process					X

4.3.4 Data Collection Activity Module

This module is the forth activity in the PAC information system. It has the objective of gathering Work Order Report (WOR) of each sequential process. Each data item in WOR report can inform us of the amount of items produced in daily operation. This module uses BOM information to identify the standard item number in WOR reports. Thus, supervisor can check and verify the correction of data from each sequential process before input to the database. The component of data collection activity module show in table 4-9.

Table 4-9 : The component of data collection activity module

The Developed Production Activity Control System	Responsibility	Form No.	Input	Output
A4 Data Collection Activity				
A41 Verifying the Work Order Report	Assembly Section	WOR		
	Machining Section	WOR		
	Die Casting Section	WOR		
A42 Input the Work Order Report	Production Department	DC-01, DC-02, DC-03	X	

Source of input data is the production result, which is identified with the standard item number and verified by supervisor in each sequential process. Then, the production department staff inputs the data to the database in the next day. A screen design is shown in figure 4-5.

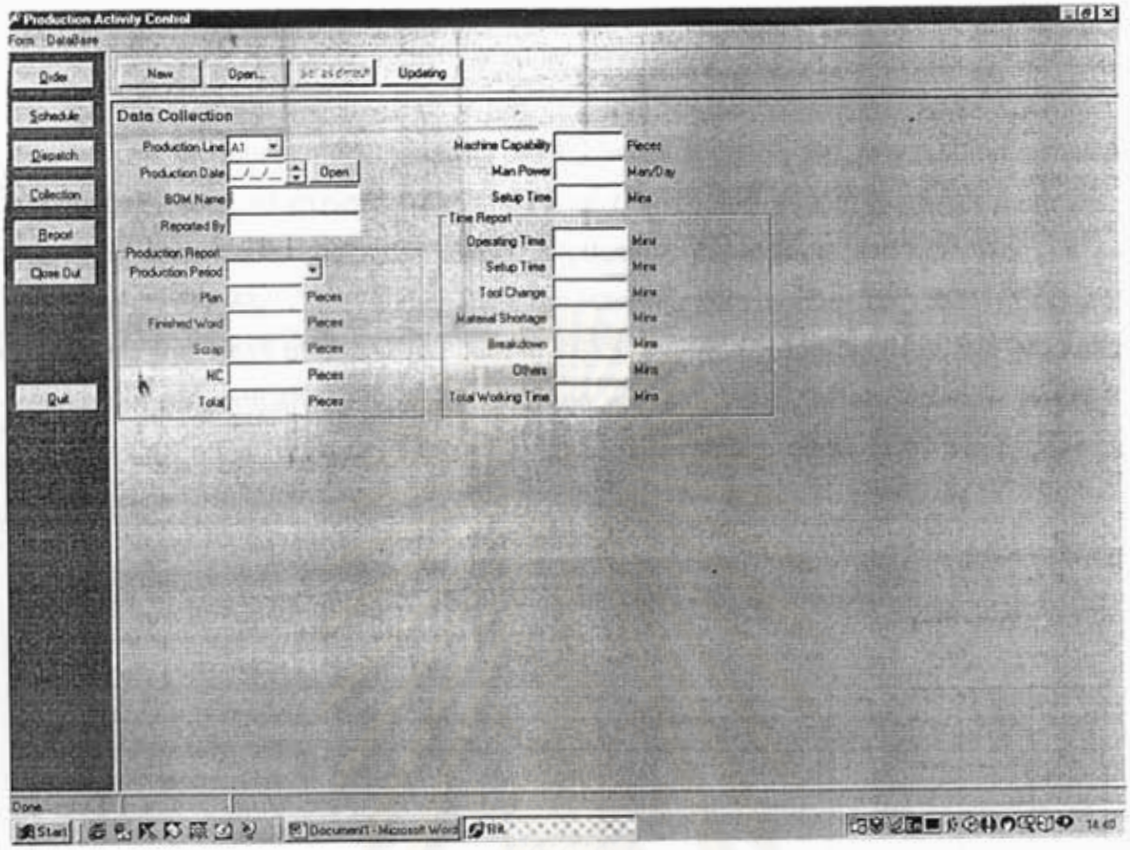


Figure 4-5 : A screen design of data collection activity module

With this module, the correction of data is improved from each sequential process by using BOM information to identify the standard item number and verifying each data item before input to the database. The comparison workflow of this module is shown in table 4-10.

Table 4-10 : The comparison workflow of data collection module

The Existing Production Activity Control System	The Developed Production Activity Control System	unchanged	Addition	Improvement	Remove
A3 Production Reporting Activity	*A4 Data Collection Activity*				
-	A41 Verifying the Work Order Report		X		
-	A42 Input the Work Order Report		X		

4.3.5 Production Reporting Activity Module

This module is the fifth activity of PAC information system, which summarizes the production result to minimize the impact of unexpected events such as absence of worker (manpower), machine failure (production capability), and shortage of part (material availability). This module uses the standard item number from BOM information to identify the detail of each data item in WOS and WOR reports. Thus, the production result can be compared and communicated with the Work Order Schedule (WOS) to minimize an effect from unexpected events. This module consists of two process as follows;

Table 4-11 : The component of production reporting activity module

The Developed Production Activity Control System	Responsibility	Form No.	Input	Output
A5 Operation Reporting Activity				
A51 Comparing with the Work Order Schedule	Production Department			
A52 Summarizing the operation reporting	Production Department	PR01, PR02, PR03		X

This module imports the Work Order Report (WOR) data from the data collection module and the Work Order Schedule (WOS) data from the operation scheduling module by identifying with the standard item number. The Production Department staff compares the production result and summarizes the production reporting to the efficiency and problem status report, which are the outputs of the module. The outputs of this module are shown in figure 4-6.

Robotics Information Technology Co.,Ltd.

Status Report for Assembly Section

Start Date : 01/11/98 Bom Code : ABC012345 Reported By : SMM

Reported Date : 06/11/98 Bom Name : FRONT COVER Checked By: KTK

Approved By : SMP

No.	Line	Date	Production Plan & Actual Data						Delivery Plan & Actual Data				
			Original	Revised	Actual	Different	% Diff	Stock	Original	Revised	Actual	Different	% Diff
1	A01	2/11/98	120	-	93	-27	-22.5	130	120	-	110	-10	-8.3
2	A01	3/11/98	120	-	110	-10	-8.3	125	120	-	93	-27	-22.5
3	A01	4/11/98	120	-	120	0	0	115	120	-	100	-20	-16.7
4	A01	6/11/98	120	100	90	-10	-10.0	105	120	100	87	-13	-13.0

Figure 4-6 : A sample of the outputs of the production reporting activity module

With the module, we can follow up/check the actual status of each sequential process to minimize the impact of unexpected events. Supervisor in each sequential process can monitor the problems by using "the efficiency report" and "problem status report". The comparison of this module is shown in table 4-12.

Table 4-12 : The comparison workflow of production reporting activity module

The Existing Production Activity Control System	The Developed Production Activity Control System	unchanged	Addition	Improvement	Remove
A3 Production Reporting Activity	*A5 Operation Reporting Activity*				
A33 Modifying the Work Order Schedule	A51 Comparing with the Work Order Schedule			×	
	A52 Summarizing the operation reporting		×		

4.3.6 Order Closeout Activity Module

This module is the last activity in PAC information system. This module is designed to solve the communicating problem between production control and sequential processes by controlling the modification of customer order plan. With BOM information, the Production Control Section identifies the order item from customer order plan and the Final Assembly Schedule (FAS) by using the standard item number. Thus, a number of order item is managed from the FAS report and monitor the change of customer requirement to improve planning process. The component of this module is shown as follows;

Table 4-13 : The component of order closeout activity module

The Developed Production Activity Control System	Responsibility	Form No.	Input	Output
A6 Order Closeout Activity				
A61 Comparing with the Final Assembly Schedule	Production Control Section	PAC-OC-01		
A62 Preparing the delivery order request	Production Control Section			
A63 Preparing back order record	Production Control Section	OC01	X	

Source of input data in this module comes from the modification of customer order plan and the order from FAS report by identifying with the standard item number. The Production Control Section sends the approved order to delivery customer and the modified order to prepare back order record, which is the manual process to discuss the problem with customer and monitor the change of customer requirement. At present, a design screen of this module can be summarized as follows;

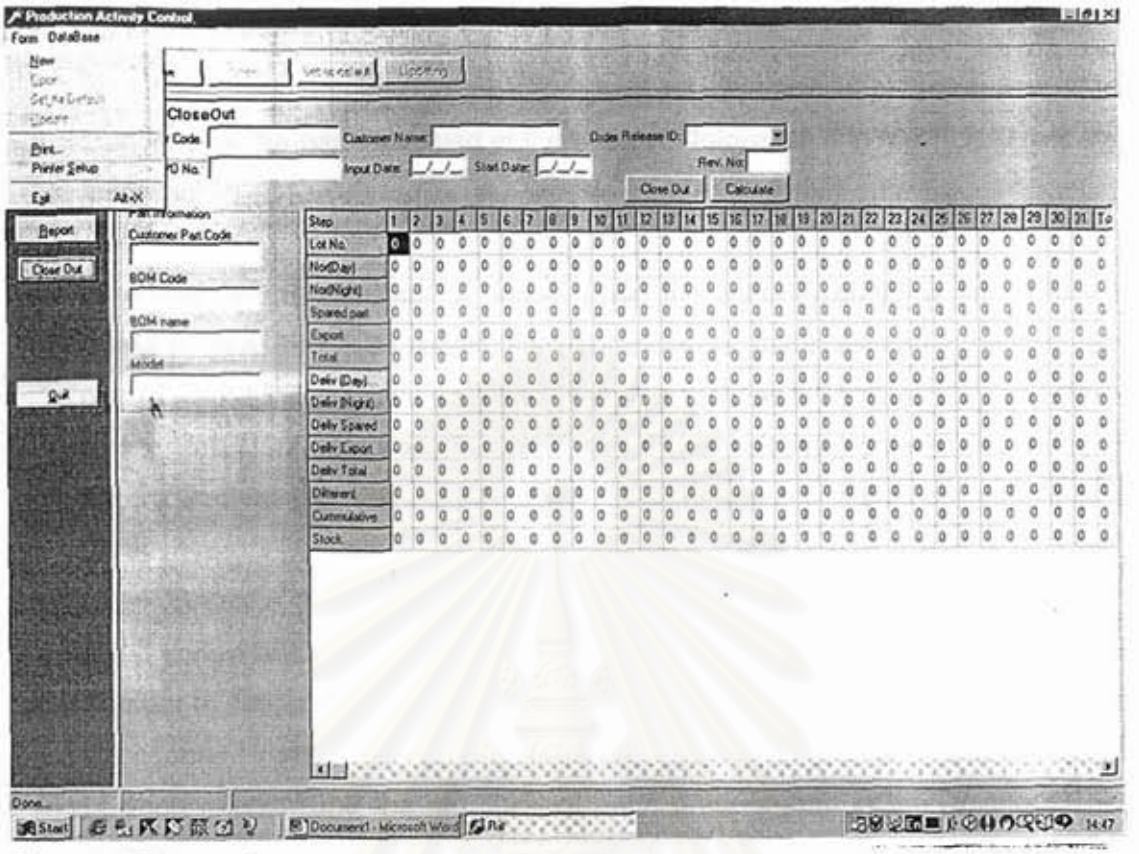


Figure 4-7 : A design screen of order closeout activity module

With this module, the Production Control staff can compares each order item and separates the approved order and modified order. The approved order is forword to delivery customer. But the modified order is passed to prepare back order record and report to the order release activity to claim with customer effect from the modification of customer order plan can be monitored the change of customer requirements to improve the FAS and WOS report in the next time. The comparison workflow of this module is shown in table 4-14.

Table 4-14 : The comparison workflow of order closeout activity module

The Existing Production Activity Control System	The Developed Production Activity Control System	unchanged	Addition	Improvement	Remove
A3 Production Reporting Activity	*A6 Order Closeout Activity*				
A34 Updating the Final Assembly Schedule	A61 Comparing with the Final Assembly Schedule			X	
	A62 Preparing the delivery order request		X		
	A63 Preparing back order record		X		

4.3.7 BOM Information

Information contained in the BOM has the objective of referring and setting the standard for the parts involved in the system. Information in the BOM consists of the following:

- *Item master file*: Consists of details upon the parts involved in the production phase such as products, assemblies, components, materials and suppliers. Each part of each type will have a unique "Item Number" as a "Primary Key" in referring to the details of that specific piece. In the developed system, Appendix C-2 shows that we can set the structure of the information about the details of the parts.

- *BOM index file*: Consists of a relationship of each item number and parent number to define the structure of each project item. The BOM index file uses "the Compound Primary Key" (item number) and parent number to define the quantity of each relation and the structure of each product item in the developed PAC system.

4.4 Physical Design

4.4.1 Data Dictionary/Directory

Data Dictionary/Directory (DD/D), which is applied to the information system, operates with the database system. The objective of DD/D is storing and managing all metadata (data about data) in each data items. DD/D can be divided into "data dictionary" and "data directory" as follows:

Data Dictionary consists of the details of record, data items, and types of data to explain the description of each data item. Data Dictionary of database system can be used to identify and categorize each data item in the database. The sample of data dictionary is show in table 4-2 and the detail of data dictionary shows in Appendix C-2.

To optimize the database system, the normalization technique is applied to improve the stability and reliability of database in the developed PAC system. This

technique can be broken by a large group of data items into two or more tables and redefining the relationship between each table.

With this technique, many data items are customized from the existing system, which uses a manual operation to the developed system, which has normalized relationship and data items into database structure. The detail of the existing system is shown in Appendix A-3 and the detail of normalized relationship and data item are shown in Appendix B-2.

4.4.2 Software and Hardware Configuration

4.4.2.1 Software Configuration

From the case study, the software configuration of the information system consists of Operating System (OS) and Database application. The interface of this system is default with Graphic User Interface (GUI). An Operating System in this case study is operated on Microsoft Windows environment and the database application is applied with Microsoft FoxPro to develop database structure and other related topics input/output such as form and relational table of database system.

The database system of this case study sets SQL (Structural Query Language) command as a standard command to query, manage, and communicate with each data item. This company requires developing with networking environment in the future.

4.4.2.2 Hardware Configuration

Hardware configuration in this case study is based on Personal Computer platform (PC), which is operated with a windows environment. Accessories of the PC in this case study consist of printer and networking interface (LAN). Communication between each PC is default to TCP/IP protocol. The details of hardware configuration in this case study is shown in table 4-15 and figure 4-8.

Table 4-15: The details of software and hardware configuration in the case study

System type	Topic	Suggestion
Software	Operating System	MS-Window 95
	Database Software	MS-FoxPro
	Database Command	SQL – command
	User Interface	Graphic User Interface (GUI)
Hardware	Architecture	Personal Computer (PC)
	Input Device	Keyboard & Mouse
	Output Device	Display monitor & Printer
	Networking Device	Network Interface Card (NIC)
	Networking Protocol	TCP / IP

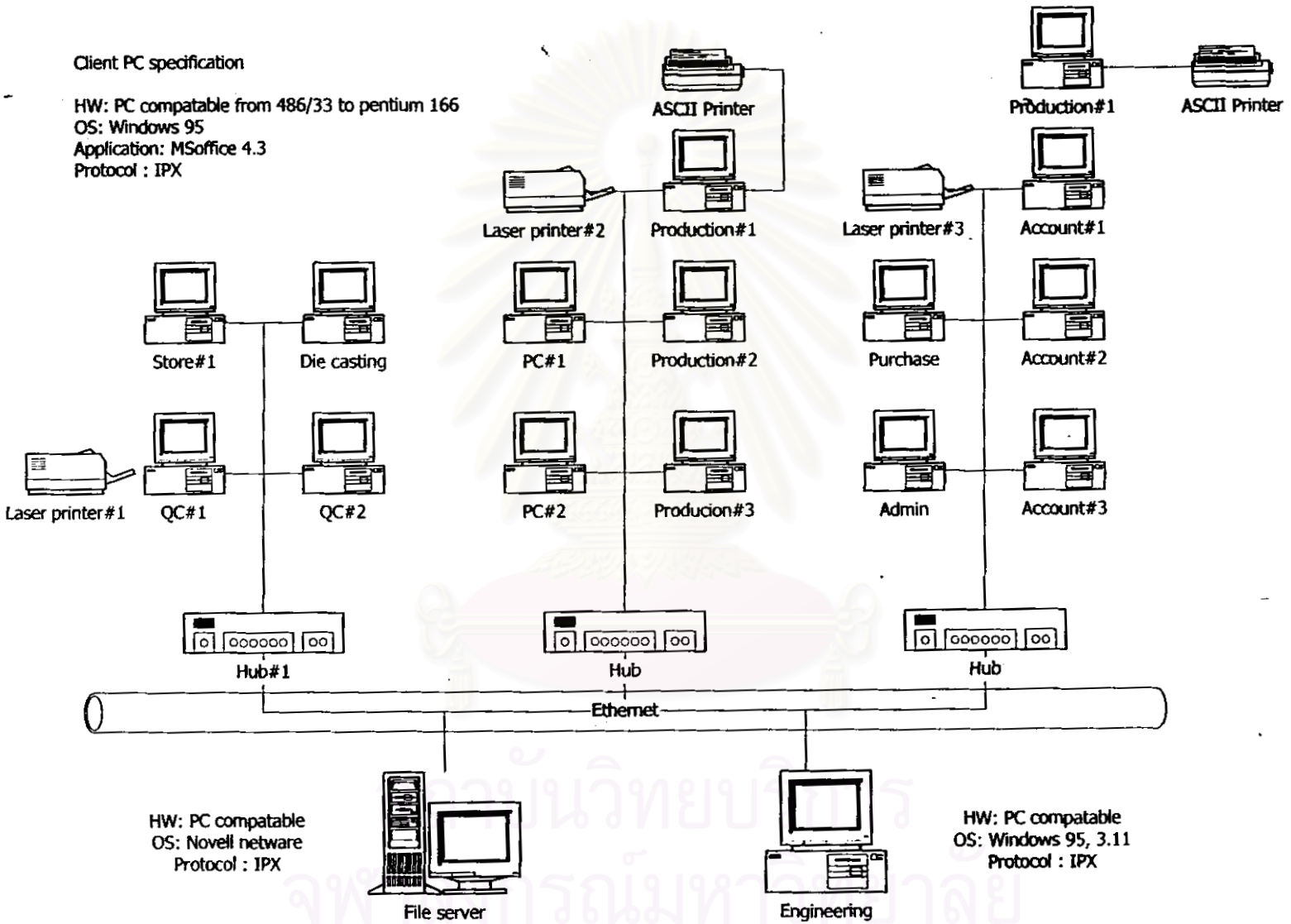


Figure 4-8 : Software and Hardware Diagram for the Developed PAC system

4.5 System Implementation and Result

4.5.1 System Implementation

Before addressing the developed PAC system in use, "Supporting Documents" and "Implementing Plan" should first be considered accordingly.

- *Implementing Plan*: Consisting of details and schedule of each activity, including the responsibility unit. Information in the implementing plan enables us to track and examine each phase of the developed PAC system.

- *Supporting Documents*: mean documents relating to the usage of the system such as user manual, variable descriptions and data dictionary/directory.

This study has set up an implementing plan to test and evaluate the developed information system in production control and sequential processes. This implementing plan is applied to the representative product during November, 1998 until January, 1999. The detail of implementing plan is illustrated as follows;

Table 4-16 : Implementation schedule from the Production Department
Product : Front Cover
Model : MC

List of activity	Start date	Duration (weeks)	Responsibility	Staff level
Overview of the PAC theory	15/03/98	3	Production Department	Management
Study the existing system	07/04/98	6	All sections	Management
Developing a model of study	02/05/98	4	All sections	Management
Setting the BOM master file & Standard variables	17/05/98	4	Production Department	Management
Training staffs & operators of the project team	16/06/98	8	Production Department	Management & operator
Preparing the user manual for the PAC system	17/05/98	10	All sections	Management & operator
Illustrating the weak points of the existing system	17/05/98	10	All sections	Management & operator
Training summary	04/08/98	4	Production department	Management & operator

Remark : All sections mean the Assembly, Machining, Die-Casting, and Production Control Sections

4.5.2 Results of the Developed PAC System

In this case study, the method and procedure for collecting data after developing the PAC system is the same as the previous collection in chapter 3. Each method and procedure is controlled by operation standard of the Front Cover product. The objective of collecting data is to focus on the changes of problem ratios and resource utilization, which affected the developed PAC system. The detail of this topic is presented as follows:

4.5.2.1 The Changing of Problem Ratio

The changing of problem ratio is collected from the production control and sequential processes. Each data item, collected from Work Order Schedule (WOS) and Work Order Report (WOR) in each process during November 1998 to January 1999. The result is separated into each topic as follows:

Table 4-17: The result of problem ratio after developed PAC system

No.	Problem list	Problems (items)				Ratio (%)
		Nov.	Dec.	Jan.	Total	
1	Shortages of Parts	7	10	6	23	11
2	Poor Resource Utilization	6	3	7	16	8
3	Excessive Work-in-Process	8	8	9	25	12
Number of transactions		75	60	69	204	

The changing of problem ratios is compared with the result of both the existing system and developed system by comparing a difference of problem ratio (%) in each problem, which is summarized in table 4-4. The result from the table indicates that the problem ratio (%) of the developed system in each problem is reduced, especially "Shortage of part before the final process and "Poor resource utilization." (Reduced 11.5% and 13.1%)

Table 4-18 : The comparison table of existing and developed system

No	List of problem	Ratio of problem (%)		
		Existing system	Developed system	Difference
1	Shortage of parts	22.5 %	11.0 %	-11.5 %
2	Poor resource utilization	21.1 %	8.0 %	-13.1 %
3	Excessive work-in-process	19.3 %	12.0%	-7.3 %

Difference = Ratio of developed system - Ratio of existing system

Each data item in table 4-18 is proof that the developed PAC system is effective, since the structure of this system can solve the problems of repetitive data, collecting enough information to make decisions, and the combining of communication between each activity. This developed system drives each process with functional operations and can be continuously improved. These developments help the supervisor in each section to manage and control production resources and operations. Results from the Production Reporting Activity relays essential information to help the supervisor for making decisions.

4.5.2.2 The Change of Production Resource Utilization

The change of resource utilization is evaluated in terms of manpower usage, production capability, and material availability as follows:

- The Additional Manpower Usage

These data items are collected from production control and sequential processes with the same condition as previous record during November to January 1999. We categorize and calculate the ratio of the average of the additional manpower usage (hours per month) to compare with the result of existing system as shown in table 4-19.

Table 4-19: The result of actual manpower usage after developed systems

Source of Manpower Usage	The average of additional manpower usage (hours/month)				Average usage (hours/month)
	Nov	Dec	Jan	Total	
Production Control Process	32	24	28	84	28.0
Sequential Process					
- Final Process	24	28	20	72	24.0
- Intermediate Process	32	28	32	92	30.7
- Primary Process	8	4	4	16	5.3

The results of the developed system are compared by calculating a difference of the average of additional manpower usage (hour/month) in each process, which is summarized in table 4-20. The results from the table show that the average of additional manpower usage in the production control process is rapidly reduced, but these averages of other processes also continuous reduce.

Table 4-20: The result of actual manpower usage between the existing and developed systems

Type of manpower	The average of additional manpower usage (hours/month)		
	Existing system	Developed system	Difference
Production Control Process	102.7	28.0	-74.7
Sequential Process			
- Final Process	29.3	24.0	-5.3
- Intermediate Process	84.0	30.7	-53.3
- Primary Process	25.3	5.3	-20.0

These results show that effect of the developed PAC system rapidly reduces in production control process, because the information system for PAC improves the data and information collecting process that cause a repetitive data and uncompleted information. Furthermore, many data items are rearranged with the normalized database system. Thus, a number of additional manpower in production control process is reduced.

However, the average number of operators in other sections is not rapidly reduce due to various factors such as machinery, quality of product and machinery. But the information system for PAC gives some essential information to help the supervisor in decision-making and establish the communication between the production control and sequential processes to share and improve the detail of WOS and WOR.

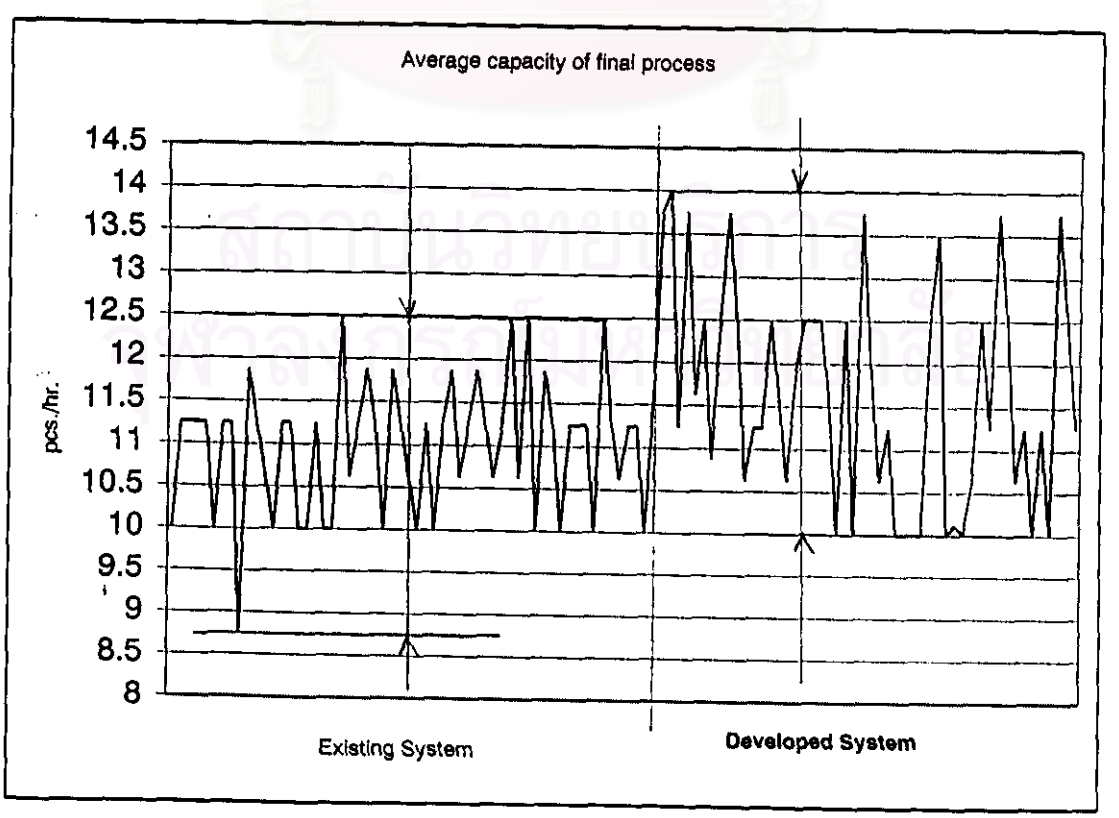
- Production Capability

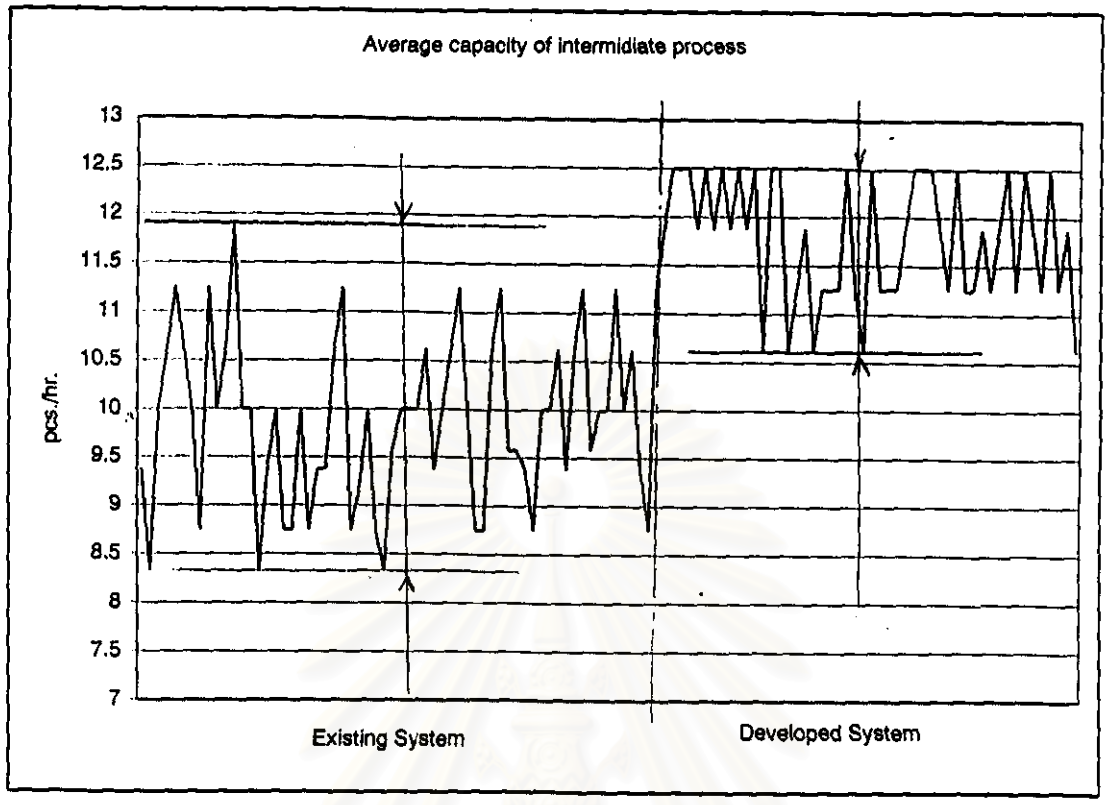
Those data items are also collected from the production control and sequential processes together with the data items of additional manpower usage. Each process separates data item, similar to previous data. The average amount of products is shown in table 4-21.

Table 4-21 : The result of production capability after developed PAC system

Type of sequential processes	Actual production Capability from WOR (pcs/hour)				Average Capacity (pcs/hour)
	Nov	Dec	Jan	Total	
Final Process	12.2	11.4	12.3	35.9	12.0
Intermediate Process	12.0	11.5	11.8	35.3	12.0
Primary Process	11.5	11.5	11.0	34.0	11.3

The result of production capability in each sequential process shows that the average of production capability becomes constant and the fluctuation in each month is continuously decrease. Because the information system can provide some essential data and information to communicate with the high-level planning of order, order release, and operation scheduling. Thus, the planned schedule and production resource can be adjusted to improve the production capability and to minimize some random events such as machine breakdown or operator absence. The result of production capability is summarized as follows;





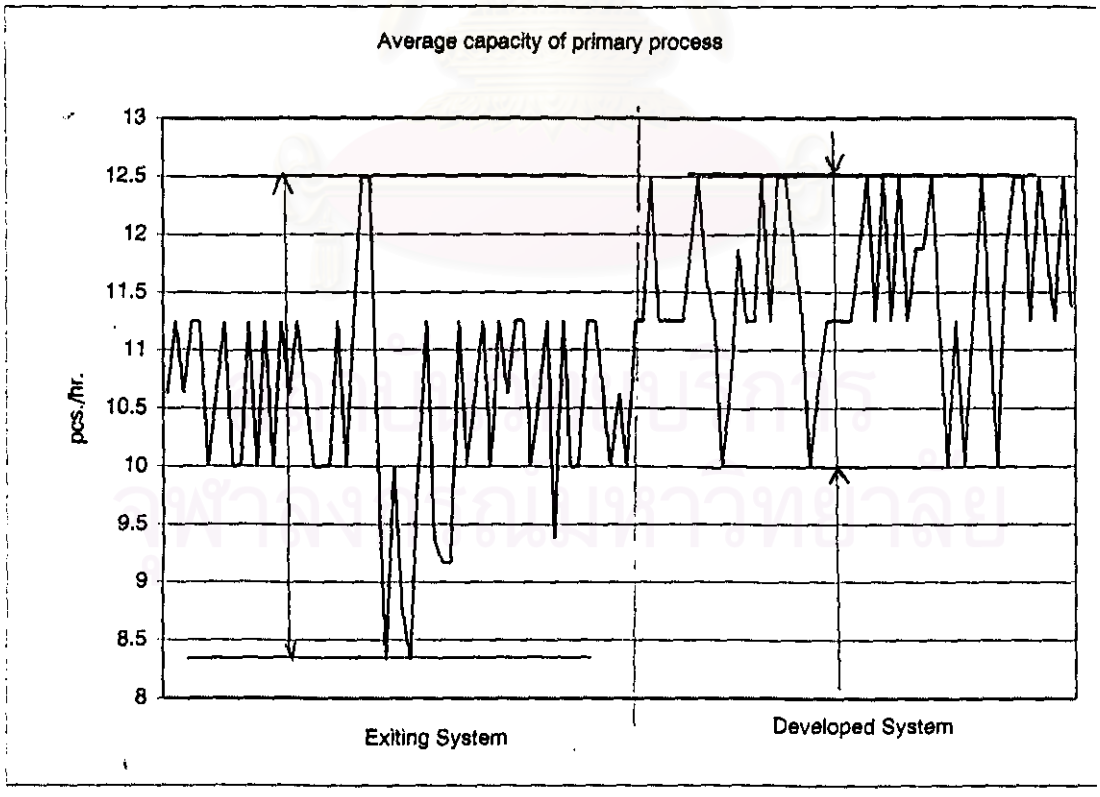
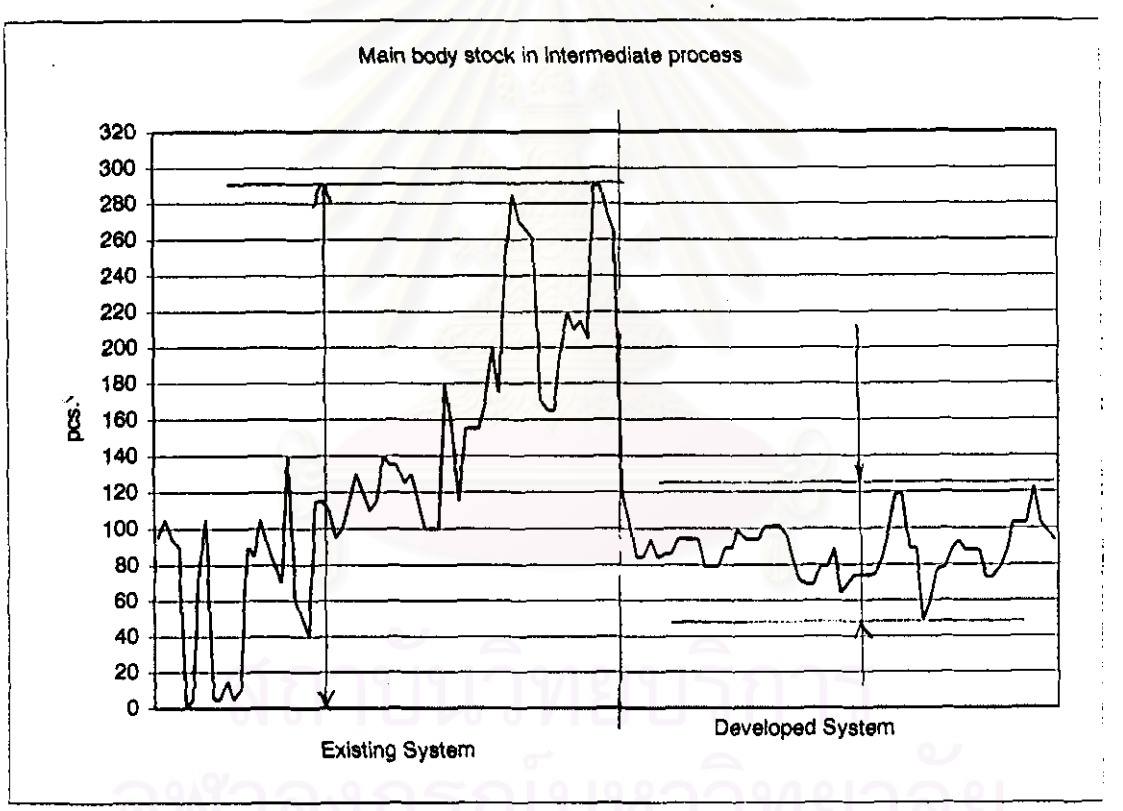


Figure 4-9 : The result of actual manpower usage between the existing and developed systems graph.

- Material Availability

Those data items are collected from the intermediate and primary processes together with the production capability. Those items are determined by the amount of finishing main body in intermediate process and the amount of die-casting main body in primary process. The average of material availability is calculated and compared with the existing system as shown in figure. The results show that the average of material availability become constant and trend to default value, the fluctuation in each month is continuously decrease. Supervisor in each sequential process can manage the production resource and supply the main body to meet the planned schedule in Work Order Schedule (WOS).



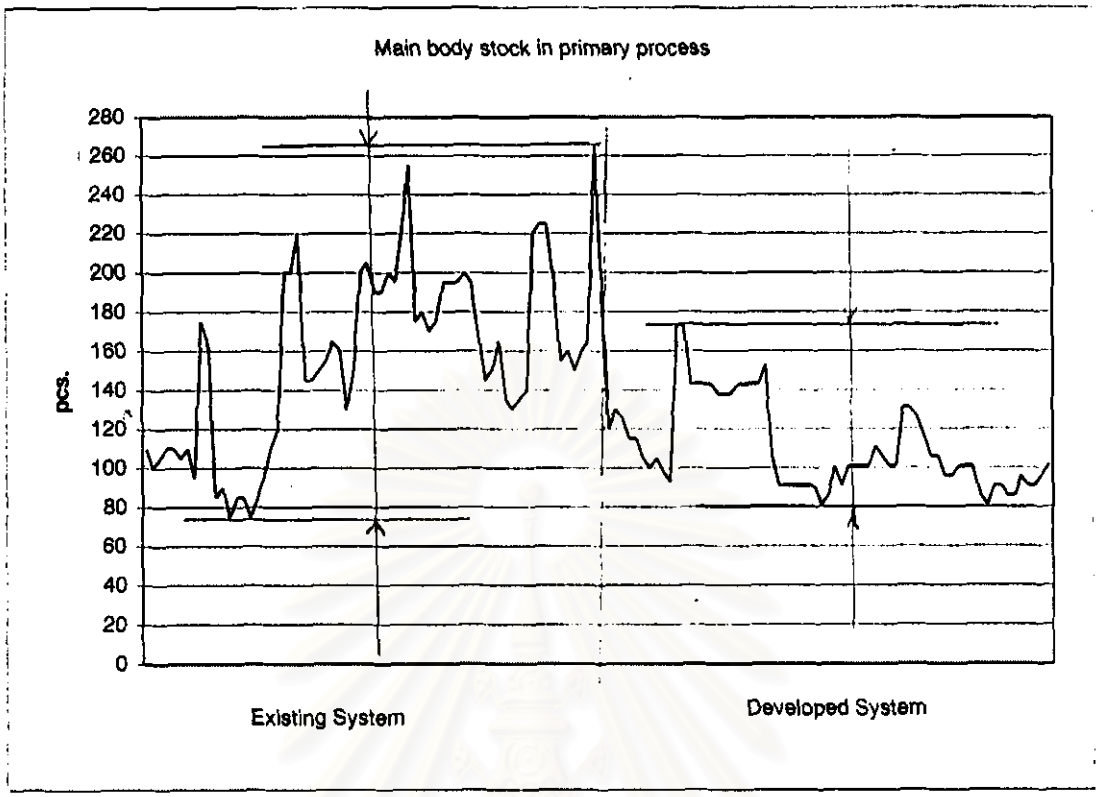


Figure 4-10 : The result of actual main body stock between the existing and developed systems graph.

From those result, which proofs the developing of information system for PAC can improve the production resource utilization and the quality of data and information. The repetitive data in each process is reduced especially item identification, that can be reduced a lot of the additional manpower usage in production control and sequential processes to edit and modify the Final Assembly Schedule (FAS) and Work Order Schedule (WOS). The detail of planned schedule can communicate and adjust with the result of sequential processes. That is the reason why the fluctuation of production capability and material availability is continuously reduce.

The developing of information system makes the efficient data collection and provides some essential data and information to feed back the actual production result, which is communicated with the FAS and WOS. The information system can monitor and control the balance of order and production resource to delivery part at the right time, the right quantity and meeting quality specification.

The developing of information system for PAC is improving the quality of data and information in term of correction, completeness and relevancy to minimize the random events such as machine break down, operator absence, and shortage of part which are proofed with the change of production resource utilization. This development also give an essential data and information to make a better decision for editing and modifying the planned schedule such as Final Assembly Schedule (FAS) and Work Order Schedule (WOS) and to communicate with each sequential process for balancing the production resources in each interval. However, this information system also need to improve the higher-level of planning such as MRP, or ERP, which can increase the efficient of planning and control system.