DESIGN OF A DECISION SUPPORT SYSTEM FOR PRODUCTION SCHEDULING: A CASE STUDY IN CRYOGENIC TANK MANUFACTURER

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DESIGN OF A DECISION SUPPORT SYSTEM FOR PRODUCTION SCHEDULING: A CASE STUDY IN CRYOGENIC TANK MANUFACTURER

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ABSTRACT

Production scheduling is a significant aspect of a competitive industry. An effective scheduling system is desired in every company. Scheduling cryogenic tank production is very complicated; the job requires a high level of managed and logistical skills. Computer software has come into play to help manage production. The main purpose of the software is to provide a decision support system in the area. While a decision support system for production scheduling is needed, software available is very expensive.

The primary purpose of this project is to develop a simple and low cost program for a decision support system in production scheduling. It is expected that the system will be able to estimate number of jobs on the shop floor. A report on the status of jobs in the production line should also be available.

The project was developed and applied in a cryogenic tank manufacturer. Cryogenic tank manufacture involves group technology; therefore, the industry is a good case study as it allows study of better software. Group technology is where each production step contains a set collection of machines doing many complicated sub-processes. The software displayed information and analysis of job orders. The program prototype was set to standard and there is a manual for the software, therefore, the software can be adapted to other industries.

KEY WORDS: DECISION SUPPORT SYSTEM/ SHOP FLOOR CONTROL/
GROUP TECHNOLOGY/ SCHEDULING

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บทคัดย่อ

การออกแบบโปรแกรมช่วยตัดสินใจสำหรับการจัดตารางการผลิตนั้น นับได้ว่ามีความสำคัญยิ่งต่ออุตสาหกรรมการผลิตสำหรับโรงงาน เนื่องจาก โปรแกรมจะช่วยให้การดำเนินงานเป็นไปได้อย่างราบรื่น สามารถที่จะจัดสรรการทำงานได้อย่างเต็มที่ โดยมีวัตถุประสงค์หลัก ก็คือ เพื่อช่วยในการตัดสินใจเบื้องต้นว่าควรรับหรือปฏิเสธงานใหม่ที่เข้ามา สามารถมองภาพรวมของงานทั้งหมดในระบบ ช่วยให้การจัดตารางการผลิตมีความยืดหยุ่นต่อการดำเนินงานในงานและสุดท้ายช่วยเรื่องของการเก็บข้อมูลและการออกรายงานเป็นลายลักษณ์อักษร ซึ่งสามารถยกตัวอย่างปัญหาคร่าว ๆ การจัดสรรการทำงานที่ไม่ถูกว่าควรจะให้งานใดเข้าทำก่อนหรือทำหลัง และงานใดควรทำต่อจากงานใด เป็นต้น ปัจจุบันมีการใช้โปรแกรมสำเร็จรูปในการวางแผนและจัดตารางการผลิต ซึ่งค่อนข้างมีราคาสูง และอาจใช้ได้ไม่ตรงกับกรณีที่ต้องการ

จากปัญหาต่าง ๆ นี้ งานวิจัยจึงได้ถูกจัดทำขึ้น เนื่องจากเล็งเห็นถึงความสำคัญของการวางแผนและการจัดตารางการผลิตและการพัฒนาโปรแกรมที่เหมาะสมเฉพาะกรณี เพื่อช่วยให้ผู้ประกอบการ หรือผู้ที่ทำงานเกี่ยวข้องได้ใช้เป็นเครื่องมือช่วยในการวางแผนการผลิตของตนต่อไป โปรแกรมสำหรับกรณีศึกษาในครั้งนี้ ได้ถูกพัฒนาให้เหมาะกับการผลิตแบบจัดกลุ่มของการผลิต คือ มีการจัดเป็นกลุ่ม ๆ ของการผลิตไว้ โดยในแต่ละกลุ่มจะถูกมองว่าเป็นกระบวนการ และในแต่ละกระบวนการภายในก็สามารถที่จะประกอบไปด้วยเครื่องจักรหลายเครื่อง ซึ่งการจัดกลุ่มแบบนี้จะช่วยให้สามารถมองภาพรวมของการดำเนินงานที่ง่ายมากกว่าการจัดกระบวนการผลิตแบบดูแต่ละเครื่องจักร ซึ่งจะมีความซับซ้อนและรายละเอียดที่มากกว่า

จากการวิจัยและพัฒนาโปรแกรมในครั้งนี้ มีข้อเสนอแนะว่า ถ้าอุตสาหกรรมใดที่มีกรรมวิธีการผลิตที่แตกต่างจากโรงงานกรณีศึกษานี้ จำเป็นที่จะต้องมีการนำไปปรับปรุงและพัฒนาเพื่อให้เข้ากับอุตสาหกรรมของตนต่อไป แต่ทั้งนี้การพัฒนาหรือปรับปรุงโปรแกรมต้นแบบนี้สามารถทำได้โดยง่าย เนื่องจากได้ใช้โปรแกรมที่เป็นมาตรฐานและเป็นที่รู้จักกันโดยทั่วไป และง่ายต่อการเรียนรู้ต่อไป

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LIST OF ABBREVIATIONS

B2B	Business to Business
CPU	Control Processing Units
DFD	Data Flow Diagram
EDI	Electronic Data Interchange
EDD	Earliest Due Date
ER- Model	Entity-Relationship
ERP	Enterprise Resource Planning
FCFS	First-come, first-served
FPC	Flow Process Chart
MRP	Material Requirement Planning
ODBC	Open Data Base Connectivity
PC	Personal Computer
QA	Quality Assurance
RAM	Random Access Memory
SDLC	The System Development Life Cycle
SMEs	Small and Medium Enterprise
SPT	Short Process Time
TOC	Theory of Constraints
WIP	Work in Process

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CHAPTER I
INTRODUCTION

1.1 Background and Statement of Problems

In the globalization era, which full of competitions, the new concept in business and industry has been strengthened. It is said that business cannot stand alone so it has to find new partner both vertical and horizontal line. The corporation of business creates the concept that called supply chain. It is the connection of business not only within organization but also outside organizations. After this concept has reached Thailand, some businesses and industries are more interested to use this new concept in particular organizations. Supply chain is an important key to bring business especially small business enterprise (SMEs) to succeed by gaining positive comments and increase ability to compete with other international competitors. Moreover, it will control business to be successful. The important event is not only supply chain management because each organization has to study more about structures of supply chain with many factor combinations to make the core concept. Every organization requires many skills and abilities especially logistic skill which is necessary for the operation of any activities including skills in production management, forecasting, planning, inventory control, capacity of production, distribution of job, etc. In production system and organization management, it requires connection and communication of information from other department especially in the dynamic environment, which can be changed all the time. The perception of everything that happens in organization and between organizations is important thing. One of the important concepts is that communication between organization and other partners has to be in real time. If we can see other information, it should require some technology for helping in exchange information that is the equipment

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aid such as ERP (Enterprise Resource Planning) and EDI (Electronic Data Interchange).

This format can make supply chain connective more essential to receive information and situation about problem on time, but the important barrier is using information technology requires high investment. The readiness of small business enterprise (SMEs) is low comparing to the high investment. According to evaluation of SMEs in Thailand, we found that SMEs grow by creating and emphasizing in production factors but do not concern about how to increase efficiency in work. Today efficiency is not the only factor for being a successful supply chain. Therefore, it is the gap of SMEs because most tend to develop business to be systematic and successful before using information technology to create supply chain or the creation of internal supply chain.

At present, the factory in this case study is facing many production problems in making a decision when receiving order from customer if that order can accept or reject because of lacking of decision support system. Frequently, make the wrong decision will affect the production system, such as job cannot to be continued, due date of jobs are delayed, which leads to customer are not satisfied that industry system. Besides, the problem of showing Gantt chart or production scheduling by using paper system is always very complex, confused, and difficult performance, due to the lack of a management system of this factory. Thus, if we built software in order to help an executive or other staff to work more efficient and comfortable, then the business will be successful.

In this research we will consider the creation of logistic management in middle or small business enterprise in order to pick up the production planning and distribute jobs as a part of this case study. Because the core problem in logistic system found in most of Thai SMEs is the lack of the production planning. In additions, job distribution will be set manually or by old traditional skill. The connections in each

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station will not occur. If they buy production-planning software from aboard or invest in information technology will be costly comparing to any possible choices but it is not worth. Since we buy software, we have to adapt the programmed investing with our organization system. Therefore, this research will develop and use technology by using simple software to be adapted and use as a pattern in SMEs in order to develop production planning and job distribution in the system by creating simple software, by using basic software and adapt it as the pattern in planning production and distributing jobs systematically.

1.2 Objectives of Study

To construct a decision support program for production scheduling at shop floor level.

1.3 Scopes of Study

Design of a Decision Support System for Production Scheduling for Group Technology and Assembly Line Production: A Case Study in Cryogenic Tank Manufacturer which manufactures various product sizes; single product size is selected to study. This is 6,000 liter liquid - gasoline tank which has a consistent quality of tank. The software program has three functions:

The first function is to show quantity of jobs in shop floor in order to make decision for the amount of jobs in the system. Moreover, this system will estimate due date of the job using First Come First Served rule, but sometimes due date is not real and accurate. It can be changed or modified, if a new job has an overlap with old job. In the first time, the system will warn, if old jobs are overlapped by new jobs in the system. Warning will show information of jobs which has an overlap, processes, and machines in order to consider if new job can be accepted. If user accepts, the system

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will save it and this job can be remarked. However, due date showed is an estimated due date only. It is not the actual due. User needs to inform customer about new due date by adding day or estimating new due date.

The second function is to show Gantt chart in order to see total jobs; such as, total processes, job priority, process part of jobs, range of each process with the starting date and finishing date by showing per day. This program will be displayed for helping staff make decision for production.

However, Gantt chart cannot show the problems of the overlapping of each job, but it will show black color for different points which have problems; the overlaps of jobs might be easily observed or easy to check. Sometimes we need to consider together with report of jobs in order to see the problems clearly. The general color of jobs shown, will be only an estimate due date. It is not accurate. This will help making decision by showing how many jobs in the system.

In addition, Gantt chart will show holiday which is Sundays. To show all of Gantt chart easily; it will show when there are many jobs and when there are fewer jobs. The system will add a number of days of processing when some process has been matched with holiday. By the system, the finishing day in each process, that falls in Sunday will be shifted in order to predict the most accurate due date possible.

The third function is to display different reports; such as, report machine on names, report on employees, report on the status of each job in the production and job description is also provided.

1.4 Expected Results of Study

Program prototype for a decision support system for production scheduling at shop floor level.

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CHAPTER II
LITERATURE REVIEW

2.1 Production Planning and Control

2.1.1 Group Technology Theory

The definitions are listed in order from those which are more general to those which are more specific. Group technology is such a technology and must be applied in its broadest sense. To accomplish this, it is important to fully understand the theory of the technology and the elements necessary for its implementation. This theory is that various situations that require decisions can be grouped together based on reselected, commonly shared criteria, and that the decision which applies to one situation in the group will apply to all of them in that group. [4]

In dealing with this theory, there are several important points that must be made; the first is that the situations or problems are grouped based on reselected criteria. However, the decisions that are shared commonly in the group are not reassigned. The decisions are made based on data made based on data that has been collected to be analyzed. This is the second major point. The process of group technology is firmly grounded on the principle of analyzing data. The decisions made are not “gut reactions.” But is the result of structured data analysis. Therefore, the creation of a data base is absolutely essential. The third major point is that no decision is viewed as the ultimate 100 percent complete solution; instead the process is based on choosing the best from a group of alternatives. One additional point needs to be made before proceeding. Much of the literature on group technology will center on the activity of coding and classification, at times if appears that, to some people,

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coding and classification is group technology. In reality, however, coding and classification is just one method of establishing a data base necessary for the decision process to take place. To fully benefit from group technology, the established database must be coupled with an application. The two elements, data base development and application, are equally important in reaping the full benefits of group technology.

2.1.2 Concepts behind Effective Production Scheduling

Planning and scheduling is the what-if process of deciding what orders should be worked on, in what sequence (e.g., priority), with what limited capacity (e.g., machines, tools and labor) and limited material (e.g., on-hand and promised), and at what time. [15]

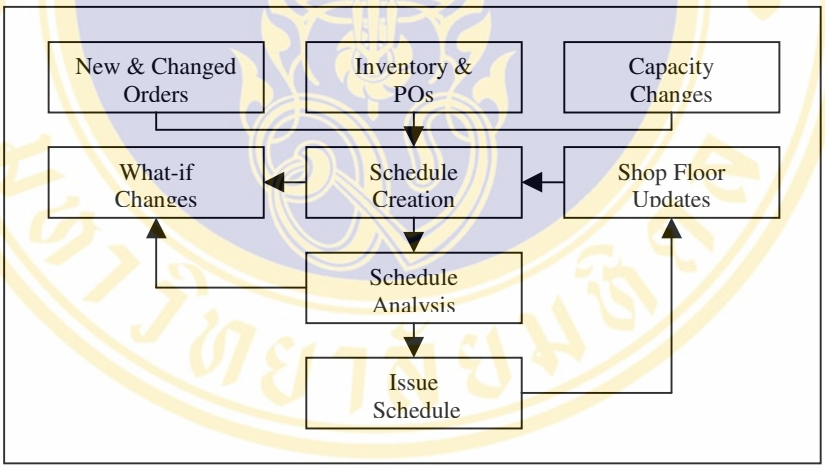

Figure 2.1 Concept Scheduling. [15]

Form the picture, for scheduling creation will have many factors which have a relation about creation. First, when new orders or changed orders are saved into the system, we need to check inventory & Pos, and capacity changes of machines to see how they are so that we can create basic schedule. But schedule creation can not consider only three factors because it will also involve with what-if changes and shop floor updates; such as, priority change, capacity, material allocation, or manpower, etc. After we have the information about what-if changes and shop floor

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updates then, we will get a schedule analysis. If this section has been changed, it will send result back to what-if change again, but if it has not been changed, it will make next process; that is, issue schedule. If there is a new data or changed information, it will send report back to shop floor updates.

2.1.3 Scheduling

Scheduling objectives – Dutkosky, Hitomi, and Ham listed fours objectives for a production control function. (Charles S. Snead, 143-145) as follows:

1. Minimize idle time on all workstations.
2. Reduce in=process inventory.
3. Minimize the time a job is in a shop.
4. Deliver a product on time.

The individuals plan their respective production jobs by attempting to guess how long each item will be in each work center before it is complete. Most planners begin with a top level bar schedule as shown in Figure 2.2 The idea is to attempt to box in the major activities that must occur to meet the required ship date for the item being planned.

The completion of the top level schedule allows the planner to begin to develop scheduler for the lower tier of product assemblies that make up the major assembly. These in turn can be further defined into lower levels until a plan and schedule exists for all component parts, subassemblies, and the top assembly.

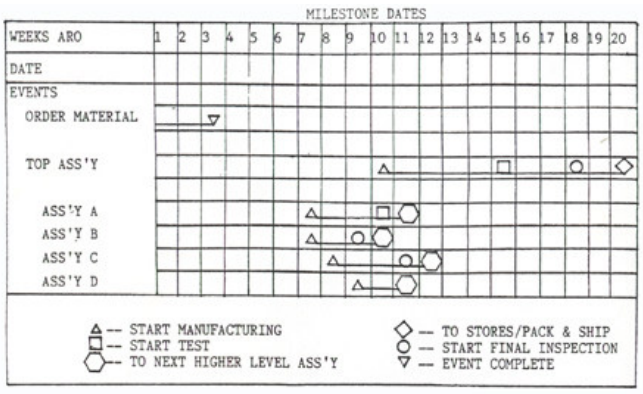

Figure 2.2 Production planning top level schedule. [1]

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Production scheduling is one of the major sub elements of the broad activity of production planning and control. To fully understand where scheduling fits, it is useful to examine the entire activity. Figure 2.3 depicted production planning and control as the top level of activity in the hierarchy of manufacturing planning. A similar structure exists (as shown in Figure 2.4) for the scheduling dimension of production planning and control. Three levels of scheduling activity are required to fully develop production planning and control for the factory. (Charles S. Snead, 1989: 140-141)

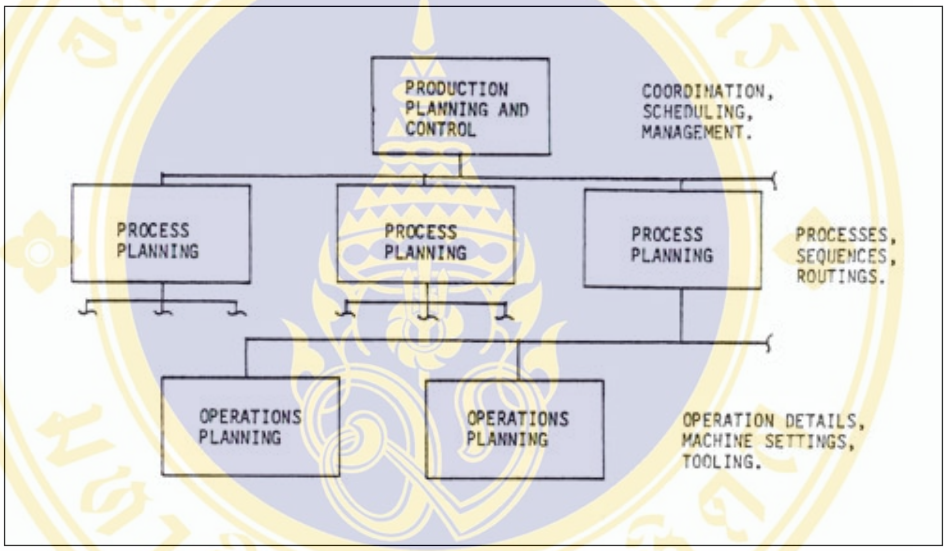

Figure 2.3 Levels of planning in manufacturing. [1]

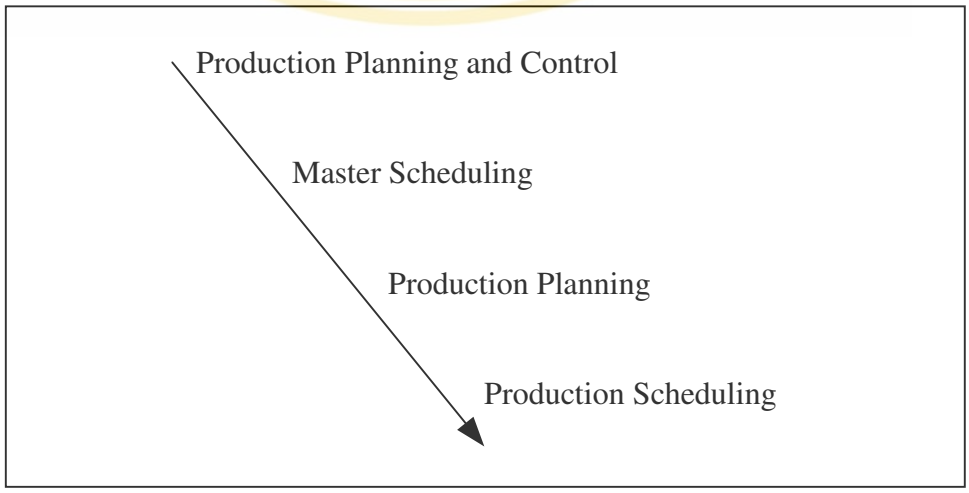

Figure 2.4 Hierarchy of manufacturing scheduling.[1]

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Master scheduling – The master schedule of a factory is a delineation of the products to be built in the future based on the FOB date or the deadlines for stock replenishment. The major constraint considered in preparing the master schedule is rough cut capacity planning. What the scheduler is attempting to do is to satisfy the end item and stock requirements as close to the due date as possible without exceeding the capacity of the major cost centers.

Production Planning – The second level of scheduling involves a breakdown of the master schedule end item demand into quantities of parts to be produced in specified time periods. This requires a good definition of the product structure, the bills-of-material, and the part routing. Production planning addresses the issues of work center capacity, product mix, lot size analysis, and production smoothing.

Production scheduling- The activity of implementing the production plan by scheduling jobs through work stations, machines, inspection station, etc., in short time periods is known as production scheduling. Other terms used synonymously for this activity are short term scheduling and shop floor control. For structure of queuing problem is to set a priority discipline by general; queues for production will have various ways but for this system will use two functions [3] that is:

- First-come, first-served (FCFS) rule: Most service systems that the average person encounters in daily life use FCFS rule. The customer at head of the waiting line has the highest priority, and so on, to the customer who last arrived. However, this rule is only one of many priority disciplines used in queuing system.

- Preemptive Discipline: The service system may even invoke a preemptive discipline. Preemption takes place when a customer of higher priority interrupts the service of another customer. Modeling queuing systems having complex priority disciplines is difficult, and most often in practice simulation is used to analyze these situations.

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2.1.4 Flow Scheduling

Using MRP by mechanism for calculation is an infinite capacity production planning which will view the total processes that have enough capacity, and MRP must leave enough time for each of the process, maybe a week or a few days. In other words, MRP is a rough production as answer for how much time the production needs. On the other hand, the production planning as flow scheduling, which bring a finite capacity to each work station will be considered immediately. When an order is received, what will be considered is the work stations that the job needs to pass and how much time for each part by planning in real-time & on-demand. That is, when a new order has been added into the plan and change plan or the production capacities, it is done in order to meet requirement immediately. If the system is used together with Kanban system (1 Card and 2 Cards), material will be pulled into production which will differ form MRP as batch will really a lot of orders then once run. [26]

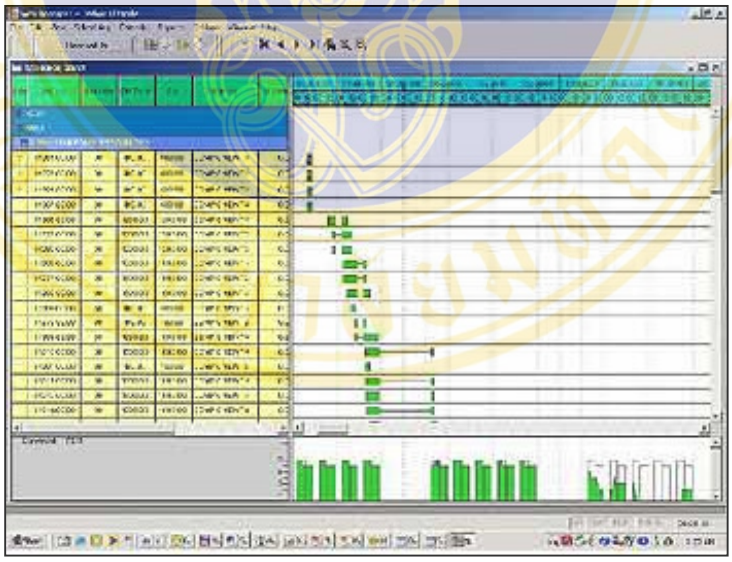

Figure 2.5 Program Made2Manage for example Flow Scheduler. [27]

2.1.5 Machine Setting

In mass production, one can find some machines which have been specially designed to make one component. In batch and jobbing production on the

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other hand, and also widely in mass production industries as well, parts are made on standard machines which are adapted to special needs of particular components, by the addition of jigs, fixtures, and special tools. [21]

The task of changing this tooling, when changing from one component to another, is known as the setting time. The early technological phase of Group Technology was important because it showed that setting time is not an inflexible constant factor, but is a variable which can easily be reduced. The following are the principal methods by which setting times can be reduced:

1. Planned sequence of loading.
2. Tooling families and composite parts.
3. Training of the setters.
4. Pre-setting.
5. Co-ordinate setting and digital read-out.
6. Improved measuring devices.
7. Improved tooling design.

2.1.6 Setting Time

The discovery which made Group Technology possible was the discovery that long setting-up times are unnecessary. Once it was realized that the same tooling and set-up could be used to make many different parts, and that tools could be accurately pre-set and changed in seconds, if provisions were made to do so, the door was opened to a complete rethink of existing production practices and prejudices.

The beauty of this setting time discovery is that it is not new, or difficult to accept. Anyone who has ever set-up machines knows that the savings are possible. Anyone who has ever set-up machines for a living has probably taken advantage of some of the methods by which setting times can be reduced, either to reduce his work, or to increase his bonus. [21]

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2.1.7 Types of Production Process

Types of production process can be divided into 2 types; that are; Continuous Production Process and Intermittent Production Process. This industry uses an Intermittent Production Process. [24]

Intermittent Production Process.

Intermittent processing is characterized by general purpose equipment such as drilling equipment, lathes, etc. that can handle a variety of different processing requirements that involve a variety of different, nonstandard products. Hence, the layout is based on different processing requirements and it is called process layout. The drilling equipments are grouped in one department; lathes are grouped in another department and so on. Each department has a special function and therefore, this type of layout is also called functional layout.

2.1.8 Types of Production Control and Planning

It is the system that helps organization in planning, controlling and purchasing material, production spare part material including any job that necessary for production divided into three systems. (รศ.พิภพ ลลิตาภรณ์, 2546: 19-22)

2.1.8.1 Pond Draining or Re-order Point system

It is the system that plans and controls the flow of water in the sink, emphasizing in holding raw material and keep it for production. Every sink is estimated to have the lowest and highest points that control inventory, not only low or high point. The concept of this system is that material will be purchased when reaching the determine point. So this system will be looked that there is high inventory; in the same time, this inventory will be lack of material because the scale of inventory does not match with customer's needs. However this system can use in production that emphasizes in product or process as core concept that will make

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information technology related to customers, supplier and production have low mistake.

2.1.8.2 Push System or Material Requirement Planning System

Push systems are effectively the reverse of pull systems in the sense that products are being produced for which there is no real customer demand and for which the associated waste costs increase for the business. This system is often described as *'Firefighting!'* environments this may a result of incorrect customer requirement determination, by launching more WIP on the assumption that the customer will want the product eventually. Systems work well in environments where there are high customer demands and quick product turn around times, in effect where there is a need to hold buffer stocks to cover customer demands, distribution system demands, and the supplier demands, hence continuous production runs. ((c) eCommerce-Now.com Est 08/00, 28/05//2001).

As a result of having too much WIP, it is often argued that this result in waste and failure to meet production targets, unless the lead batches are clearly identified and follow up batches are effectively identified. Too many batches will result in wastage.

2.1.8.3 Pull System or Just – In- Time

This system will focus on decrease level for on hand in every production process by interesting next process and considerate that process. This system is known many name such as Just – in – Time, Short – Cycle Manufacturing, Continuous – Flow Manufacture, Management by Sight, Stockless Production, Repetitive Manufacturing System, Synchronized Production, and many Japan's' Companies called "Toyota Production System".

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2.1.9 Basic Layout Types

Basic layout types into can be divided into three basic layout types discussed above are ideal models. In real life, it is common to see layouts that represent some combination of these pure layouts that are process layouts, product layout, and fixed-position layout, however, this factory uses two models: process layouts and fixed-position layout. Besides, there are 3 hybrid types of layouts that are cellular, flexible manufacturing systems, and mixed model assembly-lines. [24]

2.1.9.1 Process Layouts

Process layouts, on the other hand, are more suitable for producing a larger number of different products or customized products through the use of flexibility provided by the general purpose machinery. Even though the process layouts have the advantage of flexibility, such layouts involve complicated scheduling problems due to the multiple paths for parts to different functional departments.

2.1.9.2 Fixed-Position Layout

Fixed-position layout is transformed resources remain stationary which move as necessary, in addition to; effectiveness is governed by scheduling of transforming resources, reliability of transforming resources.

Group Layout

Group layout is the first of the key features of Group Technology. In most factories, it is possible to divide all the made components into Families and all the machines into Groups, in such a way that all the parts in each family can be completely processed in one group only. When the plant is laid out in this manner, with each group of machines and its team of workers established together in one special area, the factory is said to have Group layout.

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The three main types of plant layout, known as Line, Group and Functional layout, are illustrated in Figure 2.6. With Functional layout all machines of the same type – all lathes, or all milling machines in a machine shop for example – are laid out together in the same section under the same foreman. Each foreman and his team of workers specialize in one process. The workers in each team work independently, Co-operation between them in the execution of their tasks is only rarely needed, because the different workers in the section seldom do work on the same items. This type of layout is based on process specialization.

In Group layout on the other hand, each foreman and group of workers specialize in the production of one list of parts and co-operate in the completion of a common task. This type of layout is based on component specialization. Because the products produced in component processing departments are components or parts of products, a change form functional layout to group layout can also be seen as a change from process specialization to product specialization. [2]

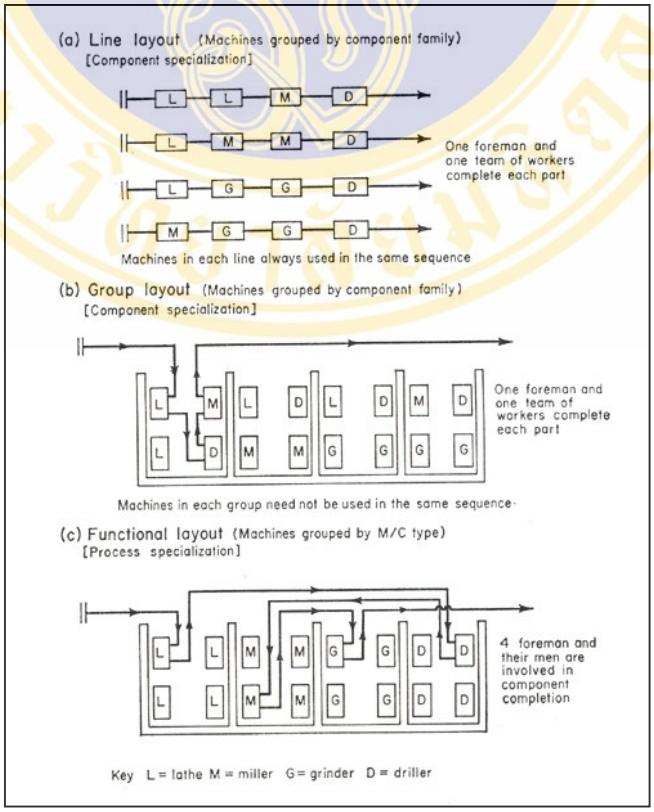

Figure 2.6 Types of plant layout. [2]

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Cellular manufacturing

Cellular manufacturing is a technique that attempts to take the advantage of the rapid, smooth, and efficient flow of production layout and flexibility advantage of the process layout to produce a variety of items in smaller amounts. In this type of layout, machines are grouped together to produce a set of similar items; such a grouping of machines is called a cell. For different dissimilar sets, we may have other machine groupings or cells. Grouping of the items is also necessary apart from the grouping of the machines. Grouping of items that have similar design or manufacturing characteristics is called group technology and it is essential for effective cellular manufacturing. (Charles S. Snead, 1989: 89)

The families of parts are usually grouped according to similarities in machining operations. Because the number of part types and shapes are limited and easily seen, cellular manufacturing often leads to other group technology application, such ad standardization of process plans, tooling, feeds and speed, and machine setups. These applications, while being related to cellular manufacturing, will be treated ad independent applications. The in - depth analysis of cellular manufacturing, including its relationship with flexible manufacturing systems.

Formal Cells. Cellular manufacturing during the infancy of group technology primarily consisted of isolated cells of a few machines grouped to produce specific families of parts. The machines were manually controlled and material was moved hand to hand through the cell. The major concentration of process efficiency improvement was in standardizing setups to reduce setup times and in minimizing material movement. Cells often consisted of four to five machines, as shown in Figure 2.7 under “actual cell”.

Virtual Cells. A second type of cell called the “virtual cell” came into existence during the same time period. A virtual cell, also shown in Figure 2.7, is not a physically constructed grouping of equipment, but is an identified path to selected equipment that families of parts will flow through. The idea of virtual cells is to

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reduce the cost of moving the equipment that is required in the formal cell concept. Often, the virtual cell equipment is identified by differing colors of paint. The drawbacks to this concept are the need to continue to move material great distances and the difficulty in scheduling caused by this movement. In spite of these difficulties, there have been documented cases of successful virtual cell implementations.

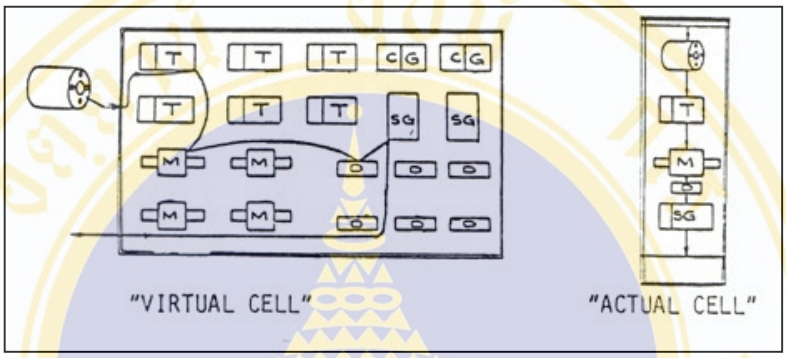

Figure 2.7 Cell definitions.[1]

Negative Characteristics of Job Shop Departmental Layout

The majority of the factories today are arranged as functional layouts with a grouping of common process equipment, as opposed to being laid out for process flow. An example of the difference is shown in Figure 2.8. The result of a factory layout based on grouping common equipment is that products must flow from department to department through the manufacturing process. The result is a nightmare in production scheduling and control as will as excessively long queue times, as shown in Figure 2.9 The end result, of course, is higher inventory cost, larger scrap due to material damage, more overhead personnel to handle the production control tasks, and less customer satisfaction because of excessively long delivery times. [1]

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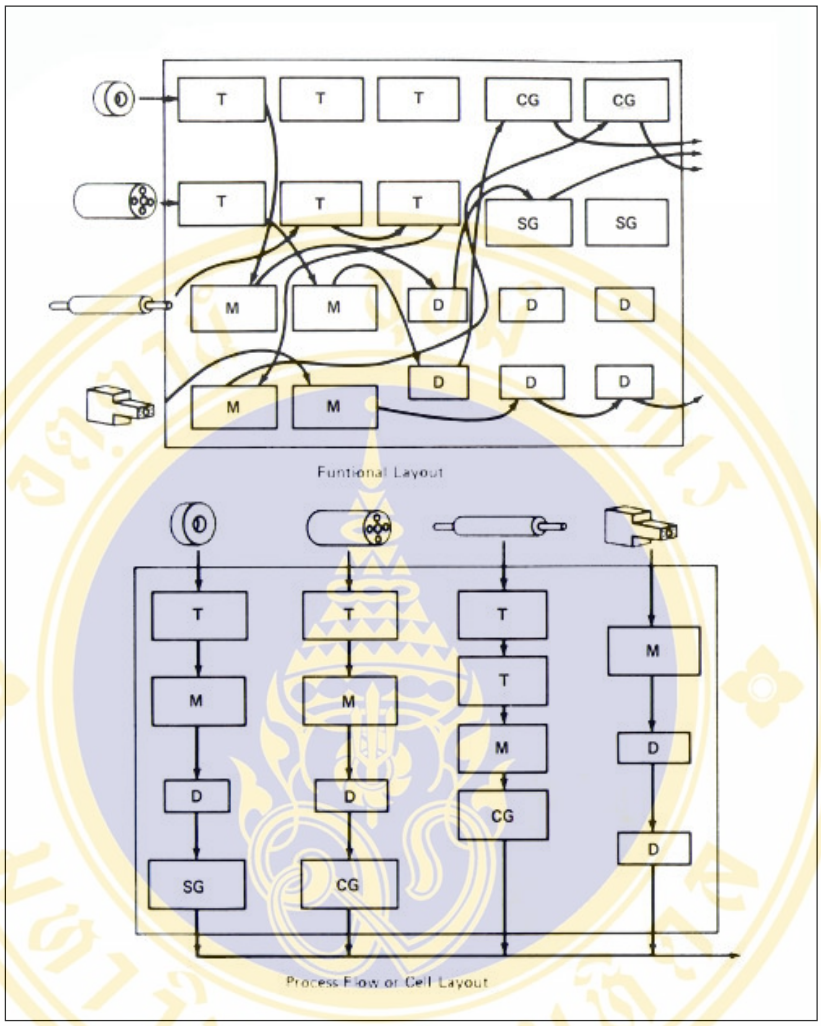

Figure 2.8 Functional versus Process Flow layout. [1]

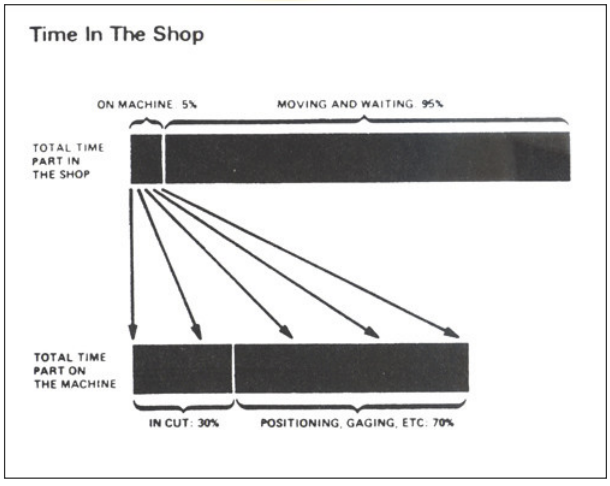

Figure 2.9 Factory queue times versus fabrication time. [1]

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2.1.10 Loading job for the machine

Loading means the assignment of the production for the machine or the station .In the case that the production can use only one machine, it is easy to assign the job for the machine. However in the case of many job which can use many machines or many stations. The problem is that how to assign which job to which machine for the best performance. In the general case we will assign the job for the machine that uses the least cost and time. (พิชิต สุขเจริญพงษ์, 2533: 443-4)

The assignment for the machine will be different from the time table production in any detail and the monthly time table sequence. But the assignment for the machine will be planned in a day, a week and an hour. Intermittent Production Process is the process when the machine or the station begins which will be pre-assigned task. Some problems have affected machines because some machines have to work all the time, some machines do not work, and some have to wait for another job. Production planning schedule will have an important role for the effective working in the factory because the production schedule will help estimate timing of job transmission or cost in preparing equipments.

Intermittent Production Process is the job that combines many activities such as aggregate planning, loading, sequencing, and detailed scheduling.

2.1.11 Process Planning

The activity of converting product design data to instruction needed for manufacturing the product is known as process planning, the plan created is line a roadmap for routing the part through the factory. It identifies the operations required to make the part, the sequence of these operations, the equipment required for each operation, the time to perform the operation, and any additional information deemed important in manufacturing the part. The generation of process plans has, in the past, required very experienced manufacturing people who completely understand the

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capabilities of their factory and can envision how the part parameters can be generated with the available processes. Even with this available experience, process planning has been plagued with inconsistency. This inconsistency can be addressed by developing a process planning system using group technology principles. (Charles S. Snead, 1989: 89)

The transformation of raw materials into a finished product requires a knowledge of the material properties, an understanding of the processes and equipments to be used in the transformation, and a definite sequence or order in which to apply the processes. Thus, a chef uses a recipe to prepare a meal, a doctor uses a surgical procedure to perform an operation, and a manufacturer uses process plans to manufacture industrial goods. Dr. Ham defines process planning as 'the subsystem responsible for the conversion of design data to work instruction in the manufacturing system." The result of this subsystem is the "recipe" to be used to turn a concoction of materials, procedures, and specifications into a usable product.

Aggregate planning is a simple plan to set capacity of production in factory for each timetable, such as capacity in each month. For this plan will consider about natural resources such as machine, equipment, manpower, etc. It will be a basic plan so it will not specify about job description or type of product to be produced, furthermore; it will not set timing of sending product or timing of task The sequencing of machine and detailed scheduling are the process that tell about detail of each machine or station that require to produce in each day, each hour. Results are a scheduling plan in each machine or each station.

2.2 Modeling Tools

2.2.1 Gantt chart Basics

Gantt chart is a project planning tool that can be used to represent the timing of tasks required to complete a project, because Gantt charts are simple to

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understand and easy to construct. They are used by most project managers for all but the most complex projects.

In a Gantt chart, each task takes up one row. Dates run along the top in increments of days, weeks or months, depending on the total length of the project. The expected time for each task is represented by a horizontal bar whose left end marks the expected beginning of the task and whose right end marks the expected completion date. Tasks may run sequentially, in parallel or overlapping. (W. Durfee and T. Chase, 2004)

As the project progresses, the chart is updated by filling in the bars to a length proportional to the fraction of work that has been accomplished on the task. This way, one can get a quick reading of project progress by drawing a vertical line through the chart at the current date. Completed tasks lie to the left of the line and are completely filled in. Current tasks cross the line and are behind schedule if their filled-in section is to the left of the line and ahead of schedule if the filled-in section stops to the right of the line. Future tasks lie completely to the right of the line.

To construct a Gantt chart, one will keep the tasks to a manageable number (not more than 15 or 20) so that the chart fits on a single page. More complex projects may require subordinate charts which detail the timing of all the subtasks which make up one of the main tasks. For team projects, it often helps to have an additional column containing numbers or initials which identify member the team who is responsible for the task.

Some projects often have important events which are not tasks, but you would like make it appear on the project timeline For example, you may wish to highlight when a prototype is complete or highlight the date of a design review. You put these information on a Gantt chart as "milestone" events and mark them with a special symbol, often an upside-down triangle.

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2.2.2 Flow Chart

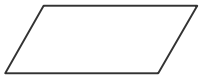
A flow chart is defined as a pictorial representation describing a process being studied or even used to plan stages of a project. Flow charts tend to provide people with a common language or reference point when dealing with a project or process.

Four particular types of flow charts have proven useful when dealing with a process analysis: top-down flow chart, detailed flow chart, work flow diagrams, and a deployment chart. Each of the different types of flow charts tend to provide a different aspect to a process or a task. Flow charts provide an excellent form of documentation for a process, and quite often are useful when examining how various steps in a process work together.

When dealing with a process flow chart, two separate stages of the process should be considered: the finished product and the making of the product. In order to analyze the finished product or how to operate the process, flow charts tend to use simple and easily recognizable symbols. The basic flow chart symbols below are used when analyzing how to operate a process.

Flow chart symbols:

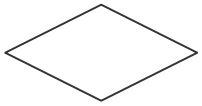
Start or end of the program



Input or output operation

Display

Computational steps or processing function of a program



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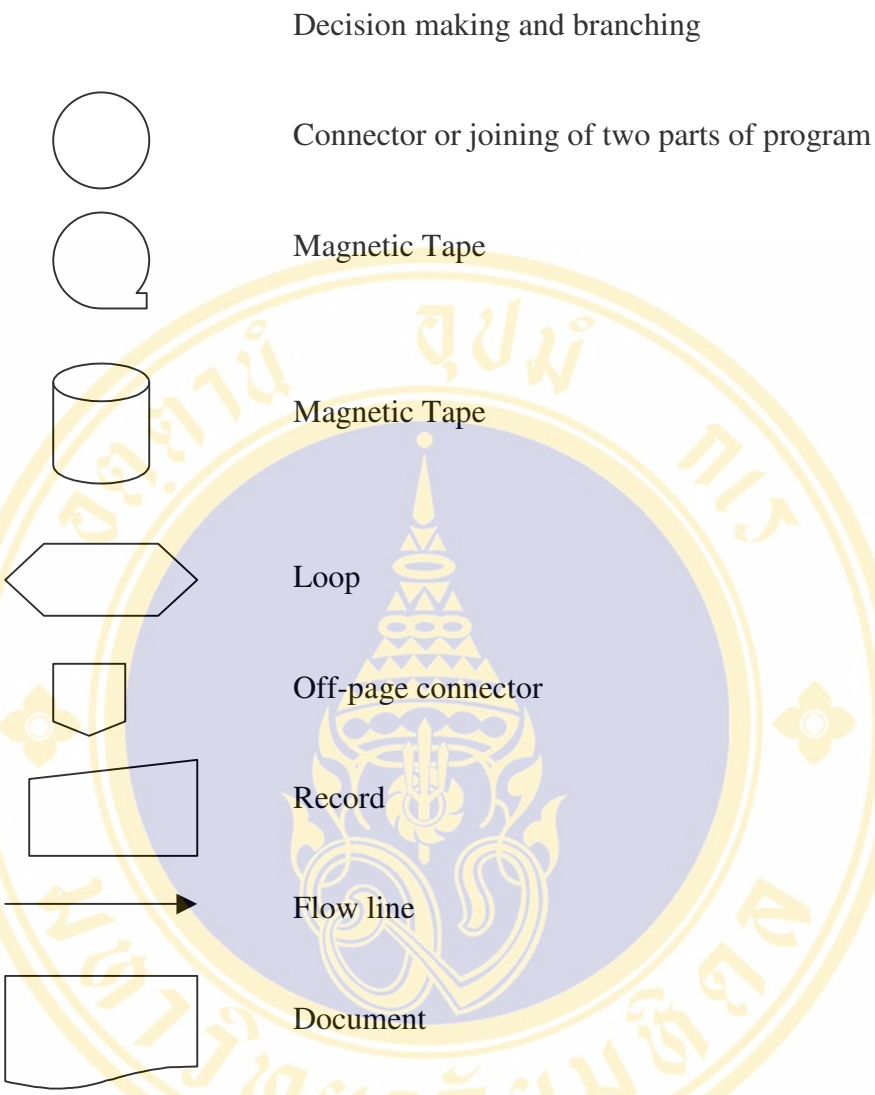

2.2.3 Flow Process Chart, (FPC)

Flow Process Chart (FPC) - A chart that is used to describe the sequence and relationship of the tasks that make up an activity. In order to analyze the second condition for a flow process chart, one should use the ANSI standard symbols. The ANSI standard symbols used most often include the following: (Dexter A. Hansen, Copyright © 1998 – 2004)

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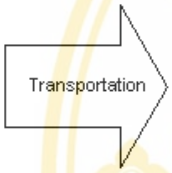
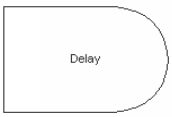
Process Flow Charting Basic Symbols:

Operation - An operation occurs when an object (i.e. product, document, etc.) is intentionally changed in any of its physical or chemical characteristics, assembled or disassembled from another object, or staged for another operation, transportation, inspection or storage. Operations also occur when information is transmitted or received or when planning or calculations take place.



Transportation - A transportation occurs when an object is moved from one place to another with the exception where such movements are a part of the operation or are caused by the operator at the work station during an operation and/or inspection / verification / approval.

Storage – A Storage occurs when an object is kept and protected from unauthorized removal. The symbol on the left typically indicates inbound goods. When the triangle is inverted, it typically represents storage or filing.



Delay - A delay is typically shown as a half circle or a capital D. A delay occurs to an object when conditions, except where intentional changes to the physical or chemical characteristics of the object do not require immediate performance of the next planned step.

Inspection, Verification or Measurement - An inspection, verification or measurement happens when an object is examined for identification or is verified for quality or quantity in any of its characteristics. The symbol also indicates that a decision must be made.

Operation & Inspection (a.k.a. Combined Activity) - When two activities are performed at the same work station or concurrently, the

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symbols can be combined. The combined operation and inspection tasks are typically "combined.

2.2.4 Data Flow Diagram (DFD)

The Data Flow Diagram shows the flow of data or information. It can be partitioned into single processes or functions. Data Flow Diagrams can be grouped together or decomposed into multiple processes. There can be physical DFD' s that represent the physical files and transactions, or they can be business DFD' s aka logical, or conceptual).

The DFD is an excellent communication tool for analysts to model processes and functional requirements. It is still considered one of the best modeling techniques for eliciting and representing the processing requirements of a system. Used effectively, it is a useful and easy to understand modeling tool. It has broad application and usability across most software development projects. It is easily integrated with data modeling, workflow modeling tools, and textual specs. Together with these, it provides analysts and developers with solid models and specs. Alone, however, it has limited usability. It is simple and easy to understand by users and can be easily extended and refined with further specification into a physical version for the design and development teams. [16] Figure 2.10

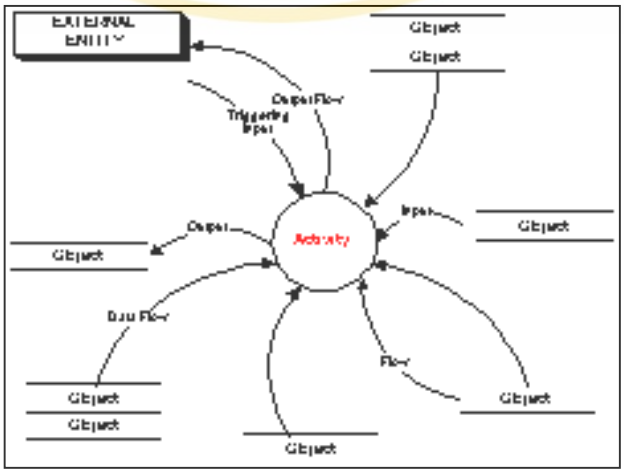

Figure 2.10 Data Flow Diagram. (DFD) [16]

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2.2.5 Entity Relationship Model(ER-Model)

Entity-Relationship (ER- Model) is a diagram which is used shows the organization and relationship between data. Moreover, ER-Diagram is a basic diagram which is easy to understand for studying.

Notation

Entity

Relationship

Attribute

Key Attribute

Cardinality ratio 1: N for E1: E2 in R

The correlation of each Entity includes in the branch of graduate office function can be presented in the Entity Relationship Diagram as show in the following chart.

2.3 Programming Tools

2.3.1 General Data Base

Data is any fact or figure from which a person can draw conclusions. The human mind develops from its earliest stages by gathering facts, storing the facts as data, and drawing conclusions from the data. When a child burns his hand on a hot stove he has gathered the facts that excessive heat causes pain and that heat comes from a stove. These facts are used to draw the conclusion to stay away from stoves

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until a determination is made as to the temperature of the stove. Similarly, the modern formal education process is designed to present facts to students who are to store them in their minds for later retrieval and use. In addition to the mind, mankind has been actively pursuing other media for storing facts into data bases. These media range form writings on cave walls to electronic data storage. (Charles S. Snead, 1989: 47)

2.3.2 Microsoft Access Version 97

Software for development will use Microsoft Access Version 97. This program can be used easily. It can manage more databases, can be learned in very short time, reports, etc., moreover; this program is very popular.

2.3.3 Microsoft Visual Basic 6.0

Microsoft Visual Basic 6.0 is selected for developing program because programming language is easy to use in developing on Windows and they use Visualize Technology. The interface is built for user in order to use it easier because controls can be selected and drawn from; moreover, technique for programming is ever-driven which will be a basic, for various controls. So the program developing on windows by Visual Basic will decrease the processes so that it will be easy and convenient to use.

2.3.4 Crystal Report 8.5

Crystal Reports Distributor is an application for Windows that saves time and money by making it easy to define single or packages of Crystal reports, schedule and run them automatically, and send the reports to print, fax, disk, ftp or email in a number of standard formats. By automating repetitive reporting tasks, Crystal Reports Distributor ensures that reports are created and distributed when needed, without error, and without costly support time.

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Crystal Report is designed for beginning users with little or no exposure. The Crystal Reports environment and get them up and reporting quickly. This program will provide the basic steps for creating, modifying, saving and viewing reports including more flexible tasks such as basic formulas and the powerful automated features. Features include the ability of Windows NT4/2000/XP/2003.

2.4 Review of production planning and scheduling research

2.4.1 Using Computer for Production Planning

Using Computer for Production Planning is the project applying computer in aggregating planning. The program used in processing and planning is program Visual FoxPro. This program can be categorized into 3 functions; 1) menu for production 2) menu for setting product and 3) menu for planning product. The result of planning method can be compared in cost and complied with guideline production and efficiency in planning. [19]

2.4.2 A production scheduling method in a knitted fabric dyeing and finishing factory

This thesis concerns the development of a production scheduling system. The scheduling system developed in this thesis uses heuristic methodology which is based on constraint-guided heuristic search, group scheduling and dispatching rule. The database is also developed to support the scheduling. Although the scheduling method developed here, which is a heuristics does not guarantee best results; it has been proven very satisfactory. The comparisons between the production performances from the developed method and existing method show that the production lead-time and work in process are reduced significantly, machine utilization and quality of product are also improved. Reductions of raw material inventory, although not formally measured, are observed. [8]

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2.4.3 A scheduling support system on the MFG/PRO program

To improve the way of work of production planners in developing appropriate production schedules by the MFG/PRO program. This is because the MFG/PRO program which is currently implemented in the sample company does not fully support the development of the production scheduling. Hence there is a need for a supporting program which can reduce such problem and support in production planning without any impact on the master program (MFG/PRO). The scheduling technique applied EDD (Earliest Due Date) that is a heuristic. The support program can run under MFG/PRO program. The result after implementation the supporting program to sample factory is that the sample factory can decrease the time for developing the production scheduling plan and also decrease the preparation time for the production schedule to support the unpredictable events, e.g. machine breakdown. Besides, the actual factory performance is improved continuously. [7]

2.4.4 Flow shop scheduling: case study foundry shop

Investigates the influence of the dispatching rules to the performance of flow shop by using computer simulation technique. The simulation language "ARENA 2.2" is applied to model a foundry shop (case study) performed the simulation. The relative effectiveness of the dispatching rules is measured against mean flow time, mean lateness, mean tardiness, proportion of jobs tardy and average system utilization. The simulation results indicated that dispatching rules affect every measure of performance for 95% significance level. The rules that show good performance in the case study for all measures are LWKR, SMT and SPT. [10]

2.4.5 Production scheduling in a textured yarn factory

To study and analyze problems occurred from inappropriate production scheduling process a yarn factory. The factory has many types of products. The production utilizes a flexible flow with a buffer at each stage. Each type of yarn is produced in the same production line but does not necessarily pass all steps of the

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line. The production line has many processing steps; each step consists of many machines, some of which are different. The developed production scheduling method uses "Group Technology" scheduling technique that schedules the production from back to front (backward scheduling) and considers the due date and just in time production. Line balancing is considered in each step of the process. Tech production scheduling method established in this thesis helps reduce the problems both in deliveries and the inventory level without increasing machine setups. [12]

2.4.6 Decision supporting system for production planning and scheduling in the kraft paper industry

This thesis is a research which proposes a decision supporting system for production planning and scheduling in a kraft paper industry. The decision supporting system is developed on a personal computer with Visual Basic 6.0 and Microsoft Access 97 by preparing problems into the transportation model. The system is used to schedule production grouping by paper grade which aimed to minimum loss. [5]

2.4.7 Computer aided die production scheduling for automotive parts industry

To find efficient scheduling method and develop computer program for die production scheduling in automotive parts industry. In experiment to find efficient scheduling method that gives minimum mean job tardiness, which is scheduling objective. The job shop scheduling technique was applied using no delay schedule generation and heuristic approach. Five heuristic rules: EDD, SLACK, SLACK/RO, SMT, SPT were tested with real production data by computer program which developed. [14]

2.4.8 TT Market: Scheduling software for creating clash-free timetables; first time or every time.

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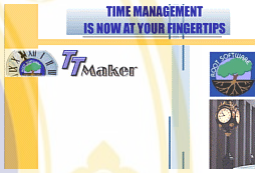
This software is from Australia. It is actually for sale, but it can use free demo for 30 days. Advanced scheduling software, TTMaker, generates clash-free *timetables*, *rosters*, and *festival programs* and suits educational timetabling, scheduling for training, conference scheduling, and meeting scheduling and many other corporate scheduling requirements. [17]

TTMaker is scheduling software that makes creating clash-free timetables easy.

Here are some of the main features of our scheduling software to:

- Create clash-free timetables in seconds.
- Specify your requirements.
- Fine control of your scheduling.
- Print your timetable.
- Publish your timetable on the Web.
- Contact management.
- Need more?



Rated ★★★★★ out of 5 stars by the highly-regarded ZDNet editors.

For display example; Any School Day Scheduling figure 2.11

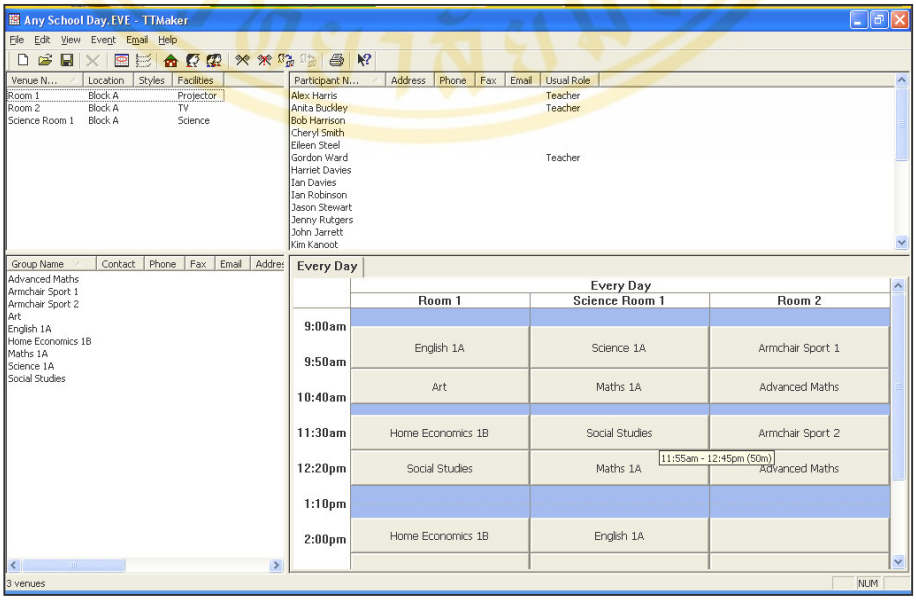


Figure 2.11 Any School Day Scheduling. [17]

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However, this program has many limitations about quantity of input, display, difficult use, and high prices. For constrain quantity, data cannot fully be input such as the input of meeting schedule because can it can be set only for a few times. If we want more input than 2-3 numbers, we have to purchase more. For display, the look is difficult to read because it does not show only ones display, but we can see other information too; nevertheless, many work are very specific, so planning need not to more flexible. But one advantage is that look we can scheduling and make a schedule work smoothly.

Prices can be divided into 2 types that are purchase pricing for outside Australia and Purchase Pricing for Australian Residents follow figure 2.12, 2.13

New Licences

Licence Level	**Price in US$**
Demonstration	*Free*
Standard	US$249
Professional	US$499

Figure 2.12 Purchasing for Outside Australia. [17]

New Licences

Licence Level	**Price *excl* GST**	**GST**	**Price in A$**
Demonstration	*Free*	*Free*	*Free*
Standard	*A$313.64*	*A$31.36*	A$345
Professional	*A$631.82*	*A$63.18*	A$695

Figure 2.13 Purchase Pricing for Australian Residents. [17]

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2.4.9 Production Scheduling Software and Advanced Planning and Scheduling Software by Waterloo Manufacturing Software's TACTIC system.

The TACTIC of which Waterloo Manufacturing Software advanced planning and scheduling system and support services to U.S. manufacturers from offices located across the U.S. Currently Waterloo offices are located in the Cleveland area, Boston area, and Los Angeles area. [15]

TACTIC system is designed to be used as both production scheduling software, and advanced planning and scheduling software (APS software). Production scheduling software, (also called manufacturing scheduling software, finite capacity scheduling software, or FCS software) allows manufacturing staff to generate detailed dispatch lists for individual production machines, units of labor and other manufacturing resources. These dispatch lists consider the finite, or limited, capacity constraints of the resources being scheduled. The production scheduling software helps users answer questions like: What job should we run next? Should I work overtime this weekend? Which job will be late? [15]

Advanced planning and scheduling software are more encompassed than production scheduling software. It considers not just shop floor capacity constraints. In additions, the advanced planning and scheduling software consider inventory and bill of material constraints, inventory stocking and replenishment levels, and order generation policies. [15]

However, it's for disadvantages can be explained as follow:

1. This system does not have a demo for testing before making decision purchasing. If we are interested in it, we need to study and inquire directly.

2. It is a big system which can support industry requirements such as network connecting system, but medium and small industry do not need to use complex system.

3. This program has many displays which might be confusing: The TACTIC screen below shows graphs of three different business metrics figure 2.14

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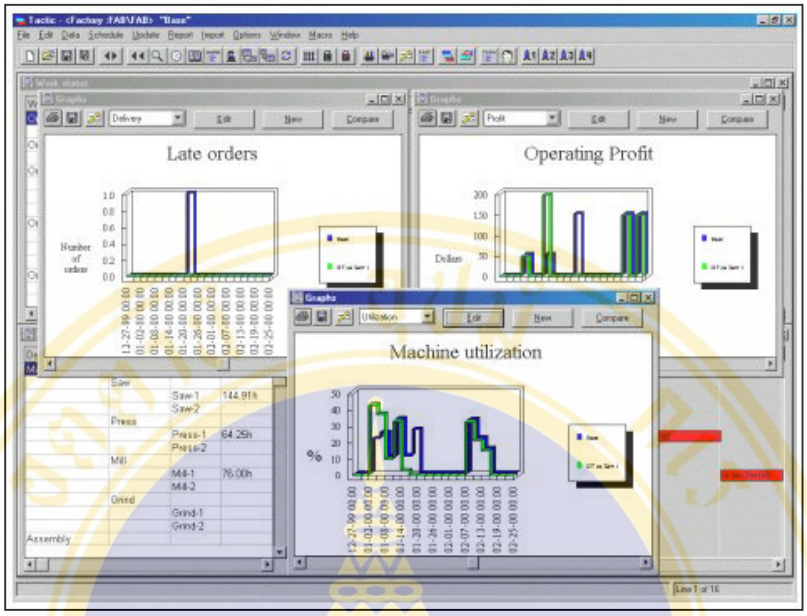

Figure 2.14 Show Displays. [15]

2.4.10 Production Scheduling System by Spreadsheet

The man behind Production-Scheduling.com is Tony Rice. Since 1990, he has operated as an independent consultant specializing in production scheduling and supply chain integration. [11]

This system understand that fast and responsive production scheduling is not only the key to good supply chain management, but also the logic that enables B2B (business to business) transactions by directly linking customer' s and supplier' s schedules together. So the developer uses finite capacity and finite scheduling techniques, and his philosophy of production planning and scheduling embraces Theory of Constraints (TOC) and Constraint Management thinking. He encourages you to use a spreadsheet for modeling and simulation. [11]

Often the pressure was to throw several thousand records of data at the prototypes and use them for live scheduling, before handing them over to the software developers. So, in order to ' shoehorn' a big scheduling task into a small PC, he recorded macro' s that wrote a formula, copied it down, overwrote the cells with

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values, then moved on to the next column so that no memory consuming live formulas were left behind. Typically, most of the macro code prepared downloaded data for scheduling, and generated reports from the schedule, with only a small portion of the macro calculating the schedule itself. He ended up with big cumbersome macro driven scheduling systems that ordinary; spreadsheet literate people were locked out of. Figure 2.15 display Production Scheduling System by Spreadsheets. [11]

For this system will:

- Assist you to design and build a scheduling system, by e-mail or on site.
- Present courses on designing and building scheduling systems.
- Custom-build a scheduling system for you.
- Consult on scheduling, and supply chain management and integration.

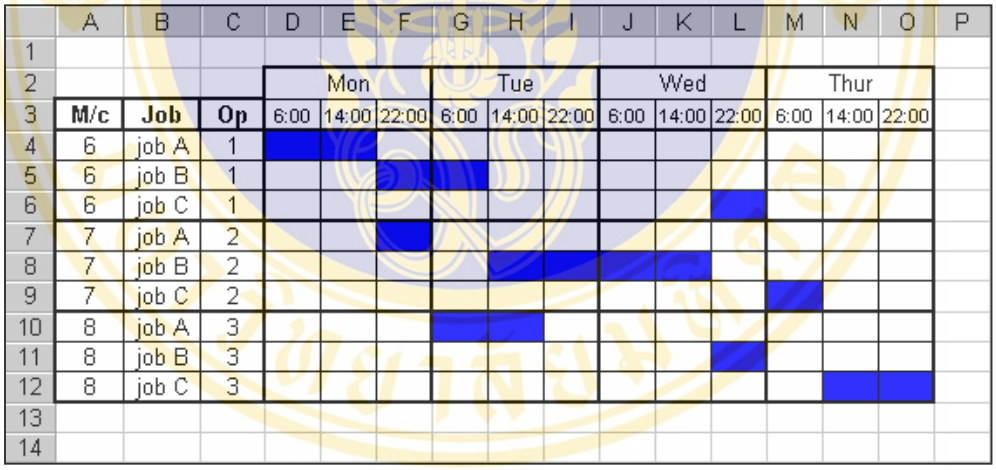

Figure 2.15 display Production Scheduling System by Spreadsheets. [11]

However, disadvantages are as follow:

- Do not recognize a particular peculiarity of their process.
- Are not sufficiently integrated.
- Are too complex and take too long to implement.
- Are too expensive both consultant and training.
- So far for contact.

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2.4.11 Scheduler Software

This program is an example for planning and scheduling production, which user can work correctly, can change various information, or other factors occurred to production by user.

Limitations:

1. This program is only a demo so it is not a complete program.
2. Number of machines cannot be input more than 10 machines.
3. Number of processes cannot be fully input due to the demo.
4. Display of Gantt chart is quite wide comparing to the computer screen.
5. Full program is very expensive.
6. Program has many details, so it is complicated and confusing to learn.
7. There are many systems for using more than requirement.

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CHAPTER III
RESEARCH METHODOLOGY

3.1 Steps of Research Methodology

3.1.1 Collecting basic information

The first step of collecting basic information is to study basic information of the pattern in the factory first and consider which pattern to be used in the factory such as continuous or Intermittent Production Process, the number of production in each time and which plan to use in production.

Information gathering will have two patterns

1. Interview: to know about working conditions of production process which would be considered since the beginning with the first step from order of production till finish production process.
2. Study in each step of production by yourself in order to see the real production process and how to do in each step. It will gather information more than interview or questionnaire.

3.1.2 Analysis

This phase will collect data in order to analyze and make reports. Moreover, we will explain that what system will do? What is a spec requirement?

After finish the gathering information, will be considered and analyzed to find average of each job in each step of production process and find

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production rate in each step. Beside, it will calculate to find average of machine job because each machine will have different capacity. The level of production and job distribution continue by gathering information in database in order to support when there are new orders by bringing some information to consider.

3.1.3 Ask the users what they want and design

This objective is to design preliminarily, design details, and write report. Preliminary design is an assignment objective. Analyst creates detailed diagrams, charts, models, and prototypes of components of the proposed new system.

3.1.4 Write the program and trial the corrective's of program

The contractor, monitored by the architect, builds the factory. Building inspectors examine the factory for quality and safety. The programmers, monitored by the analysts, build the system. Testers test the systems for quality.

3.1.5 Record the method and indication of program

Data, people, and procedures are converted from the old system to the new system; final documentation is complied; users are trained, the new system is put into operation.

3.1.6 Train and publicize the development of simple production program for SMEs

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3.2. Research Time

Table 3.1: Research Time

Activities	Time (Dec 2003 - Oct 2004)											
	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.
1. Identify objectives and scopes of the study:												
2. Study related concept to solve the problem:												
3. Collect data and requirements about the problems:												
4. Analysis and design the database application:												
5. Programming:												
6. Testing and debugging each module:												
7. Testing the whole system:												
8. Program documentation:												
9. Conclude, recommend and suggestion for further developed:												
10. Training												

3.3 Development Tools

- *Hardware*

CPU	:	Pentium IIII 2 GHz. (or faster)
RAM	:	256 Megabytes.
Hard Disk	:	20 Gigabytes.
Peripherals	:	Monitor, Keyboard, Mouse, CD-ROM Drive, and Printer.

- *Software*

Operating System	:	Microsoft Window XP.
Programming Language	:	Microsoft Visual Basic Version 6.0, Crystal Report 8.5
Database	:	Microsoft Access Version 97
Other tools	:	Microsoft Office XP, Adobe PhotoShop 6.0, and Visio 2002

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CHAPTER IV
CASE STUDY INFORMATION GATHERING

4.1 Type of Factory

Design of a Production Scheduling Prototype Program for Group Technology and Assembly Line Production: A Case Study in Cryogenic Tank Manufacturer which is the industry that produces producing tanks to various customers. Activity characteristics can be divided into 2 parts which is a factory part and an office part. Moreover, this industry is divided various departments in order to be more systematic.

The number of product per one order is normally not more than five tanks. The rate is not high and the number of production is changeable due to an order from customer.

A case study in Cryogenic Tank Manufacturer has a model between process layout and fixed-position layout, by dividing the space of factory such as connecting part, bending tank, testing water pressure etc. But there are some product layouts positioning at the same place while employees will pass connecting machine to tank until finish the job then move the tank to another workstation.

4.2 Background

This industry started from 21st January, 2002 by Cryogenic Tank Manufacturer, an industry that can produce their products with the capacity from 2,000 – 34,000 Liter.

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4.3 Organization of Industry

The administrative internal organization will carry out a manufacture. They have been cooperated between departments. There are twenty-five employees, which can be divided into five departments to:

- Accounting/ Purchasing Department.
- Human Resource Department.
- Production Department.
- Technical Department.
- Quality Assurance Department. (QA)

4.4 Current Activities:

Current activities have performed on first come first served (FCFS) basis. User can control starting date of production. Since receiving production order until giving the product to customer need to pass process from various departments which duties of each department can summarize:

1. **Financial Department.** The following are:
   - Accounting.
   - Purchasing.
2. **Human Resource Department** The following are:
   - Manage about salary employee.
   - Take care about other assurances.
3. **Production Department** The following are:
   - Receive material.
   - Management on hand.
   - Production planning.
   - Production control.

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4. **Technical Department** The following are:
   - Service customer such as manual for using, service after purchasing, or maintain, etc.
   - Design products in case a customer wants to change product different to be from original standard.
   - Take care about techniques.
5. **Quality Assurance Department (QA)** The following are:
   - Check Quality; Usually QA will check process of production every time in each process, but sometimes they need to check more especially when feature or form of the product is different from original standard.
   - Follow up results of production system in order to correct the standard of the product.

4.5 Production Process:

We will emphasize on details of production processes for more understanding.

Production Department – After receiving an order from Accounting Department, this department will check their priority, which is called “Job Number”. Next, they will reply to customer about the approximate time that the product will be done. If that order does not have problems about due date or date that customer wants, priority will be set for beginning. However, if there is an interference about time or due date of the production; Production Department will need to consider that new job so that it does not have impact or interfere the schedule or processing time of other jobs which requires plan correction. After concluding the production priority, next process is to meet with engineer section to reach a conclusion and signature for each person’s duties. There are three engineers who will take care of parts of inventory. When the job has been revived, the engineers will check material in the stock in order to be certain that there are enough materials for manufacturing. If there is a shortage of materials, they need to inform Accounting Department to purchase materials as soon

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as possible. Some materials cannot be purchased in the short time and some materials need to be imported. Moreover, when materials have arrived, they will need a signature from Production Department. Normally products will have a standard format, however; sometimes the customers might want to change or add some details to the format. Therefore, Technical Department – will design to suit a specific requirement of customer and reply to customer. If the customers are satisfied with the product, it will be sent to a Production and Quality Assurance Department to change or add more details. Parts of the products have been kept in the file by QC and QC will check in every process for production. (Figure 4.1-2)

Problems identified:

Most problems of planning occur during scheduling each production item. Usually, if any job does not have problem about due date, production will proceed in the first come first served basis. If there is a problem about time, it will lead to confusion of framework and will interfere with overlapping of production scheduling. When job is changed, what might happen is that the product cannot be sent to customer. Problem of an overlap in operating makes process unable to continue and reproduction may deviate from the primary plan. That leads to difficulties due to a great number of remaining jobs. Moreover, some machines are not performing to their potential. These are some of the problems, but the main problem is that planning and scheduling is a manual process, not professional system. Besides; this system does not have explicit documents; therefore it causes a lot of confusion on planing result. Beliefs and high income expectation causes the industry to ignore many problems. Hence, if the industry has a program to help performing the planning; the production will be more efficient.

There are four interesting points in these problems to study; that is, one, to study entire operation systems to understand the internal performance. Two, to study scheduling production to know what the related features are? What data to use? Three, problems about papers and distributing the job to each department. Nowadays, systems are lack of document managing; it works by understanding of staff basis.

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Finally, to study about paper management – recently the factory do not record in document form. Therefore, these studies need to understand the total system in order to set formal or various documents to clear a performance to every department and every part production.

Data Relate to the Problem:

Data and documents used in the system such as receiving order from customer, production order, invoice form, etc. are for realizing about various details used in an operation, and about information of machines and others. Total information find out for producing tank size 6,000 liters.

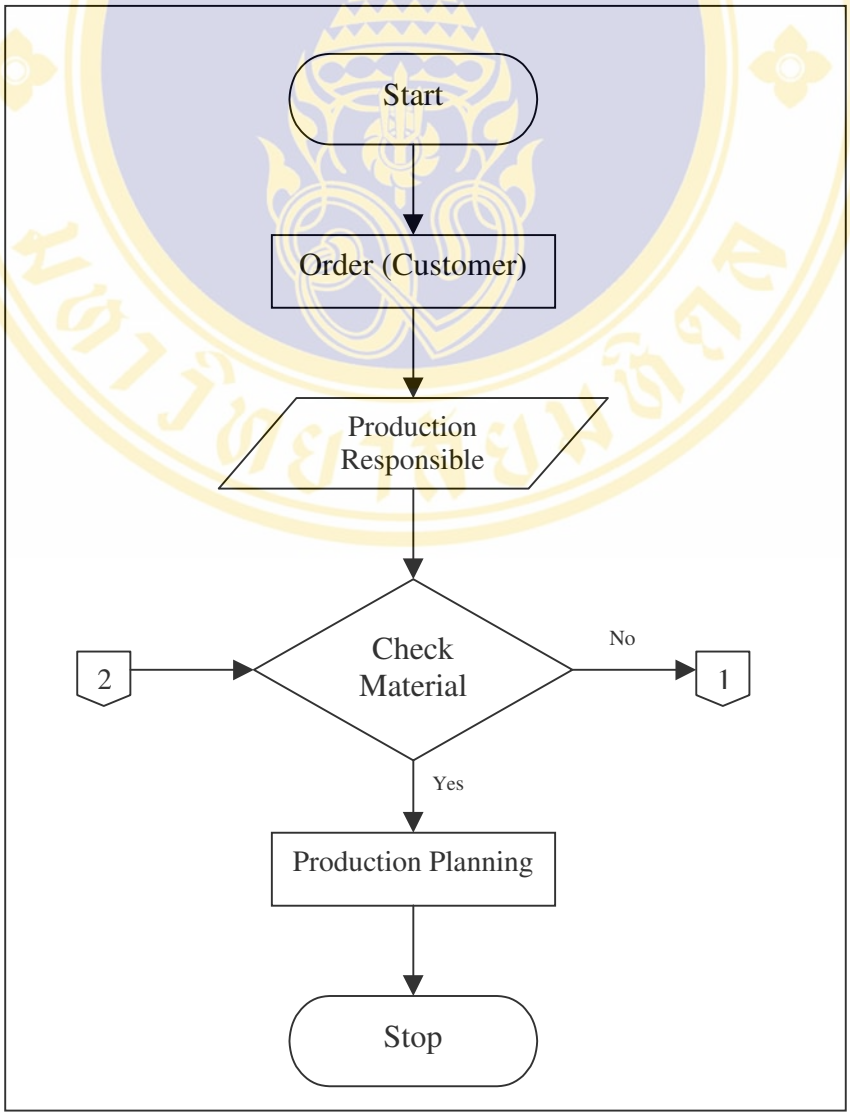

Figure 4.1 Production Process.

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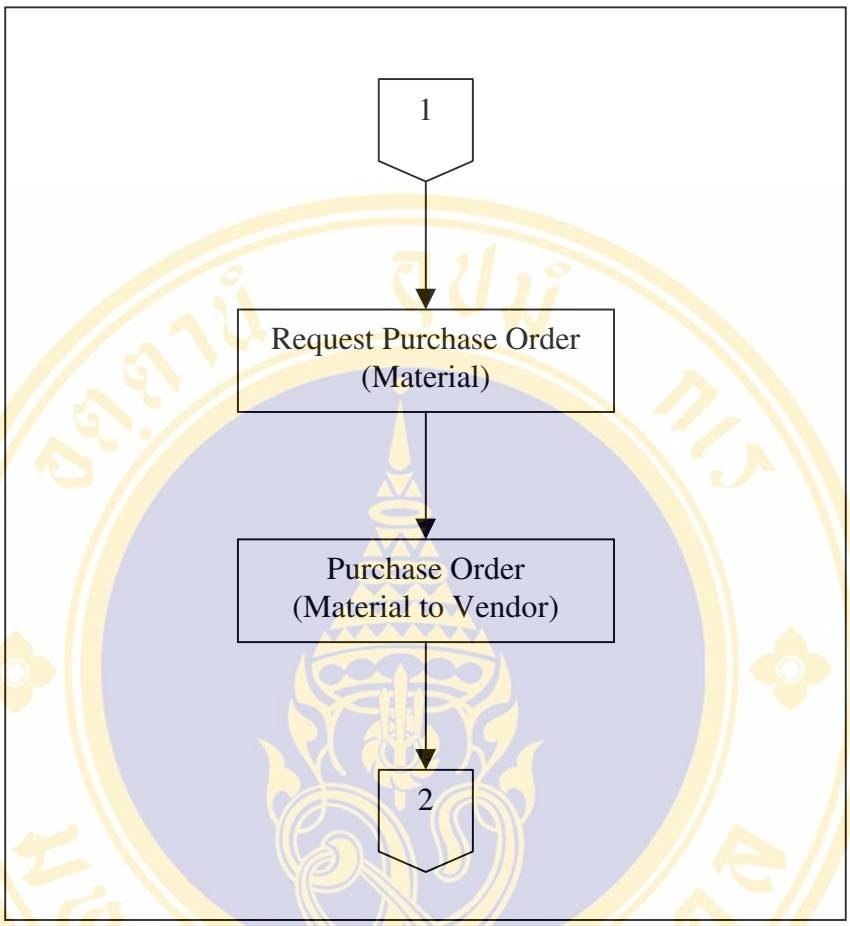

Figure 4.2 Material Purchase Process.

Process Information

Process information will use data of Cryogenic Tank Manufacture for 6,000 liter Tank size, for smooth orders. There are sixteen processes in the production standard. For production line can show roughly to:

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Machines Information:

Table 4.1 Machine Information.

No.	Items	Quality
1	FCAW	2
2	SAW	1
3	TIG	3
4	Cutting machine	2
5	Water Pump	1
6	Pipe bender	1
7	High Pressure water Pump	1
8	Heater	3
9	Vacuum pump	4

Machine for Usage in each Process:

Table 4.2 Machine for Usage in each Process.

Process	Machine Name for Use
Process A, C, O, P, T	Cut
Process B, D, N, AA, AH	Tig
Process E, F, G, I, J, V, X, Y, Z	Saw
Process K	Pipe Bend
Process M, Q, U, W	Fcaw
Process R	Pump
Process AC, AD	Heater, Vacuum Pump

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Relationship Details of Main Activities:

Table 4.3 Relationship Details of Main Activities**.**

Process	Previous Process	Process	Previous Process
A	-	T	-
B	A	U	T
C	-	V	-
D	C	W	V
E	-	X	U, W
F	D, E	Y	S, X
G	F	Z	Y
H	B, G	AA	Z
I	H	AB	AA
J	I	AC	AB
K	-	AD	AC
L	K	AE	AD
M	J, L	AF	AE
N	J, L	AG	AE
O	-	AH	AE
P	O	AI	AH
Q	M, N, O	AJ	AE, AE, AH
R	Q	AK	AJ
S	R		

4.6 Development of the program

The total problems can be solved by using program planning and scheduling system. Nowadays, there are many programs that help to support planning and scheduling, whether they have a copyright. These programs may not be suitable for

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new industry because it will have a high risk and high cost. Some programs can be used without any costs by download method, which is an advantage because it is a low cost method. On the other hand, the program might have many specifications and maybe does not match with our industry. If we want to use it, we need to adjust some functions in order to match with our industry but the development maybe more complicated to use. Therefore we have to build an application which is standard or specific for our industry, easy and suitable to use, for the industry. The program application might be a better option than using a free method. The program that we selected is Microsoft Access Version 97 application for managing database and Microsoft Visual Basic Version 6.0. The application for designing is the interface, which make it easy to work and to understand, in additions, pattern can be referred to easily when job is being transformed from one to another.

Concept changing from original system to new system:

Today operating of production scheduling plan is having many problems such as priority of jobs, machine capacity setting, production scheduling, job flexibility, unfinished job in processing, job delay, etc., So if we use the new system, it will solve the problem in the one step by programming the system.‖ First, an order is input, this program will set priority first come first served (FCFS) which can estimate time of job finishing. This due date is not accurate because sometimes there is a problem about overlap of jobs. So, due date of job maybe changed. However, if there is a new job input, the programme will consider the time of each process by comparing with timing of other jobs, and if the new job does not have time overlap, that job will be saved when user accept. If the job has a time overlap time with old jobs, the system will warn in order to make decision if this job will be saved or not.‖ Second, the program will take care about plan scheduling which will show a number of jobs to be produced. Moreover, program will have flexibility by showing job status which shows the unfinished jobs in order to re-schedule for continuing last process. Program application will consider the cellular production that is scheduling plan by grouping process – not individual machine in the process. Since the processes of each machine will have short processing time, but not include the set up time, it is not convenient

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for movement until finishing process. Thus, during one production process, other process will not be inserted until that job finishes. The data of this study which is a production of a tank sized 6,000 liters shows that there are sixteen processes in total for a tank production and last section of program will show database of jobs in order.

4.7 System Analysis and Design

This System analysis and design will start studying from requirements and problems of the original system. After that these data will be considered in order to solve the problems by analyzing studied problems, probability, and development new system. All data will be designed to know information for input and output data of next processing. It can be categorized into three sections which are to see total program (Context Diagram), to see relative the internal organization (Data Flow Diagram Level: 0), and to see the entire system of case study. (Data Flow Diagram Level: 1)

Context Diagram:

Context diagram will include an operating relation of the case study to show how the system is related within the environment, that is, the performance of receiving and sending what data within the system. From study, we found out this system has related to six systems in outside environment; Accounting/ Purchasing Department, Vendor, Technical Department, Quality Assurance Department, Customer, and Production Department. All of them can be described from the start that customer will make an order the Accounting Department and this order will be sent to the Production Department by co-operating with the Technical Department, next this order will be sent in a quotation form in order to inform details about prices and due date. If customer accepts, the Production Department will start to do a planning by checking materials if there are enough for production. If there are not enough for production, they will request a purchase order (Material) to the Purchasing Department and the form will be sent to the Vendor. Materials and invoice form will

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be sent to the Production Department and temporary receipt form will be sent back to the Vendor. Figure 4.3

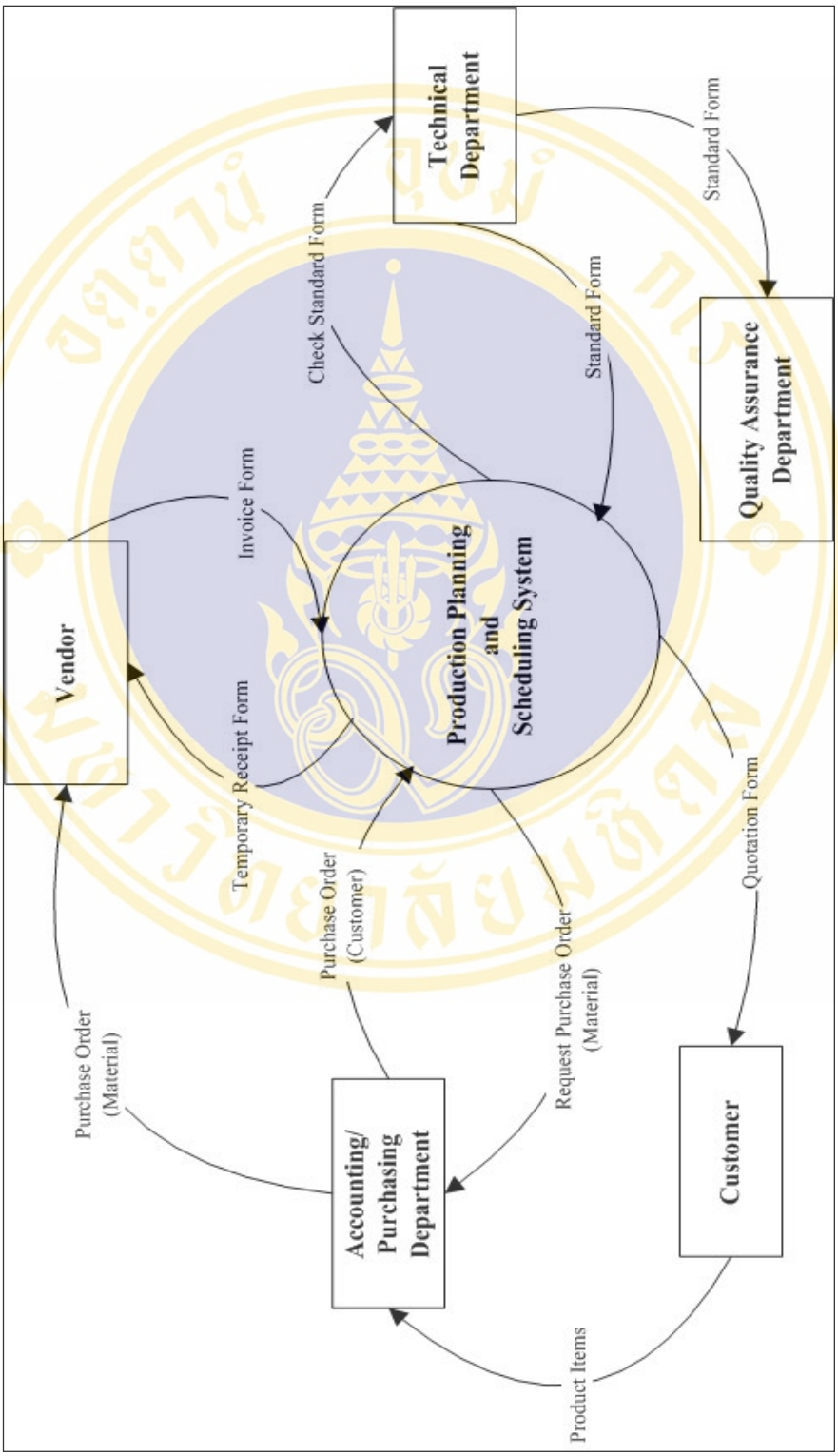

Figure 4.3 Context Diagram**.**

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Data Flow Diagram: DFD

Data Flow Diagram: Level 0

This section will describe steps of work in the Context Diagram starting at Customer. When Customer has submitted a production order to Accounting/ Purchasing Department, this order will be sent to the Production Planning and Scheduling System (1.0) in order to consider if this can accept or reject and will send a quotation form to the Customer about prices and due date. The production pattern will be sent to the Production Department to check the standard of that production (2.0). If it is standard, this order will be sent back to quotation form. But if job is not standard, it will be designed for new product (3.0) by the Technical Department. The standard change form will be saved in standard production files. Moreover, new job pattern will be sent the Quality Assurance Department for using in during production in order to check if each process has a correct specification according to new standard form; however, this section will occur only when the Customer accepts. If the Customer accepts already, The Production Department will start the production planning by checking materials if there are enough for production (4.0), with inventory material files. If materials are not enough for production, the Production will send request purchase order (materials) to the Purchasing Department. Materials and invoice will be sent to the Production Department, and temporary receipt form will be sent back to the Vendor. From description can show Figure 4.4

Data Flow Diagram: Level 1

This section will study deeply in part of manage system level 1.0 is to manage planning and distribution Figure 4.5

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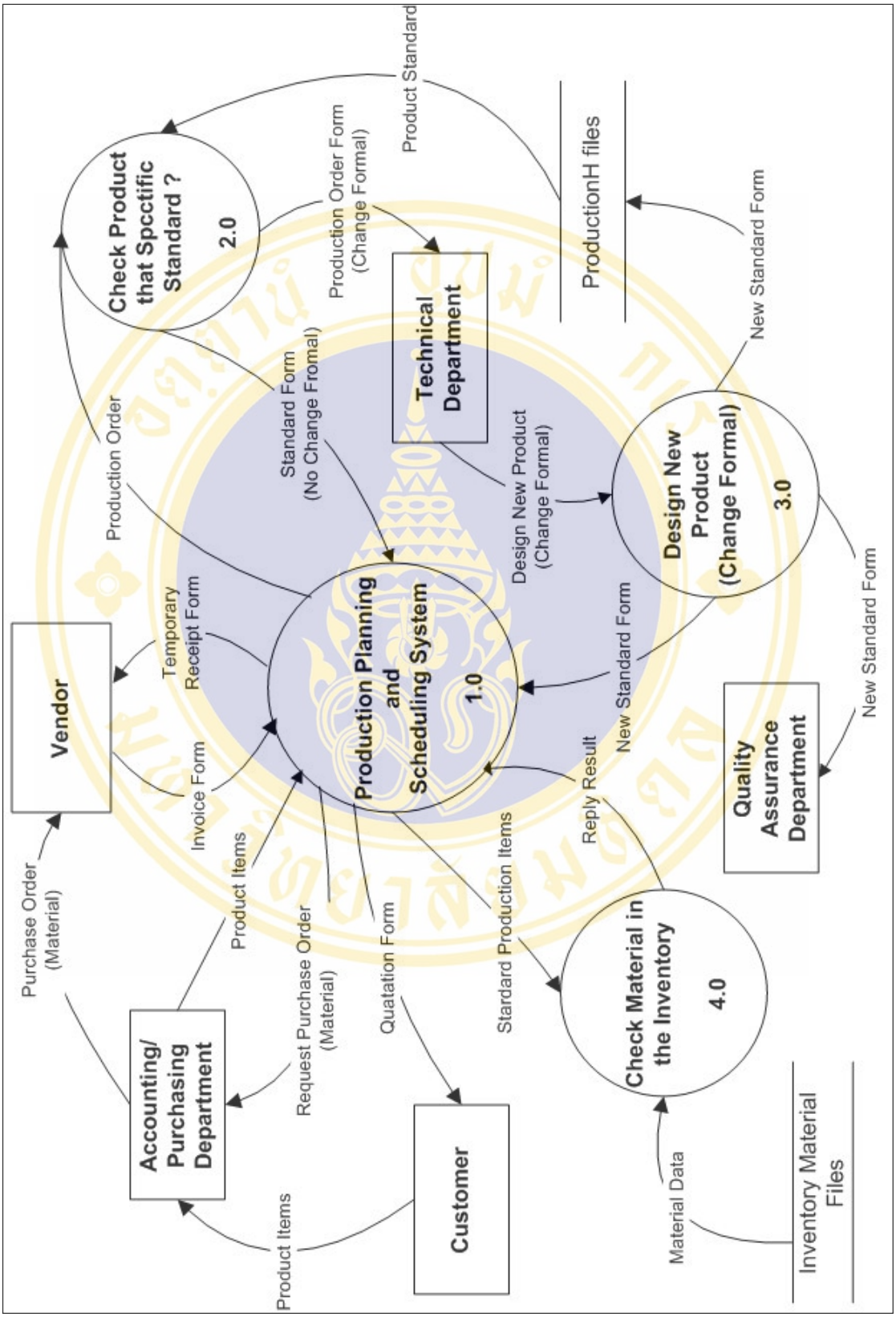

Figure 4.4 Data Flow Diagram: Level 0. (DFD: 0)

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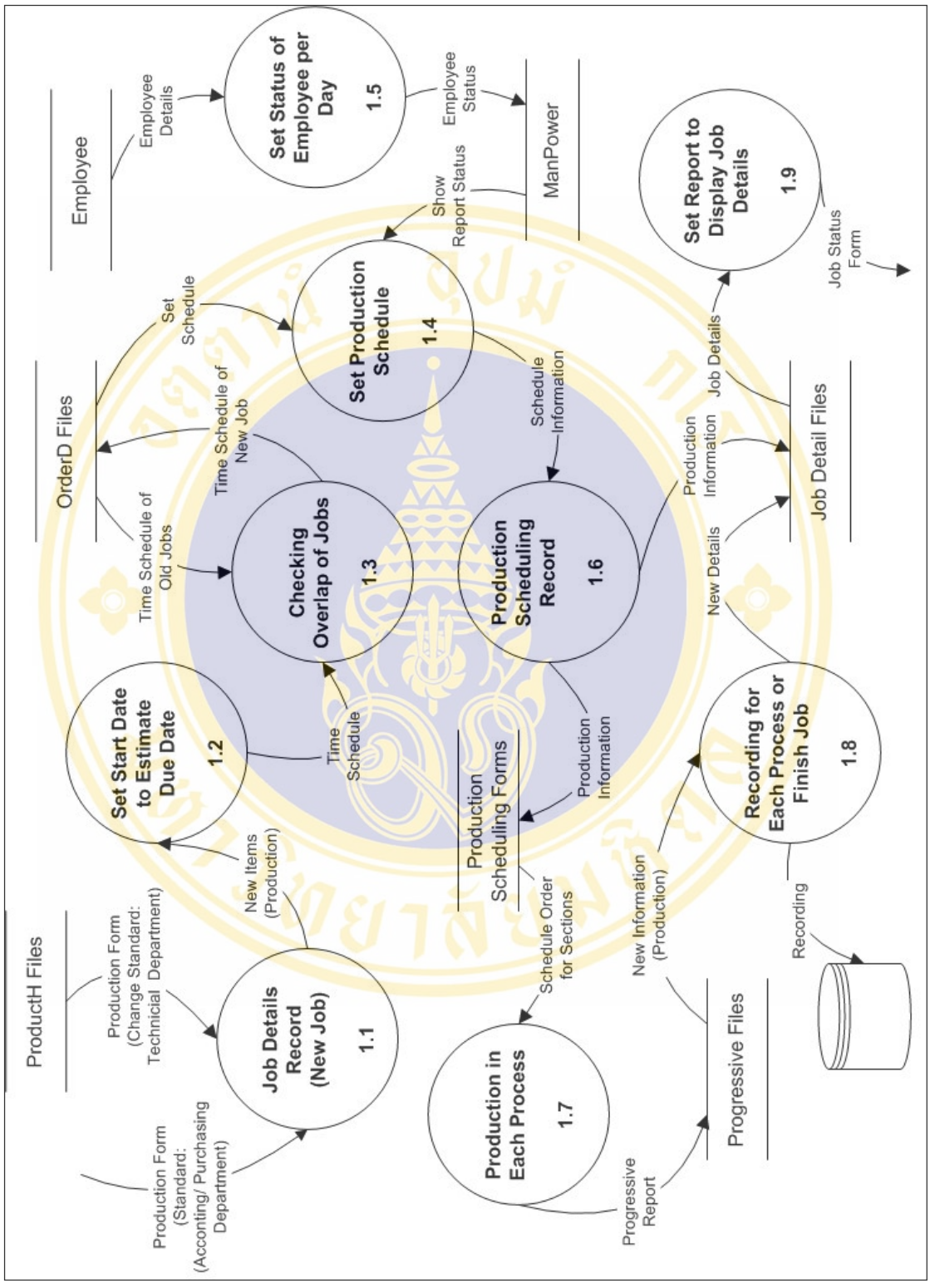

Figure 4.5 Data Flow Diagram: Level 1. (DFD: 1)

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In this Data Flow Diagram Level: 1; it starts with the display when an order form is received as production standard or change standard form. Information for producing items will be recorded in job details record (1.1), and sent to set start date to estimate due date (1.2). Next it will check overlap of jobs (1.3) refer from OrderD files to bring time schedule of old jobs for comparison of the starting date and timing of each process, then it will be sent back to OrderD files. Job schedule will set production schedule (1.4), and then will set production scheduling record (1.5) which the entire processes from the step 1.1-1.4 can be show in the display of program in receive order section. Figure 4.6

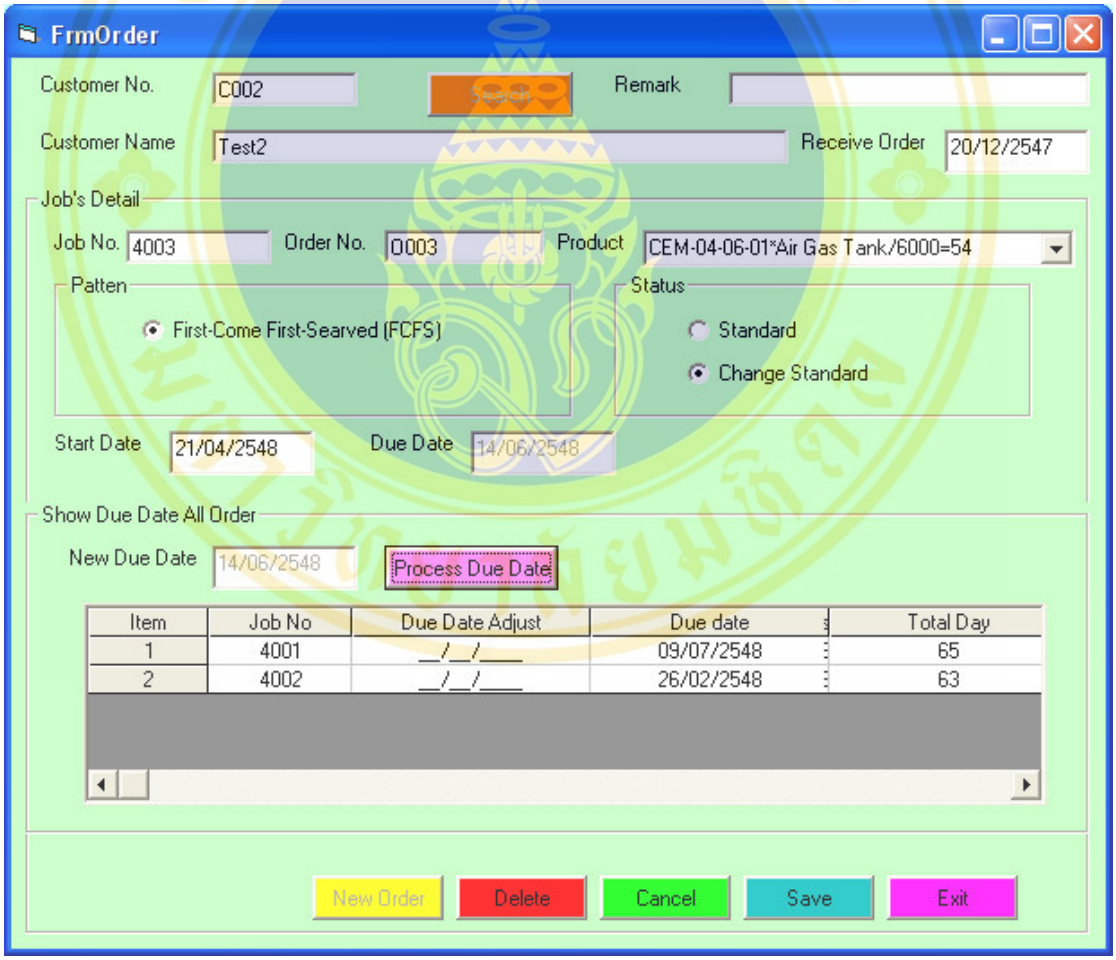

Figure 4.6 Submenu Order**.**

Information for production will be saved as job detail files and production scheduling forms. Production scheduling forms will be saved in order to print

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schedule order for section into production in each process (1.6), after finishing one process or many processes, and then a progressive report must be put into progressive files. New item (production) from progressive files will help for inserting jobs; to continue old jobs, to change pattern production, or to set order for job etc. After we have a progress report, then the program may be re-scheduled by recording each process or finish job (1.7) in the database and this data will be sent to job detail files.

Production information which is sent to job detail files in the first time will report about job status and how the steps of production are (1.8). Reports will have many patterns such as showing total of finished jobs, delayed jobs, set schedule production of each job, as shown in Sub menu Work in Process Figure 4.7 and Main Menu display program in part of Gantt chart and Reports. Figure 4.8

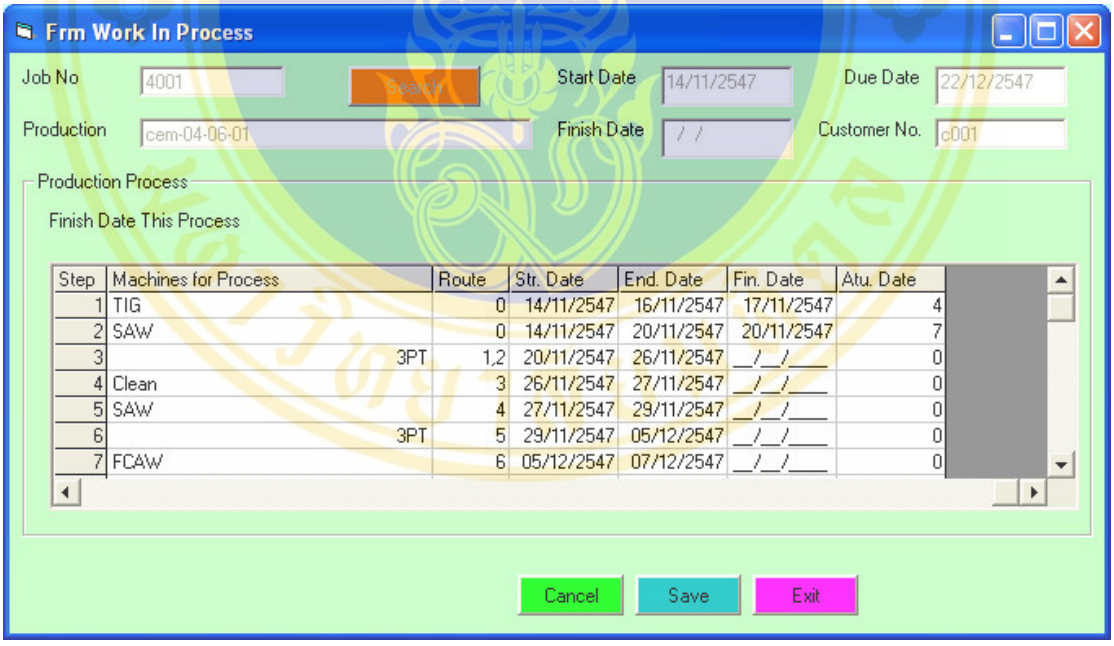

Figure 4.7 Sub menu Work in Process**.**

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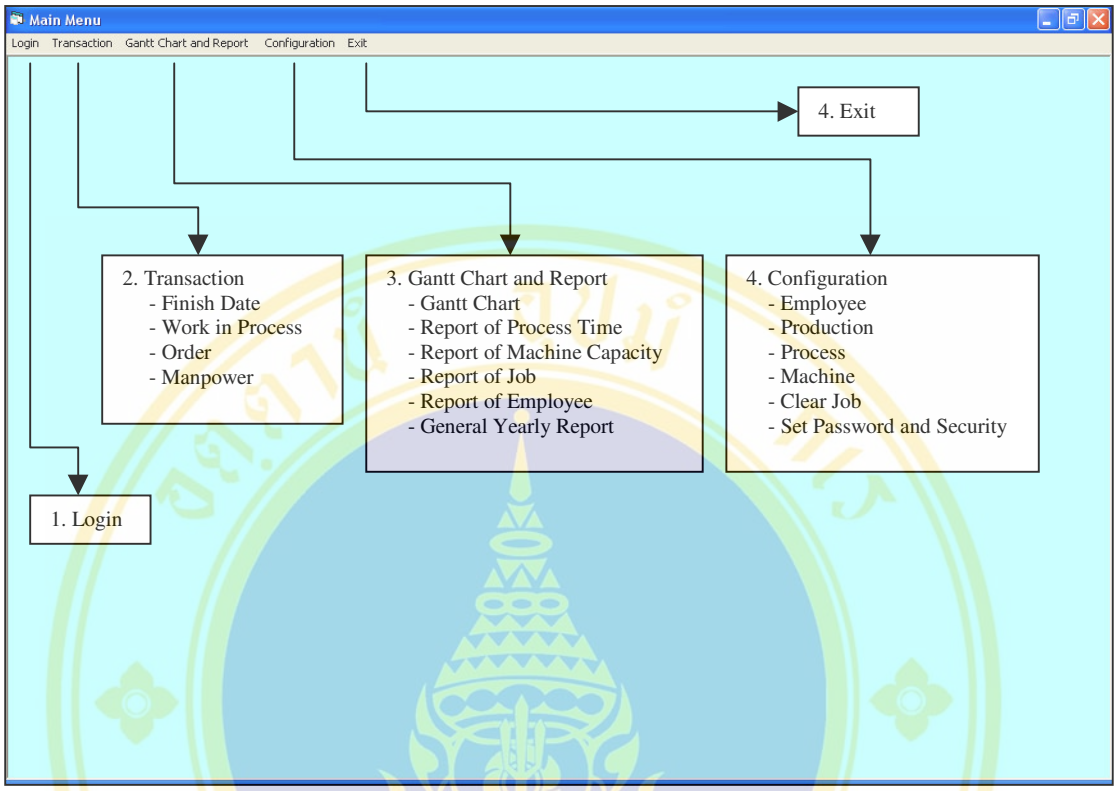

Figure 4.8 Main Menu.

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CHAPTER V
RESULTS

This chapter will describe the analysis of the existing process, and propose a design of new processes using easy software, and finally develop the program prototype for helping decision in the planning and scheduling.

5.1 Analysis of the Current System

From primary information, the database shows many relationships. We are able to know which part has relationship with other parts. However, the present database are scattered, sometimes they have many problems occurring due to data change which needs to rectify each point manually. So from this source, we will reanalyze the data in order to design new system for easier management.

5.2 The new system design

This program will help making decision for planning and scheduling. The application can help making decision from the first time that the company should or should not receive new orders. The system will warn when new jobs have overlapped with old jobs in order to consider that user can accept or reject a new order. Sometimes, overlapping can affect the due date. The due date set might be delayed because the overlap of jobs can cause some job not to be finished in time. Overlapping can also cause that the number machines for production is not enough. These problems, if user can accept, user needs to inform customer about new due date

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which comes from new estimate due date. However, the system will help showing remark to know that this job has an overlap. In addition, this application will show many reports and Gantt chart will show all jobs in the system. Gantt chart also show Sunday to be easy for observation and consideration. The program is composed by two sections; that is, design database/ design structure, and feature of program or user interface design.

Designing of database will use method called “Normalization”. After the table is separated, a redundancy of data will be decreased which can be divided into nine tables as shown in Figure 5.3.

For structure and feature of program, it describes how information system communicates with user. The design will be user friendly. There are five main menus; that are, Log In, Transaction, Gantt chart and Report, Configuration, and Exit.

Each menu consists of different function for each type of using. Some main menus will be composed by many sub menus as show in 5.6, 5.7, more details in each module can be seen in Appendix C: User Interface.

5.3 Database Design

From variety of data we want to develop and decrease redundant data in order to change or modify data automatically, we need to use a method called “Normalization”. After normalizing data already, we will find that the database can be divided into nine tables. For nine tables following:

1) Table: Employee
2) Table: Machine
3) Table: Manpower
4) Table: OrderD
5) Table: OrderH

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6) Table: Process

7) Table: ProductionD

8) Table: ProductionH

9) Table: UserLogin

An Entity-Relationship (E-R) diagram is used to represent to design of the system is show in 5.4

Data Dictionary containing the definition of all data is collected; the details of data dictionary of this application are given in the Appendix A.

5.4 Entity Relationship Model (ER-Model)

The relationship between E-R Model in "A Case Study in Cryogenic Tank Manufacturer" From Figure 5.1 can be categorized to:

1**. Table Employee:** This table will keep information about which employee use which machine. To check menu Manpower to see that employee will be present or absent in each day will have impact with type machines.

2. **Table Machine:** This table will keep information of all machines in the system with machine name, quantity, and type.

3. **Table Manpower:** This table will keep data of employees who present or absent in each day. This menu can help making decision for scheduling or changing production plan.

4. **Table OrderD:** This table will keep data when orders are received from customer. OrderD is a part of orderH which orderD will consider data of order from customer correctly. This data will be recorded in order to set schedule of job type or order. The received order each time does not need to have the same scheduling. So time of production in each process is different.

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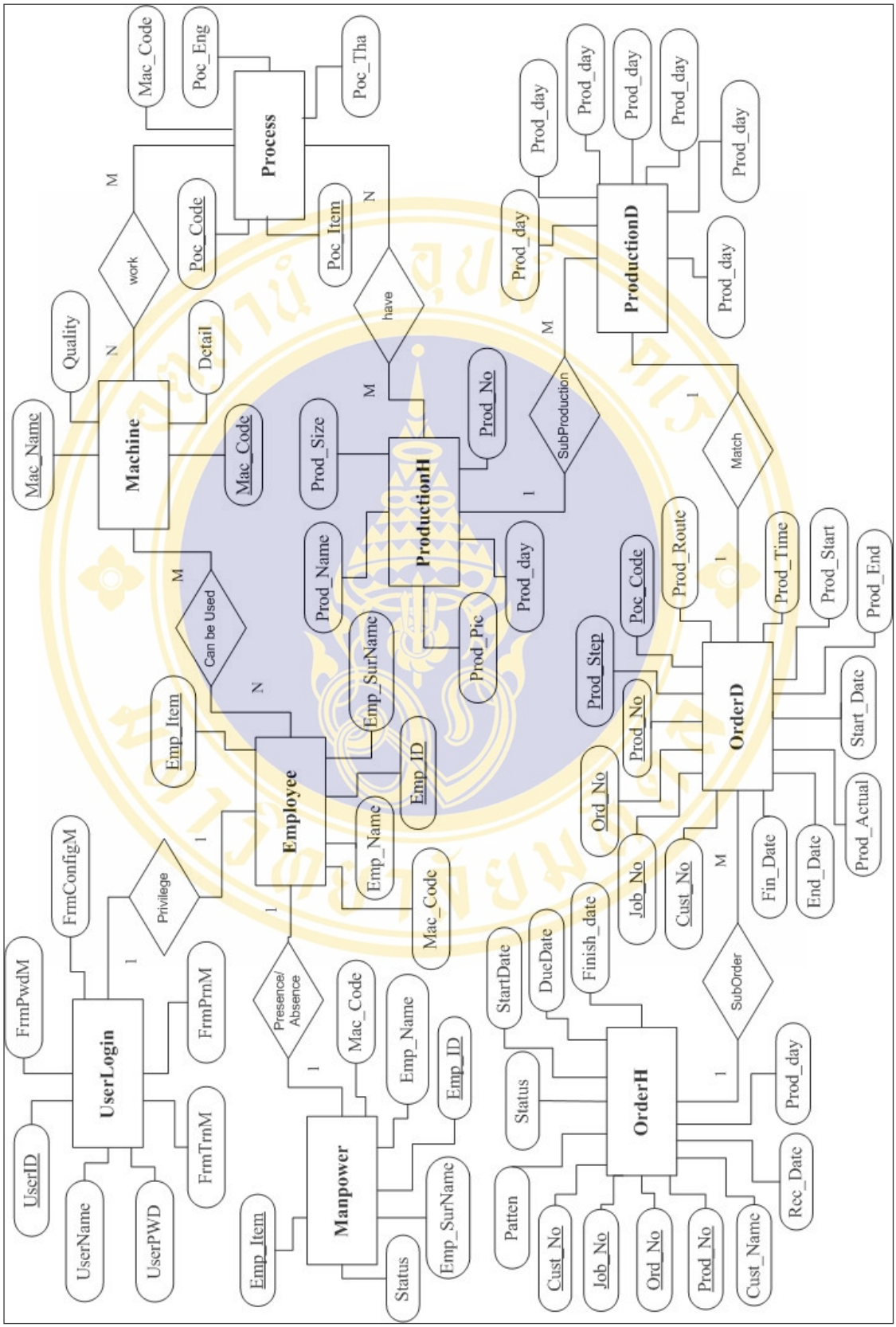

Figure 5.1 E-R Model of DDS-PGAP.

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5. **Table OrderH:** This table will receive main order of each customer to record in the database of orders.

6**. Table Process**: This table of production process shows that in the system, there are how many types of processes in the production and which machine in each process.

7. **Table ProductionD:** This table for production shows each order production details. Since item in each production may not have original standard, so this part is a subset of productionH. If the product needs to be changed or modified, this productionD will be changed and kept in this table.

8. **Table ProducthonH:** This table is part of information for original standard production.

9. **Table UserLogin:** This table will keep information of employee who have accessed into the system.

5.5 The relationship of table database

Working of all tables will have a relationship in order to transfer and process data to be more efficient and accurate in addition to decreases time.

The relationship between UserLogin and Employee will be 1 to 1 related because of 1 employee will get 1 code and password for login, and 1 code and password can be accessed by 1 employee. Figure 5.2

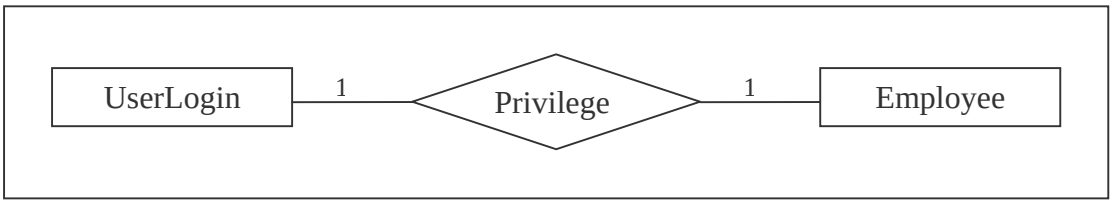

Figure 5.2 E-R Models between UserLogin and Employee.

The relationship between Employee and Manpower will be 1 to 1 related because 1 employee will be either present or absent which will affect database of

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Manpower only himself. And his presence or absence from work in each time will show in his database. Figure 5.3

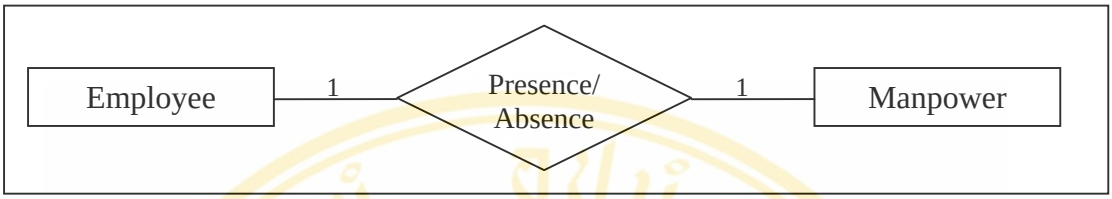

Figure 5.3 E-R Models between Employee and Manpower.

The relationship between Employee and Machine will be N to M related because 1 employee can use many machines and each of the machines will be used work form many people. Figure 5.4

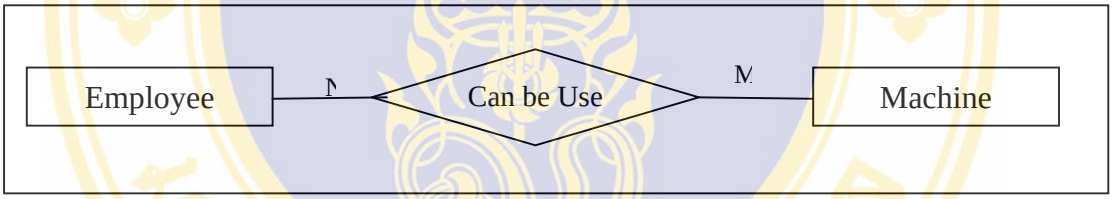

Figure 5.4 E-R Models between Employee and Machine.

The relationship between Machine and Process will be N to M related because 1 machine will be used in many processes. Each of the process can be used by many machines. Figures 5.5

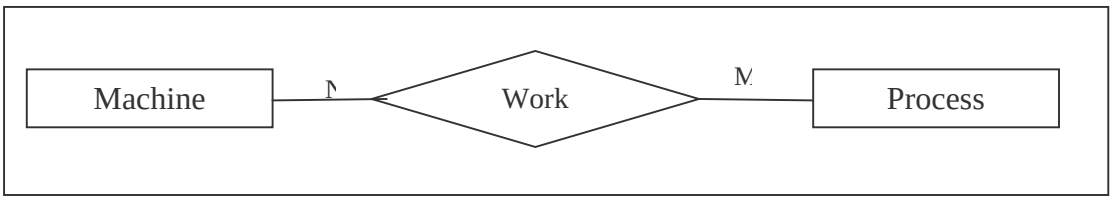

Figure 5.5 E-R Models between Machine and Process.

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The relationship between Process and ProductionH will be N to M related because 1 process can have many productions. Each of the production has many processes more than one process. Figure 5.6

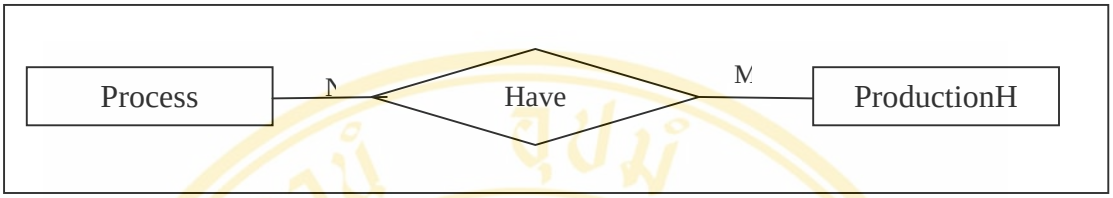

Figure 5.6 E-R Models between Process and ProductionH.

The relationship between ProductionH and ProductionD will be 1 to M related because the original standard of production of one product size will have many sub productions; depending on what customers want. One sub production is a part of main standard production in product size. Figure 5.7

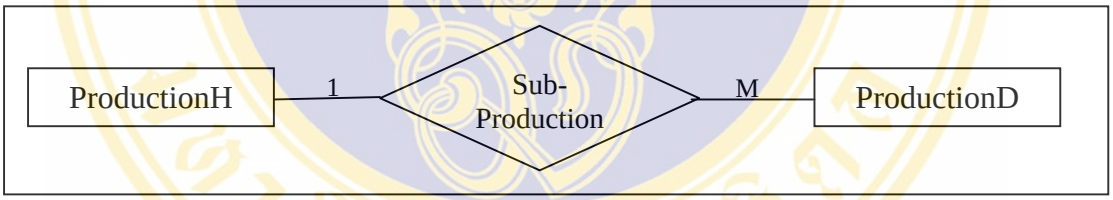

Figure 5.7 E-R Models between ProductionH and ProductionD.

The relationship between ProductionD and OrderD, will be 1 to 1 related because one product size which have an order or change pattern for production will be matched with order of customer in each order. And the number of the products will be matched with product size which be ordered. Figure 5.8

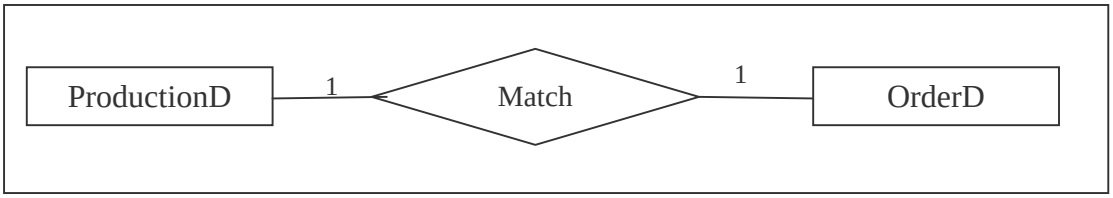

Figure 5.8 E-R Models between ProductionD and OrderD.

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The relationship between OrderD and OrderH, will be N to 1 related because an item of order have a variety by 1 item of order will be separated form OrderH. And OrderH which is a main order will have collected order which is a standard. From orderH, 1 item can become many sub orderD. Figure 5.9

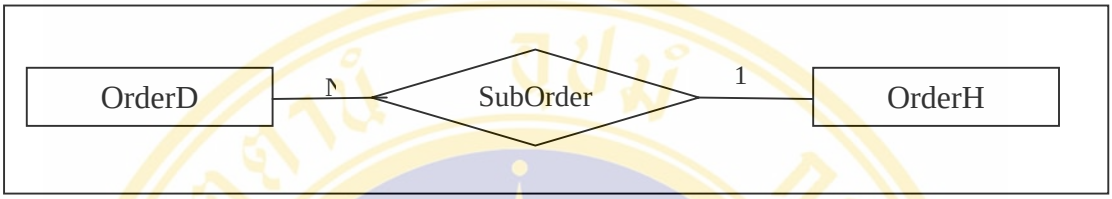

Figure 5.9 E-R Models between OrderD and OrderH.

5.6 Using of Program

Designing of “a Decision support system for Production Scheduling for Group Technology and Assembly Line Production” has developed and designed for production system by applying basic software to use for easy developing and using. This system can be divided into five main menus and many sub menus. So this chapter will show example of some main and sub menus which are used in the application; that is, Log in the first time before accessing into system; Receive Order, decision of work input for each employee in sub menu; Manpower, Display result; and Print report for ground or information forecast in the future. However, many details in each main menu or sub menu will be shown in Appendix C.

5.7 Concept for System Management

5.7.1 Log In

To log in the first time, we can access into the system immediately, then go to the menu configuration to set a password and restrict user for the next time.

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Then next time, any users, who want to log in, they will have to type in username and password. Moreover, the system will be restrictive for using and a user who wants to use the system must be authorized from admin.

- Admin : Admin will have a big privilege which can look, change, or delete information. Figure 5.10
- User : is to log in for using, usually, user can not change or modify password of other user until admin will privilege.

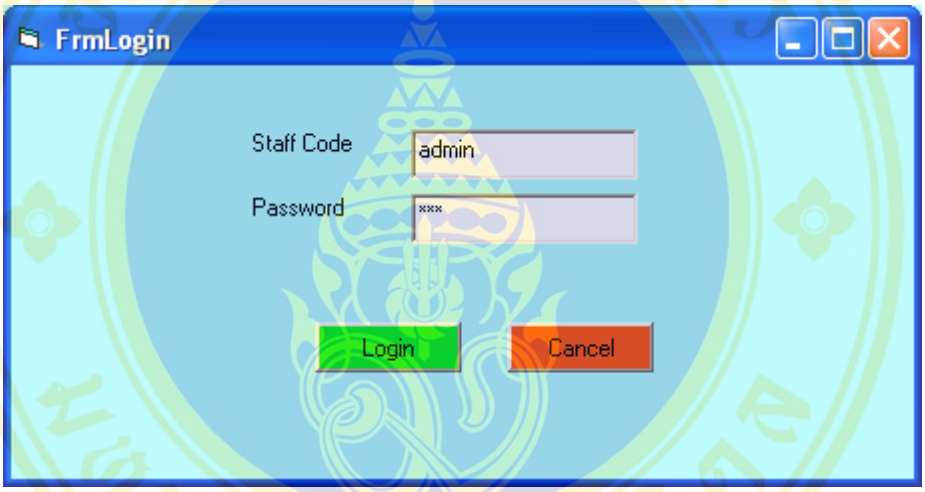

Figure 5.10 Example Log in

If password for admin is input, the system will show and can use sub menu in part of “Set Password and Security” Figure 5.11. On the other hand, if user don’t set or privilege with this sub menu, the system will not show this sub menu. Figure 5.12

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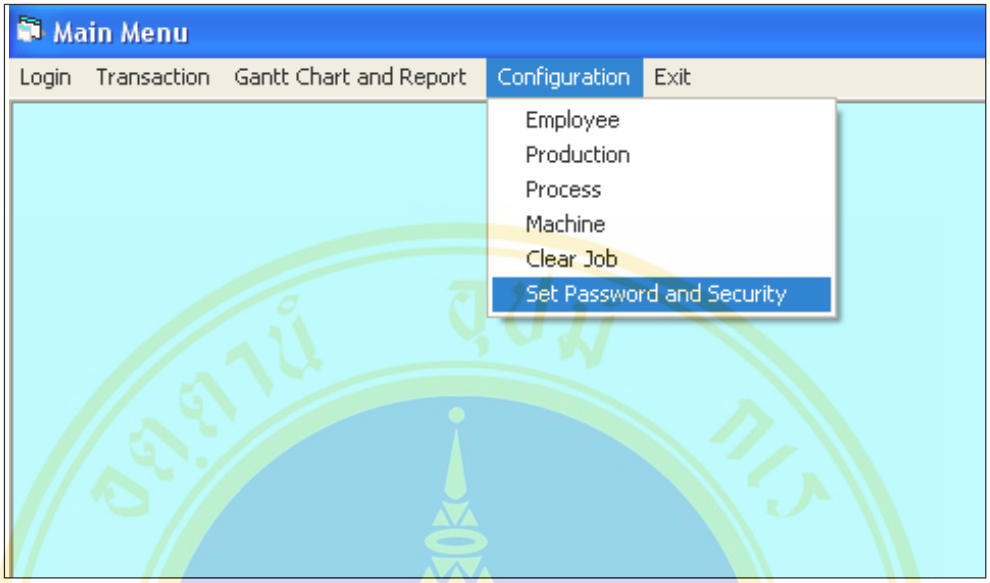

Figure 5.11 Example the system will show sub menu Set Password and Security.

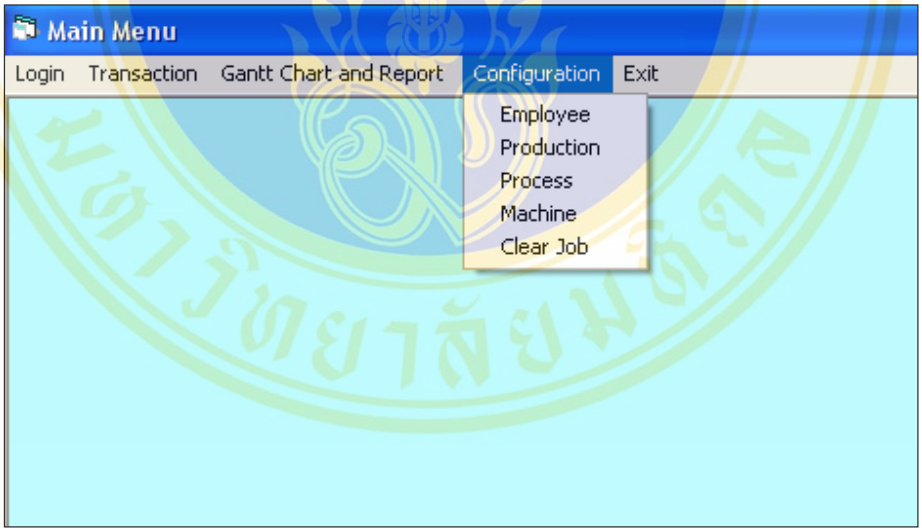

Figure 5.12 Example when the system does not show sub menu Set Password and Security.

Privilege of using other sub menus in Set Password and Security is that user can select from sub menu Set Password and Security for the first time when start to use program. Figure 5.13 Example for privilege use the system.

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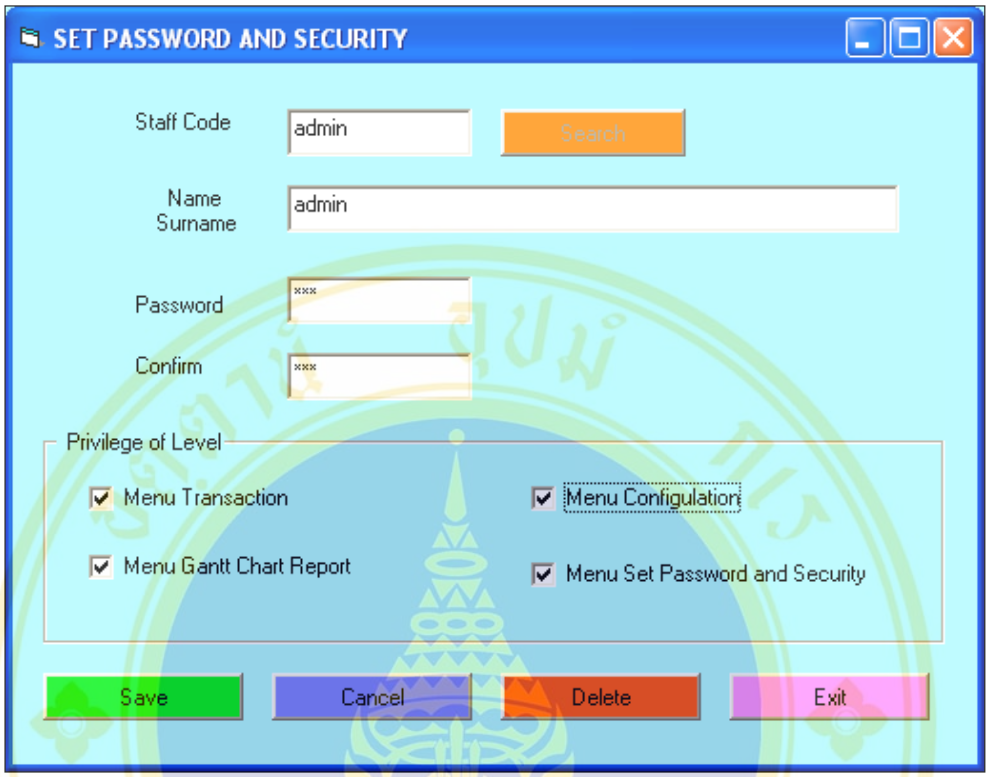

Figure 5.13 Example for privilege use the system.

5.7.2 Receive Order Management

This system will authorize planning department to use data in order to make decision in accepting, rejecting, or delaying order as starting date. User needs to input information of customer and details of job shown in Figure 5.14.

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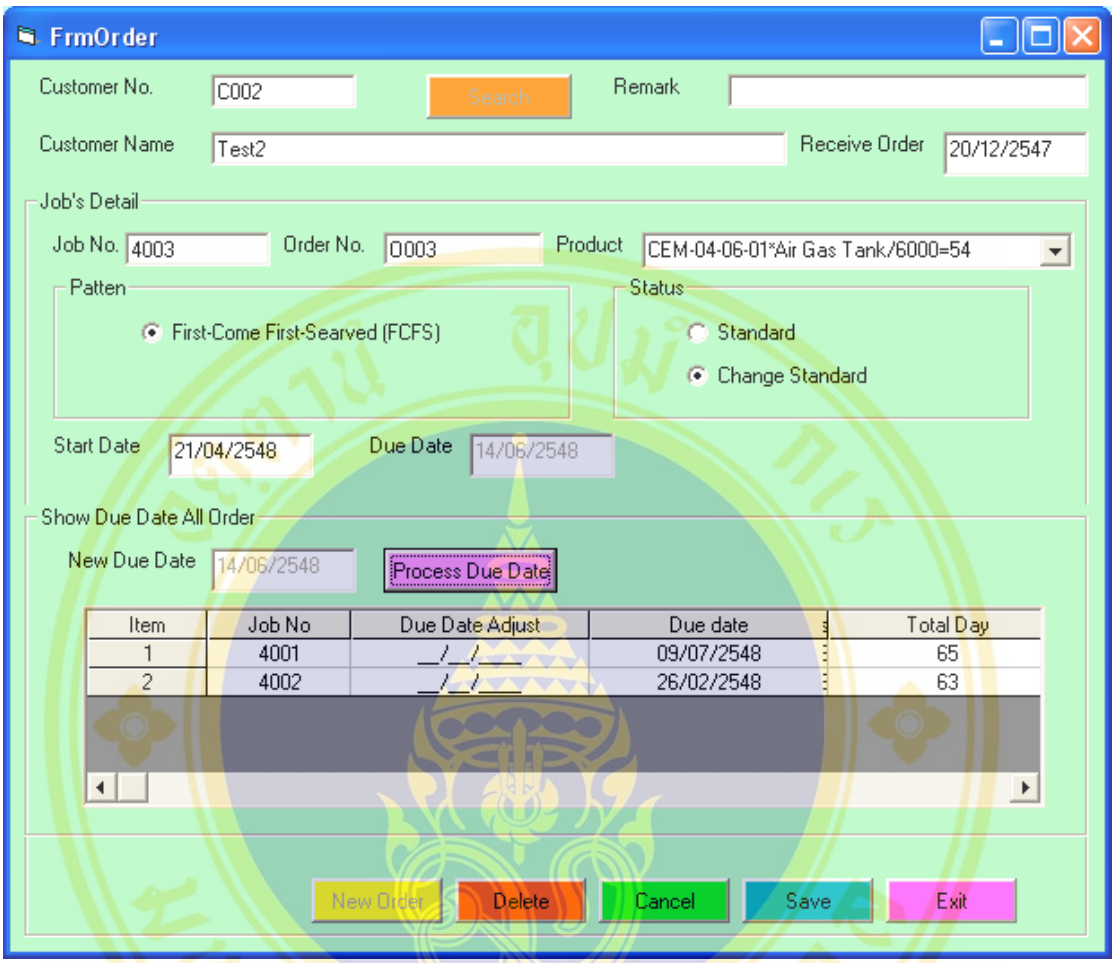

Figure 5.14 Example of order received form from customer.

Sometimes, user has a new job, but the system cannot save this job because the system recognizes duplication between old jobs and new job. If a new job has duplicated before saving to the database, the system will show information of jobs, processes, and machines which are duplicated as in Figure 5.15.

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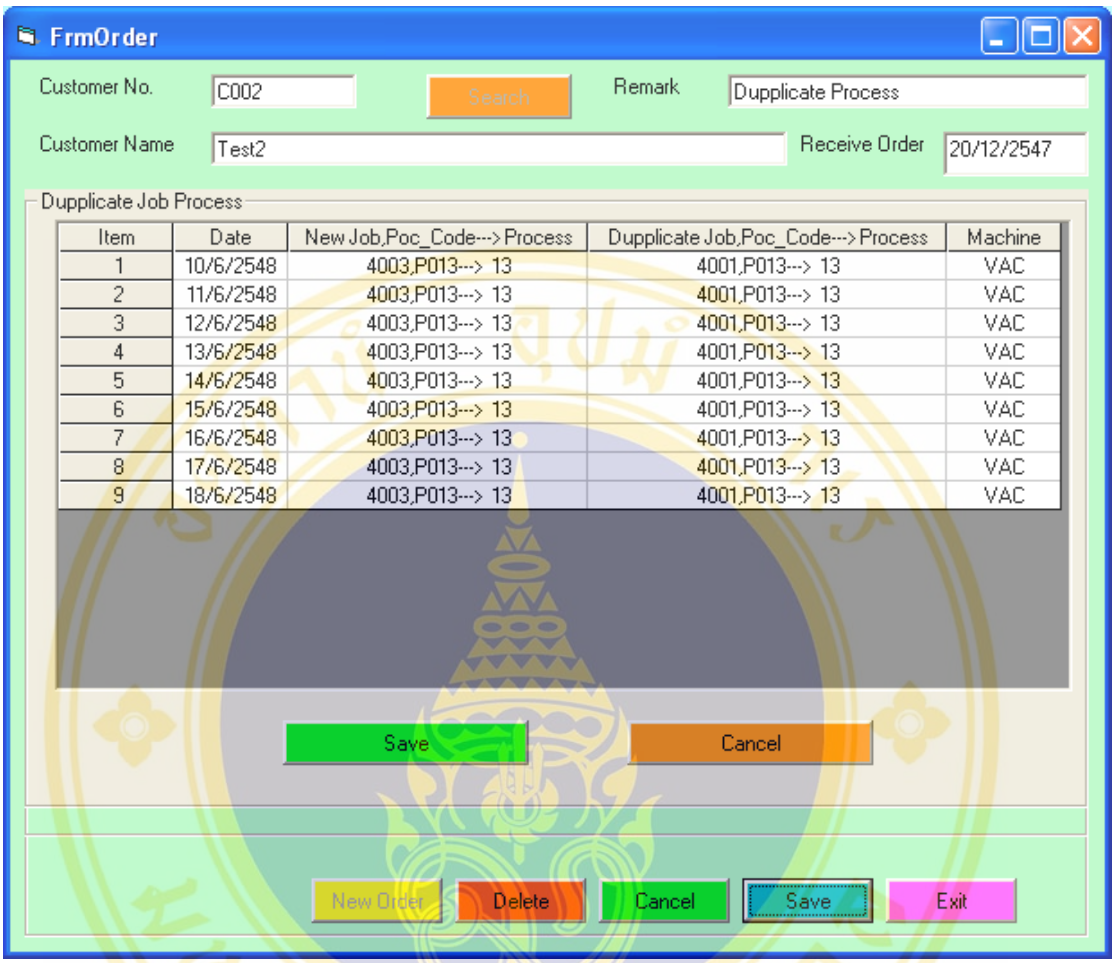

Figure 5.15 Show information for duplicate jobs.

5.7.3 Manpower

This section is about making decision by a user who has duty on production planning to allocate employee for production. The first time, scheduling will have schedule already. Sometimes employee's absence may effect the due date of job which needs to changing. So the employee information will be used by an authorized person in order to make decision on their work. Figure 5.16.

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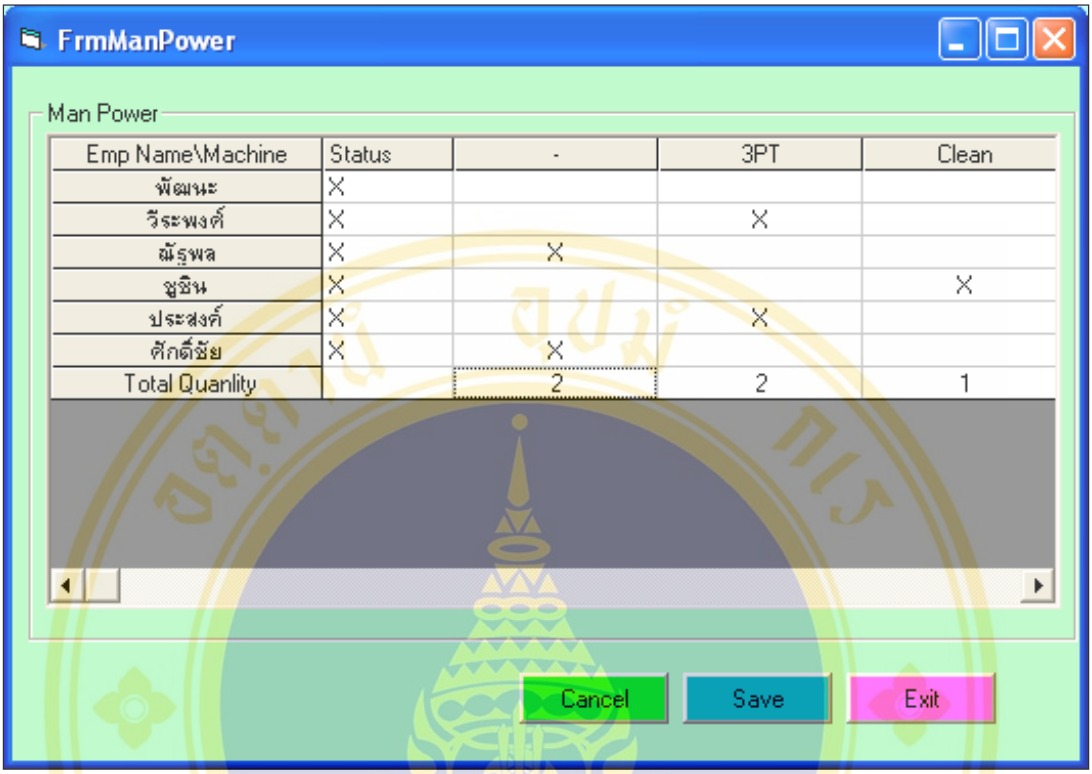

Figure 5.16 Example of Manpower.

5.7.4 Display of Total Jobs in the System

The Gantt chart pattern will be displayed in order to see the total jobs in the system easily; especially, point of overlapped jobs. This system wills hi-light black color in the point of problems so that the impacts to other jobs can be considered. And user needs to decide what job needs to be started before others. Moreover, Gantt chart will also display Sunday, which is a holiday. Since the chart shows that what day is a holiday, the system will add more days and calculate new due date in order to predict the due date as close as possible. However, this date might not be every time accuracy because there still are problems about time overlapping with other jobs. So, user needs to estimate and expect a new due date in case overlap to inform customer. This Gantt chart will show each job clearly with different colors, which is easy to look. The schedule will be broadly displayed in calendar pattern with process name. Figure 5.17

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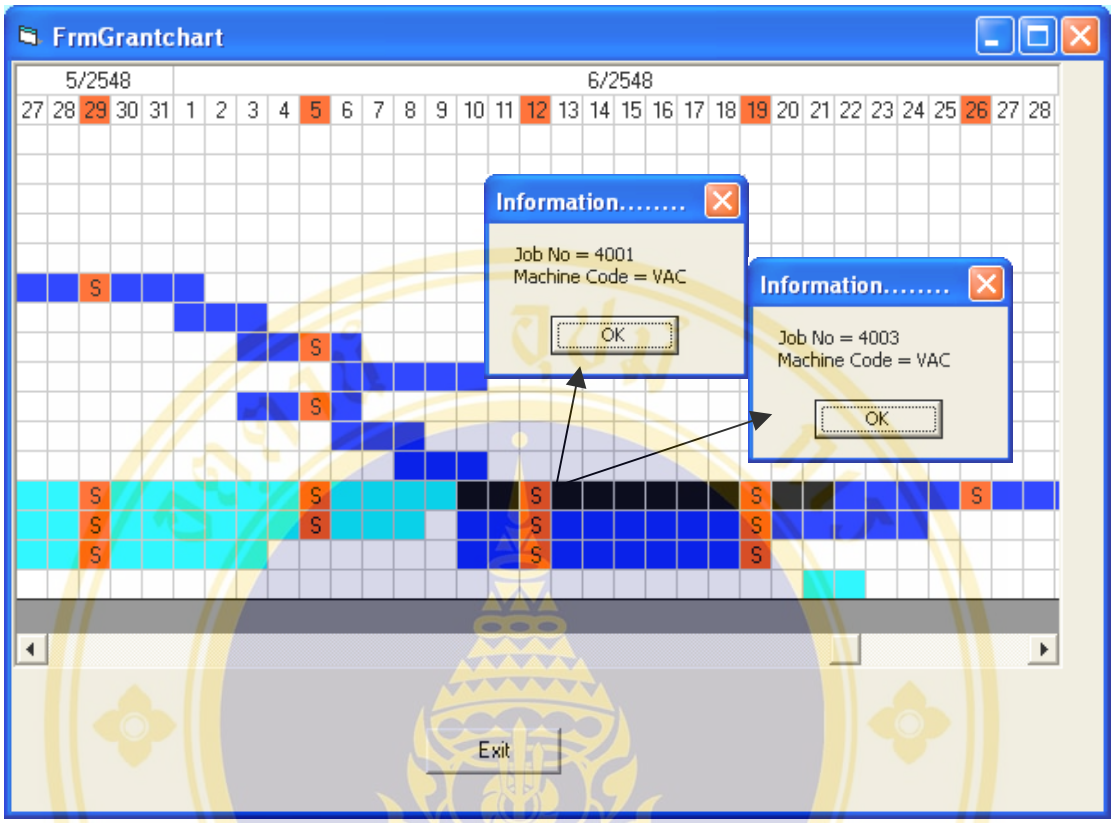

Figure 5.17 Example Gantt chart showing total jobs in the system.

5.7.5 Print Report for Evidence

The programme can have a report printing to know the progress of work or to be an evidence on the performance; moreover, this information will show a lot of details such as machine name report, finished job report, summary of jobs per month report, job delay report and, etc. Figure 5.18

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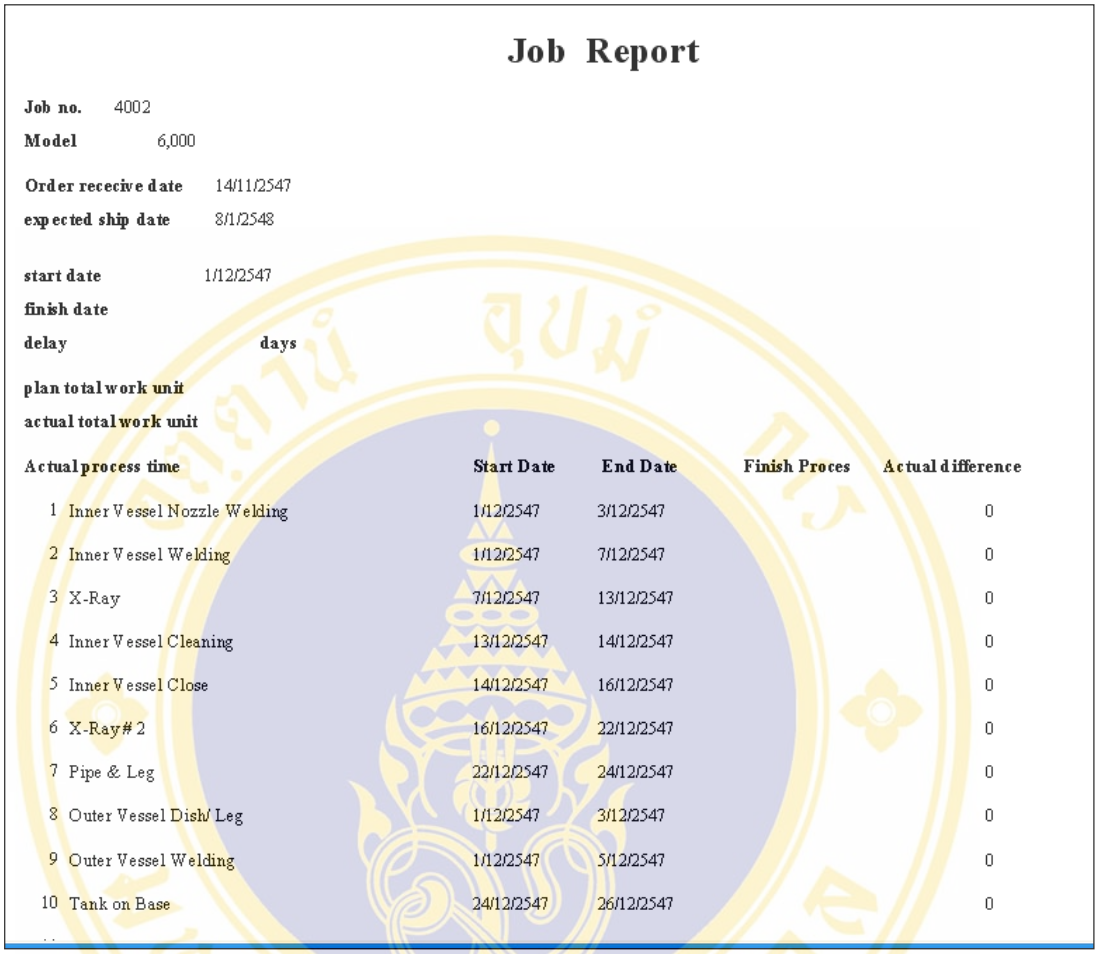

Job Report

Job no. 4002
Model 6,000

Order rececive date 14/11/2547
expected ship date 8/1/2548

start date 1/12/2547
finish date
delay **days**

plan total work unit
actual total work unit

	Actual process time	Start Date	End Date	Finish Proces	Actual difference
1	Inner Vessel Nozzle Welding	1/12/2547	3/12/2547		0
2	Inner Vessel Welding	1/12/2547	7/12/2547		0
3	X-Ray	7/12/2547	13/12/2547		0
4	Inner Vessel Cleaning	13/12/2547	14/12/2547		0
5	Inner Vessel Close	14/12/2547	16/12/2547		0
6	X-Ray# 2	16/12/2547	22/12/2547		0
7	Pipe & Leg	22/12/2547	24/12/2547		0
8	Outer Vessel Dish/ Leg	1/12/2547	3/12/2547		0
9	Outer Vessel Welding	1/12/2547	5/12/2547		0
10	Tank on Base	24/12/2547	26/12/2547		0

Figure 5.18 Examples for Report.

5.8 Software Used in the System

The database will use Microsoft Access Version 97 which is popular, easy to learn, and can support work. Moreover, the data for this case study is not too much; therefore, we do not need a complicated database.

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5.9 Computer Language for Development

This application selected “Visual Basic 6.0” for development which is easy to use, various, colorful, easy to learn, and easy to continue developpingt because this program is an object-oriented which can be divided into many modules and each of the module is unattached. Therefore, in the future if we want to develop, it can be integrated with the original.

5.10 Method for development Program

First, all input data which require Normalization needs to be designed in order to gain information which is less redundant. After Normalization, we can allocate nine tables. Next, structures of program are designed for the input that we want to display. Nevertheless, some of the menus cannot be accessed because it might damage the file.

5.11 Benefit of this system to other production

This case study “A Case Study in Cryogenic Tank Manufacturer” is the study of a middle factory having mixed work and produced the Cellular by Group Technology and assembly line. So, the industry which is appropriate for introducing the new system should be a group - production industry. The new system should not be designed for more details in production, but should review only in the comprehensive way. However, this system can apply to many industries because the system use the object-oriented standard.

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5.12 System Efficiency

- Display Mode and Resolution

Can display size 800 X 600 and result at 32 bit.

- Storage Requirement

Computer should have a lot of memory, very large space, and fast because the system must support the data which will increase in the future. Besides, the system can process for calculating, when the process needs to use more space for running process in order to protect computer crash or slow process during work.

- Complexity in System

Since the production is complicated, the system design of program for input data or output data will have the pattern that is difficult to use for the first time. Thus, we will have to train the user; and help the user manually.

5.13 The Security

The security system for this software will restrict user in order to protect changing information of entire internal production system. Only authorized user who has the username & password can use this system.

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CHAPTER VI
DISCUSSION

The objective of the study is to analyze and develop a production scheduling and planning application prototype by using software that is easy for small or middle industry, based on the data acquired form case study in Cryogenic Tank Manufacturer.

This chapter is to discuss the system development, collecting information, advantages, disadvantages, limitations, and exceptions of using this program.

Collecting time in order to use or set schedule was selected and kept long time ago. At present, a lot of data has been scattered everywhere so it is difficult to manage and to gather for result of production scheduling.

The application of system is developed by using Visual Basic 6.0, Microsoft Access 97, Microsoft Office XP, and Cystal Report 8.5. There are many reasons for using this software that are:

1. Using Visual Basic 6.0 for developing has many benefits because in the future this software can support to modify or change more requirements such as open source codes, crossable platform. Moreover, the software is stable, well known, easy to use or learn, and has an object-oriented structure which will be easy for adding, deleting, and modifying program.
2. Using Microsoft Access 97 for management system can support the large amount of data and easy to use.
3. The design of this system uses the relational database modeling technique to reduce the data anomalies.

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4. Selecting Cystal Report Version 8.5 for report because this program can be more flexible than Report Designer from Visual Basic directly, and the reason why using version 8.5 is that not many problems occur and less error appear; supporting with Visual Basic.

There are many advantages compared to disadvantages, limitation, and other exceptions for the program prototype of the design of a decision support system for production scheduling for group technology and assembly line production: a case study in cryogenic tank manufacturer. This program has been tested by the industry already and it is admitted for efficiency of being practical in using and the system is satisfactory. Each item can be summarized as follows:

6.1 Designs for Implementation

Using this program will be appropriate for a user or admin who wants to use the application directly in the planning and scheduling system. In the beginning of using, user can set begin and privilege for using. For example, if admin wants any staff to only use in planning and report and not be able to access to modify in the configuration section, that employee will not be privileged to use this section because it will appear invisibly. More details can be seen in Appendix C. The program has inputs and outputs in each department.

6.1.1 Input data can be divided into two parts; tangible data which can be an evidence and intangible data which cannot be an evidence.

Tangibles

- Input new machine: data of machine will be sent from suppler directly after Purchasing Department was sent an order for buying machine to supplier. If the machine is already delivered, the system needs to add information to the database.

- Input employee information: when there is a new employee or old employee resigns, this information will come from Human Resource Department.

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- Input order from customer: this data will come from Accounting Department when the customer has ordered.

- Input Manpower: This section come form real data of daily staff's absence or presence.

Intangibles

- Input process: come from information of machine in each process. This data is standard.

- Input production: most of data come from Production or Technical Department because they will check a quality, set standard of production, and estimate timing before input information to database of production.

- Input work in process: this data come from real performance of process when each process finishes and how.

6.1.2 Output data

Most of data will be sent in order to be used especially by Production Department, to know how the product is produced, what the total jobs are. etc., Moreover, output will help forecast in the primary that what period has many jobs and what period has less jobs. This output will show in the form of what we call "Gantt chart", which can report a lot of information such as report of jobs, report of employee, report of machine, etc.

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6.2 Advantages of the developed prototype

- Help performance quickly

The system can abridge time automatically for calculating due date of each job. It's help performance quickly by changing from manual to computer system. So time for management will shorten.

- Help decision in the first time that will accept or reject order rapidly.

Objective of this program is to help decision in the primary that should or should not receive new order? Presently, the system is used in working and estimating time of each job only. So, it is difficult for making decision to accept or reject new order. However, this software will help decision in receiving order in a short time.

- Help keep and reduce many data and information in the system.

A lot of data are scattered kept. When user wants change any, he or she data needs to modify data everywhere. Sometimes, this can caused confusions and mistakes. So this database will help keep and reduce unnecessary data and information in the system automatically.

- Help security.

The application has a security system that is the program must be privileged for using; such as, admin can access to every main menu in the system, but some staff cannot use some menus in order to protect data and to have system security.

- Help decision for set employee

Manpower is a menu for update data of present or absent employee in each day. This menu will show status of employee and machine. If an employee does not come, will there be any impact to the machine and how a new schedule will be decided?

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- Help flexible in production.

When receiving a new job, the program will set a priority for jobs. If old jobs are first come first served basis, the system will allow job insertion. But if old jobs are preemptive, the system will show that the new job cannot be inserted and the due date must be changed. Moreover, each job will have database of itself because details of each job can be changes and it might not be the same as other jobs. And when user wants to change or update new data, they can modify that job only. If any job is stopped or interrupted during a process and has not completed yet, the system can set the new schedule immediately to continue from the old process.

- Help forecast requirement in the future

User can forecast a production by Gantt chart which shows total jobs in the system, so user can know and decide when they can receive a new order or can not receive order.

- Show many reports when user wants.

The program will report many details such as a report of jobs which will help for a considering each job, report of employee which will show name, surname, and duty of employee with the name of machine used, a report of machines which will show total machines in the system, etc.

6.3 Disadvantages of developing prototype

Since this program is a prototype, which was developed in a very limited time, it is not 100% perfect. That means it can not cover every industry. However, this program has completed more than 95% for this case study. Disadvantages can summarize to:

- This program is a tool for helping decision in assigning employee who is present or absent in each day, which might have an impact to machines, and decision

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how schedule should be changed But application does not focus on automatic system management in case an employee is absent.

- Gantt chart Display shows total jobs in the system, but does not include timing in each process when to start or stop? Moreover, it does not prepare Gantt chart report printing to printer.

- Gantt chart is not flexible for moving, modifying, and changing with mouse; but user needs to change from menu Order.

- Gantt chart cannot mix colors of jobs when there are more than two jobs. However, user can see the obvious difference and will not be confused in Gantt chart. This Gantt chart will use black color in the point of overlapped jobs. User can consider this Gantt chart with the report of jobs to see how the production has been processed and how user can solve the problem.

- This is a new application. So whoever wants to develop this program, he/ she needs to buy a software and hardware in the future. Estimated prices and details are as follow:

Total Cost

- *Hardware:*

CPU	: Pentium IIII 2 GHz. (or faster)
RAM	: 256 Megabytes.
Hard Disk	: 20 Gigabytes.
Peripherals	: Monitor, Keyboard, Mouse, CD-ROM Drive, and Printer.

Prices 50,000 Bath.

- *Software:*

Operating System	: Microsoft Window XP.
Programming Language	: Microsoft Visual Basic Version 6.0, Crystal Report 8.5.
Database	: Microsoft Access Version 97.

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Other tools : Microsoft Office XP, Adobe PhotoShop 6.0, and Visio 2002.

Prices 150,000 Baht.

6.4 This development is the better than shareware or freeware

It is known that production planning and scheduling is software, which nowadays are in various forms both shareware and freeware. However, these software have many disadvantages for using; such as, limitation of using, inappropriateness to case study, high investment, too many functions more than needed, limitation for data and quantity of using, etc., So, this software prototype is better than shareware or freeware because this software is appropriate to case study, low cost, easy to use, responsive to specific requirement, easy to learn, many colors, and easy to develop because programmer can use easy language to develop the software in the future, etc.

6.5 Limits of developing prototype

Limits of developing can be divided into, two parts; that is, limits of program and limits of other industry.

Limits of program

Limitation of program is to relate between Manpower, Machine, and Gantt chart. If employee is absent in each day, the system might have an impact to machines. It cannot work as planned and the due date in the schedule of Gantt chart is changed. At present, the Gantt chart faces with this problem. This Gantt chart cannot be changed, but it will show only original status. So, up matter the employee will be present or absent, it will not affect the data shown in the chart. However, user can

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know in the first stage that if employees are absent, the system will have an impact with machines in Menu Manpower. Moreover, the relationship between Manpower, Machine, and Gantt chart can also have a limit in case machines do not function. The system does not support with this section, so user needs to consider and change the schedule manually.

Limitation of display of Gantt chart; it cannot be changed, modified, or moved by using mouse. In case user wants to move jobs or change schedule of any production; such as, machines break down or stop immediately. This situation cannot be controlled. So, the finished job will be delayed and due date will be changed. The information will be recorded and status of delay will be shown in report.

Limitation of job overlapping; at the beginning, the overlap of jobs will be highlighted with black color to differentiate the overlapped time in order to help in considering. But it cannot move anything because user accepts the overlap of jobs in the first time. User will be warned before saving the new job in the record. With the system, it will warn about the new job which will be overlapped with old jobs and maybe have an impact to machines. If user can accept, the system will save and remark that this job is an overlap. Moreover, due date does not need to be correct and accurate because it is only estimation. Some processes cannot be performed, some jobs cannot be finished within due date. User needs to estimate new due date and inform customer. However, this system is the only system to warn about overlap of jobs. And Gantt chart display will show point of problems which is overlapped. Then user can use report of job in considering before making decision.

Limit of other industry

This program is a program prototype which uses case study in Cryogenic Tank Manufacturer by using cellular manufacturing of Group Technology. So, if other industry which has this kind of production or methods similar to this case study, they can fully and efficiently get advantages. For other kind of industries, if they want

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this program, they need to apply or change in order to use in their industry. However, this program uses software which is easy for developing.

6.6 Exceptions in developing prototype

This program is built by using Cryogenic Tank Manufacturer which is a case study. So the program will be appropriate with main requirements for this industry. And something of program may not support to other industry and on the other hand, something that other industry wants, this program cannot provide. Anyway, this program should be continued developing and applying to continue in order to make this program perfect, standard, and flexible for every industry.

6.7 Developing carry on in the future

Developing software to be perfect or able to support ERP should increase information for receiving order when the Accounting Department receives order. Presently, the system can tell when an order or a job to start, what to be produced, and what machines to be used. So if the system can connect with inventory in order to know stock of materials, the system will be perfect and automatic, because Production Department can know and forecast that when purchasing materials from supplier should be done to have enough materials for scheduling. In additions, information of store may kept for lead time of purchase, point of time of material, address of suppler, or cost of material, etc.

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CHAPTER VII
CONCLUSION AND RECOMMENDATION

7.1 Conclusion

In the industries, there are many management patterns for production. Today, we are emphasizing on mid or small industries (SMEs). In order to make business successful, we have to bring in logistics to help in planning. Therefore, in this case study we will emphasize on planning and scheduling because we have found out that there are a lot of problems occurred in this industry due to inefficiency in planning. This effects on performance on manpower and machines. As a result of this, we might lose trust from customers. From this case study, we will focus on “Design of a Decision Support System for Production Scheduling for Group Technology and Assembly Line Production: A Case Study in Cryogenic Tank Manufacturer.

This research uses “The Systems Development Life Cycle (SDLC)” for developing, by using Visual Basic 6.0 for development and feature designing. This software is easy to learn, popular, beautiful, and object oriented which will be easy for developing in the future. Database is created by using Microsoft Access Version 97 because this software has been developed long time ago; moreover, it has a stability and can support various software. The number of database in the system does not have to be large, so this software is an appropriate development. Finally, the software Cystal Report Version 8.5 is selected for designing report because it has a stability, it is easy to use, and can support with Visual Basic 6.0. These are the main reasons why these software are chosen for development.

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The program is composed of five main menus. These menus are: Menu Login, Menu Transaction, Menu Report and Gantt chart, Menu Configuration, and Menu Exit as the details shown in Appendix C.

After we have created software and tested it, we have found out that it helps in decision making or refusing the production. Moreover, it will organize the work to be more professional. Therefore, this program is very useful to many industries which use this kind of technology. It can be applied or adapted to other industries as well since the program is easy to use, and user friendly.

7.2 Recommendation

Although there are a lot of useful things in this program, there are some disadvantages as well. To increase uses of this prototype, the recommendations for further development are shown as follow:

1. The Gantt chart

The Gantt chart should display more details on time. It does not specify the time of the performance and the time when the production finishes. But, it will display the date of the performance and the finishing date. If the job is a half - day process, it will display the finish on that date. In additions, if there are two jobd and they are both half - day performance, the person who is in charge will have to divide which job to be done first.

2. Manpower and machines

At present, information of employees and machines is a tool for helping decision making only, but it is not automatically managed. For example, if one of the employees is absent, the program will show that it will have an effect to machines.

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Then the related information will be used for considering which machine to be used or what process to be used, when somebody is absent. In the future, the system which is more systematic and automatic will need, to join manpower with machines together, that is, if an employee is absent, the system can decide automatically what impacts to machine, what process to use, and how to change the schedule.

3 Developing in other industries

The prototype is built in order to be appropriate for the case study. This industry has a special manufacturing process which uses a Cellular Manufacturing by Group Technology. Therefore, if other industries want to bring this prototype to use, they need to change properties or features of the program in order to be appropriate to their industry.

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APPENDIX

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APPENDIX A
DATA DICTIONARY

Data Dictionary – Processes

Process Name	:	0. Production Planning and Scheduling System.
Description	:	This is the main process of planning which are mainly about set scheduling and displaying each job. Information will be related to decision by reviewing the entire data both internal and external.
Inbound Data Flows	:	Purchase Order (Customer), Invoice Form, and Standard Form.
Outbound Data Flows	:	Request Purchase Order (Material), Temporary Receipt Form, Check Standard Form, and Quotation Form.

Process Name	:	1.0 Production Planning and Scheduling System.
Description	:	The system will study about flow data. This study will look at more details than level 0 which will show wide view only.
Inbound Data Flows	:	Production Items, Invoice Form, Standard Form (No Change Formal), New Standard Form, and Reply Result.
Outbound Data Flows	:	Temporary Receipt Form, Production Order, Standard Production Items, Quotation Form, and Request Purchase Order (Material).

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Process Name	:	2.0 Check specific standard of Production.
Description	:	This section will check the order if it is standard or different from standard by comparing between new order with original standard.
Inbound Data Flows	:	Production Order and Product Standard.
Outbound Data Flows	:	Standard Form (No Change Formal) and Production Order Form (Change Formal).

Process Name	:	3.0 Design New Production (Change Formal).
Description	:	Technical Department will calculate time and design production for new standard.
Inbound Data Flows	:	Design New Product (Change Formal).
Outbound Data Flows	:	New Standard Form.

Process Name	:	4.0 Check Material in the Inventory.
Description	:	Checking materials availability for production. Because if there are not enough material, it may affect the production plan.
Inbound Data Flows	:	Standard Production Items and Material Data.
Outbound Data Flows	:	Reply Result.

Process Name	:	1.1 Job Details Record (New Job).
Description	:	In the first time, when receiving order, recording data must be done.
Inbound Data Flows	:	Production Form (Standard and: (Accounting/ Purchasing Department)), Production Form (Change Standard: Technical Department).
Outbound Data Flows	:	New Items (Production).

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Process Name	:	1.2 Set Production Priority.
Description	:	When receiving the new order, we need to set new schedule for the list of items of production.
Inbound Data Flows	:	New Items (Production), Production Priority Information (Original).
Outbound Data Flows	:	Production Priority Information (New Priority).

Process Name	:	1.3 Set Production Schedule.
Description	:	Scheduling will be considered by manpower in order to make decision.
Inbound Data Flows	:	Set Schedule and Show Report Status.
Outbound Data Flows	:	Schedule Information.

Process Name	:	1.4 Set Status of Employee per Day.
Description	:	Check status of employee who is present or absent for a decision of production planning.
Inbound Data Flows	:	Employee Information.
Outbound Data Flows	:	Employee Status.

Process Name	:	1.5 Production Scheduling Record.
Description	:	Recording from set scheduling.
Inbound Data Flows	:	Schedule Information.
Outbound Data Flows	:	Production Information.

Process Name	:	1.6 Production in Each Process.
Description	:	Details of each process.
Inbound Data Flows	:	Schedule Order for Sections.
Outbound Data Flows	:	Progressive Report.

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Process Name	:	1.7 Recording of the finished job in each process.
Description	:	Recording job when finishing process already.
Inbound Data Flows	:	New Items (Productions).
Outbound Data Flows	:	Recording, and New Details.

Process Name	:	1.8 Set Reports to Display Job Details.
Description	:	Display job specification.
Inbound Data Flows	:	Job Details.
Outbound Data Flows	:	Job Status Form.

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Data Dictionary – Data Flows

Process Name	:	Product Item.
Description	:	Order from customer need to be submitted to Accounting Department.
Composition	:	Cust_No + Cust_Name + Prod_Name + Number + Pattern + Status + Rec_Date + (Due Date).

Process Name	:	Purchase Order (Customer).
Description	:	Order from customer which Accounting Department sent to Production Planning and Scheduling Syetem.
Composition	:	Ord_No + Cust_No + Cust_Name + Prod_No + Prod_Name + Pattern + Status + Number + Rec_Date + (Due Date).

Process Name	:	Check Standard Form.
Description	:	Check purchase order from customer that order is the standard or is not standard by sending to technique department to check.
Composition	:	Prod_No + Prod_Name.

Process Name	:	Standard Form.
Description	:	Standard form of product.
Composition	:	Prod_No + Prod_Name + Status (standard or not standard).

Process Name	:	Quotation Form.
Description	:	Quotation Form sent to customer.
Composition	:	Cust_No + Cust_Name + Prod_No + Prod_Name + Number + Pattern + Status + Due date + Prices + staff responsibility.

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Process Name	:	Standard Form (From Technical Department).
Description	:	Standard information details for production.
Composition	:	Prod_No + Prod_Name + Prod_Size + Prod_Pic + Prod_Step + Proc_Time + Poc_Code + Poc_Tha + Poc_Eng + Mac_Code + Poc_Item + Prod_Day.

Process Name	:	Request Purchase Order (Material).
Description	:	Request Purchase Order (Material) from Production Planning and Scheduling System to Purchasing Department and sent to Vendor.
Composition	:	Depart_Code + Material_Code + Material_Name + Quality + Req_Date + Req_Material_Date + Staff_Name.

Process Name	:	Purchase Order (Material).
Description	:	Purchase Order (Material) from Vendor.
Composition	:	Purchase_No + Company_Name + Material_No + Material_Name + Description + Quantity + Req_Date + Req_Material_Date + Purchaser.

Process Name	:	Invoice Form.
Description	:	Invoice & Receipt.
Composition	:	Invoice_No + Sent_Date + Material_Code + Material_Name + Description + Quantity + Prices + Sender.

Process Name	:	Temporary Receipt Form.
Description	:	Temporary receipt form.
Composition	:	Receipt_No + Receipt_Date + Material_No + Material_Name + Description + Quantity + Prices + Sender.

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Process Name	:	Production Order.
Description	:	Production order from customer for standard product by submitted by Accounting/ Purchasing Department.
Composition	:	Prod_No + Prod_Name + Cust_No + Cust_Name + Number + (Due Date).

Process Name	:	Production Order Form (Change Formal).
Description	:	Production order form (Change Formal) submitted by Technical Department.
Composition	:	Prod_No + Prod_Name + Pattern + Status + Cust_No + Cust_Name + Number + (Due Date).

Process Name	:	Design New Product (Change Formal).
Description	:	Design new product (Change Formal).
Composition	:	Prod_Name + Prod_Detail + Prod_Route + Prod_Day + Mac_Code + Mac_Name + Start_Date + End_Date + Job_No (New).

Process Name	:	New Standard Form.
Description	:	New product information.
Composition	:	Prod_No + Prod_Name + Prod_Details + Prod_Route + Start_Date + End_Date + Mac_Code + Mac_Name + Prod_Day.

Process Name	:	Production Standard.
Description	:	Production standard.
Composition	:	Prod_No + Prod_Name + Prod_Details + Prod_Route + Start_Date + End_Date + Mac_Code + Mac_Name + Prod_Day.

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Process Name	:	Standard Production Items.
Description	:	Standard master form.
Composition	:	Prod_No + Prod_Name + Prod_Detail + Prod_Route + Start_Date + End_Date + Prod_Day + Mac_No + Mac_Name + Material_Code + Material_Name.

Process Name	:	Material Data.
Description	:	Material data.
Composition	:	Material_Code + Material_Name + Material_Detail + On_Stock.

Process Name	:	Reply Result.
Description	:	Information on materials in stock.
Composition	:	Material_Code + Material_Name + Material_Detail + On_Stock.

Process Name	:	Production Form (Standard/ Change Standard).
Description	:	Production form (submitted by Accounting or Technical Department).
Composition	:	Ord_No + Cust_No + Cust_Name + Prod_No + Prod_Name + Quanlity + Rec_Date + (Due Date).

Process Name	:	New Item (Production).
Description	:	Set priority of new production.
Composition	:	Job_No + Ord_No + Prod_No + Prod_Name + Quanlity + Rec_Date + (Due Date) + Cust_Name.

Process Name	:	Production Priority Information (Original).
Description	:	Old Job, which have been set priority aready.
Composition	:	Item + Job_No + Ord_No + Prod_No + Prod_Name + Start_Date + End_Date.

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Process Name	:	Production Priority Information (New Priority).
Description	:	New job which has been set priority already.
Composition	:	Item + Job_No + Ord_No + Prod_No + Prod_Name + Start_Date + End_Date.

Process Name	:	Set Schedule.
Description	:	Schedule setting for each job.
Composition	:	Job_No + Prod_No + Prod_Name + Prod_Start + Prod_End + Prod_Step.

Process Name	:	Employee Details.
Description	:	Employee information.
Composition	:	Emp_No + Emp_Name + Emp_Item + Emp_SurName + Mac_Code.

Process Name	:	Employee Status.
Description	:	Employee Status.
Composition	:	Absence + Presence.

Process Name	:	Schedule Information.
Description	:	Schedule Information.
Composition	:	Job_No + Ord_No + Poc_No + Poc_Tha + Poc_Eng + Mac_Code + Mac_Name + Detail + Prod_Start + Prod_End + Start_Date + End_Date + Due Date.

Process Name	:	Production Information.
Description	:	Production Information.
Composition	:	Job_No + Ord_No + Prod_No + Prod_Name + Poc_No + Prod_Step + Start_Date + End_Date + Fin_Date + Prod_Start + Prod_End + Cust_No.

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Process Name	:	Show Report Status.
Description	:	Employee Status.
Composition	:	Absence + Presence.

Process Name	:	Schedule Order for Sections.
Description	:	Production detail in each section.
Composition	:	Job_No + Ord_No + Prod_No + Prod_Name + Cust_No + Poc_No + Prod_Start + Prod_End + Start_Date + End_Date.

Process Name	:	Progressive Report.
Description	:	Progressive Report.
Composition	:	Job_No + Ord_No + Prod_No + Prod_Name + Cust_No + Cust_Name + Poc_No + Prod_Step + Start_Date + End_Date + Fin_Date.

Process Name	:	New Information (Production).
Description	:	New product information after changing data.
Composition	:	Job_No + Ord_No + Prod_No + Prod_Name + Poc_No + Prod_Step + Start_Date + End_Date + Prod_End + Cust_No.

Process Name	:	Recording.
Description	:	Recording progressive report for each process or finished job.
Composition	:	Job_No + Ord_No + Prod_No + Prod_Name + Poc_No + Prod_Step + Start_Date + End_Date + Fin_Date + Prod_Start + Prod_End + Cust_No.

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Process Name	:	New Details.
Description	:	New information of job after progress.
Composition	:	Job_No + Ord_No + Prod_No + Prod_Name + Poc_No + Prod_Step + Start_Date + End_Date + Fin_Date + Prod_Start + Prod_End + Cust_No.

Process Name	:	Job Details.
Description	:	Job Details.
Composition	:	Job_No + Ord_No + Prod_No + Prod_Name + Cust_No + Cust_Name + Rec_Date + Due Date + Poc_No + Start_Date + Fin_Date + Prod_Actual.

Process Name	:	Job Status Form.
Description	:	For printing report or displaying job status.
Composition	:	Job_No + Ord_No + Prod_No + Prod_Name + Cust_No + Cust_Name + Rec_Date + Due Date + Poc_Code + Prod_Start + Prod_End + Start_Date + Fin_Date + Prod_Actual.

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Data Dictionary – Data Stores

Process Name	:	Standard Product File.
Description	:	For keeping standard production in order to check product.
Composition	:	Prod_No + Prod_Name + Prod_Details + Prod_Route + Start_Date + End_Date + Mac_Code + Mac_Name + Prod_Day.

Process Name	:	Inventory Material Files.
Description	:	Check total materials in system to prepare for production.
Composition	:	Material_Code + Material_Name + Material_Detail + On_Stock.

Process Name	:	Product Files.
Description	:	For new product which Technical Department have a new design, then recorded in database.
Composition	:	Ord_No + Cust_No + Cust_Name + Prod_No + Prod_Name + Quanlity + Rec_Date + (Due Date).

Process Name	:	Production Priority Files.
Description	:	For updating data about setting job schedule.
Composition	:	Item + Job_No + Ord_No + Prod_No + Prod_Name + Start_Date + End_Date.

Process Name	:	Employee.
Description	:	Employee information.
Composition	:	Emp_No + Emp_Name + Emp_Item + Emp_SurName + Mac_Code.

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Process Name	:	Production Scheduling Forms.
Description	:	For keeping information of total jobs which will show all information about jobs.
Composition	:	Job_No + Ord_No + Prod_No + Prod_Name + Poc_Code + Prod_Step + Start_Date + End_Date + Prod_End + Cust_No.

Process Name	:	ManPower.
Description	:	Employee status of begin absent or present.
Composition	:	Absence + Presence.

Process Name	:	Progressive Files.
Description	:	This is a total progress report ofjobs.
Composition	:	Job_No + Ord_No + Prod_No + Prod_Name + Cust_No + Cust_Name + Poc_No + Prod_Step + Start_Date + End_Date + Fin_Date.

Process Name	:	Job Detail Files.
Description	:	To update files for show report.
Composition	:	Job_No + Ord_No + Prod_No + Prod_Name + Poc_No + Prod_Step + Start_Date + End_Date + Fin_Date + Prod_Start + Prod_End + Cust_No.

Process Name	:	User Authorization.
Description	:	User Authorization stores authorized data in order to manage data, which are to copy, to modify, delete data and authority to access each table.
Composition	:	UserID + UserName + UserPWD.

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APPENDIX B
DATABASE DETAILS

Table B.1: Employee

No	Field Name	Description	Data Type	Field Size	Primary Key
1	Emp_ID	Employee ID	Text	4	√
2	Emp_Item	Machine Item	Number	Integer	√
3	Emp_Name	Employee Name	Text	50	
4	Emp_SurName	Employee Surname	Text	50	
5	Mac_Code	Machine Code	Text	10	

Table B.2: Machine

No	Field Name	Description	Data Type	Field Size	Primary Key
1	Mac_Code	Machine Code	Text	10	√
2	Mac_Name	Machine Name	Text	20	
3	Quanlity	Quanlity of Machine	Number	Integer	
4	Detail	Detail of Machine	Text	50	

Table B.3: ManPower

No	Field Name	Description	Data Type	Field Size	Primary Key
1	Emp_ID	Employee ID	Text	4	√
2	Emp_Item	Employee Item	Number	Integer	√
3	Emp_Name	Employee Name	Text	50	
4	Emp_SurName	Employee Surname	Text	50	
5	Mac_Code	Machine Code	Text	10	
6	Status	Status of Employee	Yes/No	Yes/No	

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Table B.4: OrderD

No	Field Name	Description	Data Type	Field Size	Primary Key
1	Cust_No	Customer Number	Text	5	√
2	Job_No	Job Number	Text	4	√
3	Ord_No	Order Number	Text	5	√
4	Prod_No	Production Number	Text	12	√
5	Prod_step	Production Step	Number	Integer	√
6	Poc_Code	Process Code	Text	4	√
7	Prod_Route	Production Route	Text	10	
8	Prod_Time	Production Time	Number	Double	
9	Prod_Start	Production Start	Number	Double	
10	Prod_End	Production End	Number	Double	
11	Prod_Date	Production Date	Date/Time	Short Date	
12	End_Date	End Date	Date/Time	Short Date	
13	Fin_Date	Finish Date	Date/Time	Short Date	
14	Prod_Actual	Production Actual	Number	Double	

Table B.5: OrderH

No	Field Name	Description	Data Type	Field Size	Primary Key
1	Cust_No	Customer Number	Text	5	√
2	Job_No	Job Number	Text	4	√
3	Ord_No	Order Number	Text	5	√
4	Prod_No	Production Number	Text	12	√
5	Cust_name	Customer Name	Text	80	
6	Rec_Date	Receive Date	Date/Time	Short Date	
7	Patten	Patten of Job	Yes/No	Yes/No	
8	Status	Status of Job	Yes/No	Yes/No	
9	StartDate	Start Date	Date/Time	Short Date	
10	DueDate	Due Date	Date/Time	Short Date	
11	Prod_day	Production Day	Number	Long Integer	

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12	Finish_date	Finish Date	Date/Time	Short Date	

Table B.6: Process

No	Field Name	Description	Data Type	Field Size	Primary Key
1	Poc_Code	Process code	Text	4	√
2	Poc_Item	Process Item	Number	Integer	√
3	Poc_Tha	Process Thai Name	Text	50	
4	Poc_Eng	Process English Name	Text	50	
5	Mac_Code	Machine Code	Text	10	

Table B.7: ProductionD

No	Field Name	Description	Data Type	Field Size	Primary Key
1	Prod_No	Production Number	Text	12	√
2	Prod_Step	Production Step	Number	Integer	√
3	Poc_Code	Process Code	Text	4	√
4	Prod_Route	Production Route	Text	10	
5	Prod_Time	Production Time	Number	Double	
6	Prod_Start	Production Start	Number	Double	
7	Prod_End	Production End	Number	Double	

Table B.8: UserLogin

No	Field Name	Description	Data Type	Field Size	Primary Key
1	UserID	User For Logging	Text	5	√
2	UserName	User Name	Text	50	
3	UserPWD	User Password	Text	5	
4	FrmTrnM	Menu Transaction	Yes/ No	Yes/ No	
5	FrmPrnM	Menu Report	Yes/ No	Yes/ No	
6	FrmConfigM	Menu Configuration	Yes/ No	Yes/ No	
7	FrmPwdM	Sub Menu Password and Security	Yes/ No	Yes/ No	

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Table B.9: ProductionH

No	Field Name	Description	Data Type	Field Size	Primary Key
1	Prod_No	Production Number	Text	12	√
2	Prod_Name	Production Step	Text	50	
3	Prod_Size	Production Size	Number	Double	
4	Prod_Pic	Production Picture	Text	50	
5	Prod_Day	Production Day	Number	Long Integer	

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APPENDIX C
USER INTERFACE

The Program:

When entering the program, system will show two menus which are the menu Login and the menu Exit. Figure C.1

Figure C.1 Log In. (1)

When clicking menu Login the screen will display. Figure C.2

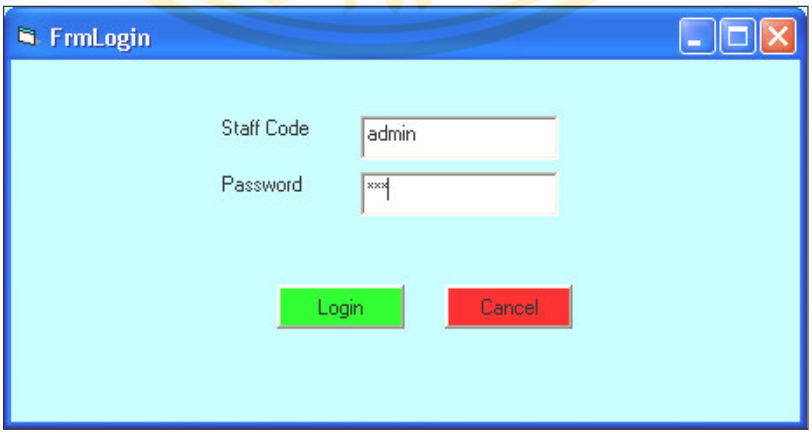

Figure C.2 Log in. (2)

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In the first time, authorized user doesn't have to put username and password. User can login immediately. After logging in to program, the user can set password and security at menu Configuration in part of submenu Set Password and Security which will described in Menu Configuration.

After Login into the system, user will find five main menus Figure C.3

- Menu Login.
- Menu Transaction.
- Menu Gantt chart and Report.
- Menu Configuration.
- Menu Exit.

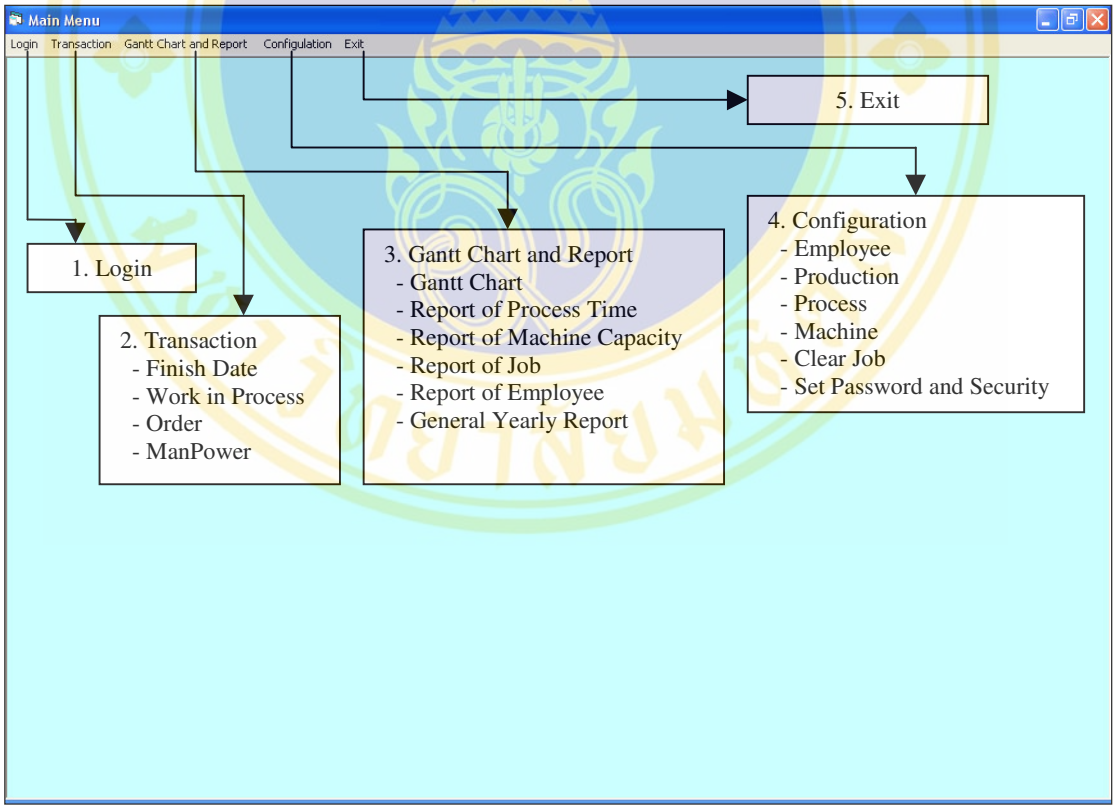

Figure C.3 Main Menu.

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1 Menu Login:

Menu Login will be similar to the first one on this program.

2. Menu Transaction:

Menu Transaction will be composed of four submenus which are:

- Submenu Finish Date.
- Submenu Work in Process.
- Submenu Order.
- Submenu Manpower.

Submenu Finish Date: "Finish Date" is to record the date when the job has already finished all the process which will help design report about incorrect plan with real finishing date. For this data will be considered in order to improve performance in the future. Figure C.4

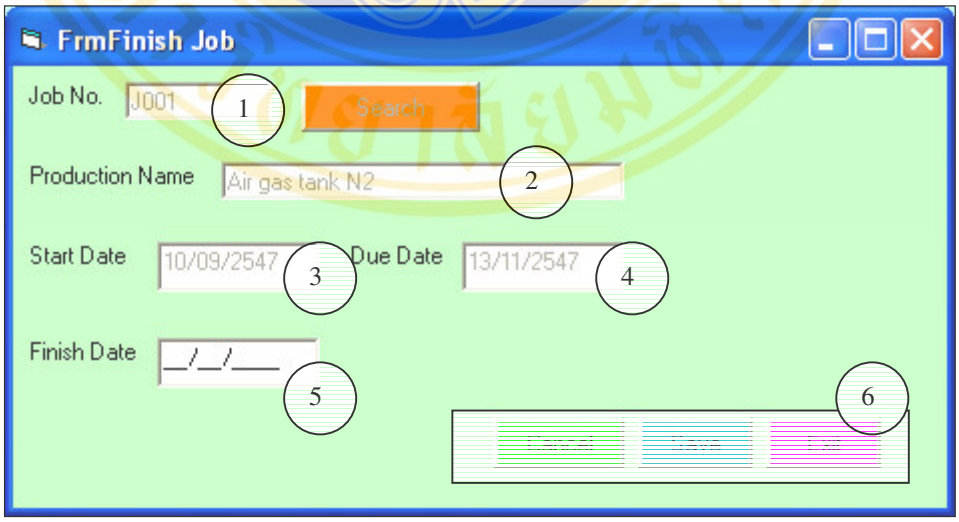

Figure C.4 Submenu Finish.

Number 1 Input Job No. of job which will input Finish Date.

Number 2-4 Program will show automatically according to Job No.

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Number 5 For input Finish Date.

Number 6 General Function.

Submenu Work in Process: "Work in Process" is the menu for recording time change in each process so that user knows how to change the start date. Figure C.5

Figure C.5 Submenu Work in Process. (1)

Number 1 Input Job No in order to input finishes each of process.

Number 2-4 The system will show automatically.

Number 5 Usually it will not show Finish Date of job if user does not input Finish Job in submenu Finish Job. But if user input finish job already, this menu will not change or modify End date of each process. Figure C.6

Number 6-7 The system will show automatically.

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Figure C.6 Submenu Work in Process. (2)

Number 8 Production process: this section will show step of processes of one job. When moving scrollbar down, user will find that column of Fin Date have a space for input date (Number 10). User can double click in white block and will found that in part of Finish Date this Process pop up (Number 11). This section, user can determine finishing date of each process by the system will calculate missing time from plan.

Number 9 General Function.

Submenu Order: "Order" is a submenu for receiving order in the first time. Order will be input in the program in order to set priority for production. Figure C.7

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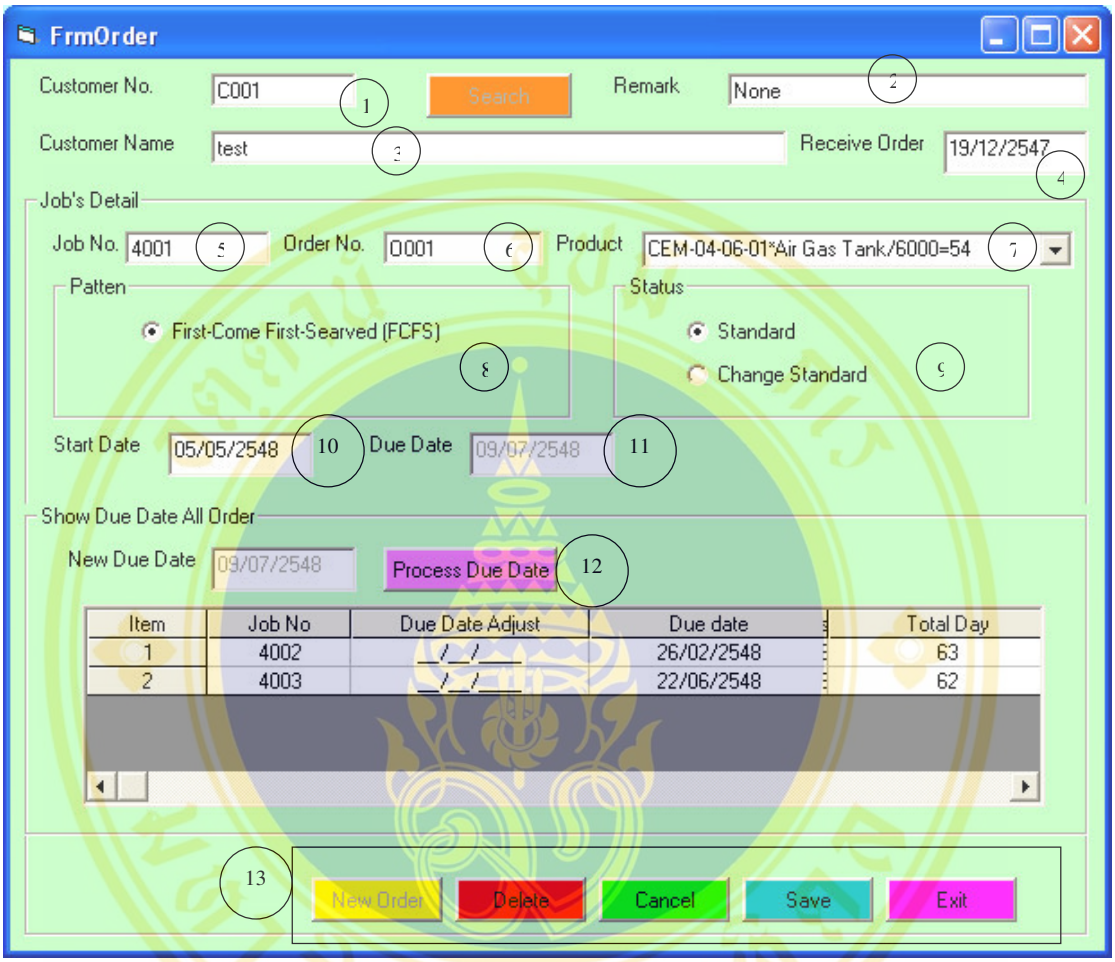

Figure C.7 Submenu Order.

Number 1 Input Customer No.

Number 2 Input remark manually or show automatically.

Number 3 Input Customer Name.

Number 4 Input Receive Order.

Number 5 Input Job No.

Number 6 Input Order No.

Number 7 Select Type Production.

Number 8 Select Pattern.

Number 9 Select Status that what user wants such as standard or not standard.

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Number 10 Usually, if Number 8 select First Come First Served Pattern and Number 9 select Standard, display in Number 10 will show start date automatically. But if Number 8 and Number 9 select different pattern, in Number 10, user must input start date manually then enter, this program will show due date in Number 11 by automatically.

Number 11 This part will show according Number 10 from timing after of start date. If input filled in Number 10 is incorrect, this program will warn such as when input start date after the present day. If customer wants to control the due date, user need to estimate start date in Number 10.Afer estimations the start date, the due date will be correct according to customer' s correction.

Number 12 When Click Process Due Date button, if new due date which user inputs have priority more than old due date the system will preemptive automatic.

Number 13 General Function.

However, in number 1 if input customer which had already, the system will show information of customer that have amount of order. Figure C.8

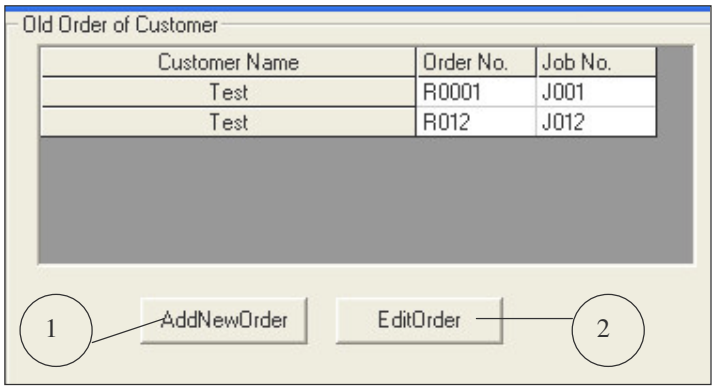

Figure C.8 Show information old order of customer.

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From picture, if old customer wants a new order or to edit order, user can modify as number 1: “AddNewOrder” or number 2: “EditOrder”.

And sometimes new job has occurred duplicate. So before user will save it, the system will show information of jobs, processes, and machines which it will be duplicated between old jobs and new job. If user can accept, user can click save as shown in Figure C.9.

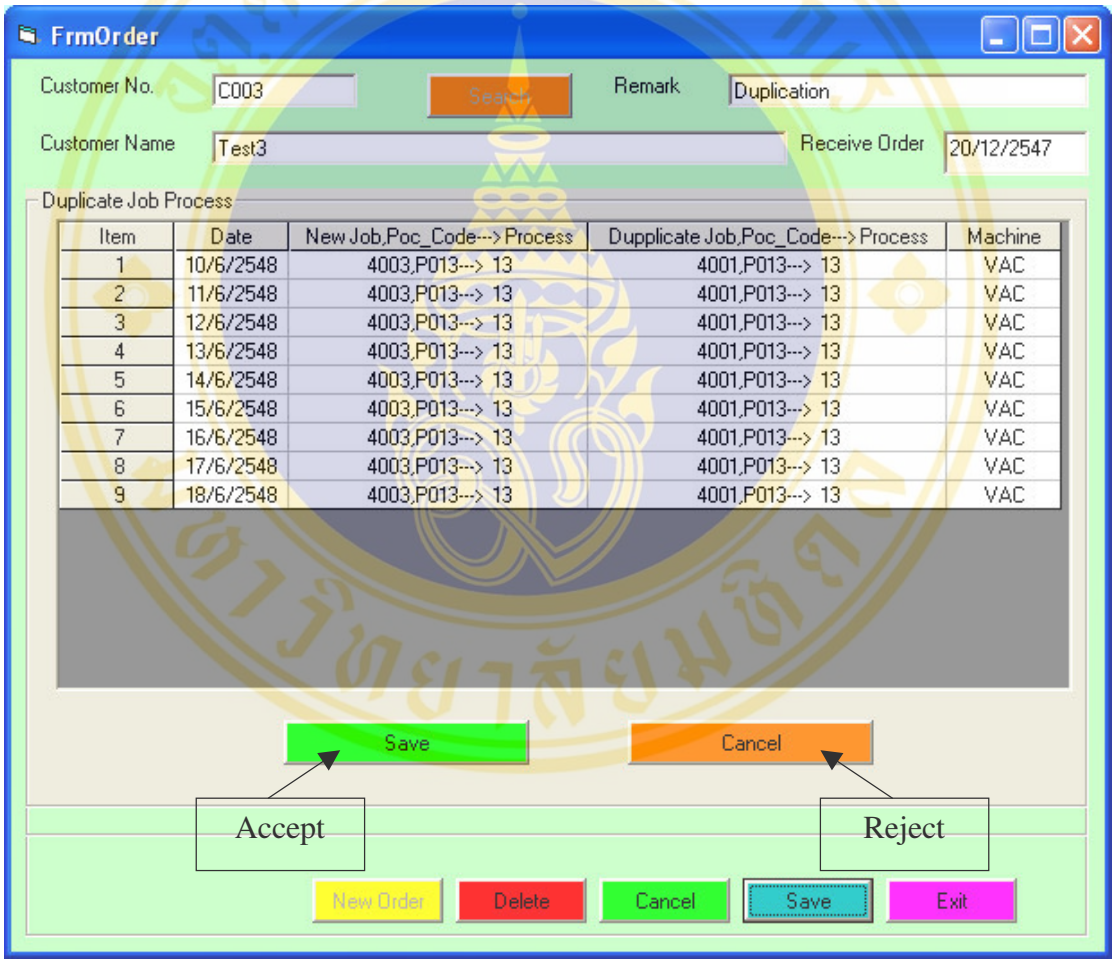

Figure C.9 Show information of duplicate job.

If user click save, new job will be saved in database and will show duplicate in Gantt chart for point of problems with black color. On the other hand, if user click cancel, the system will reject new job and not save it.

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Submenu ManPower: "ManPower" is information showing status of employee working in each day. Figure C.10

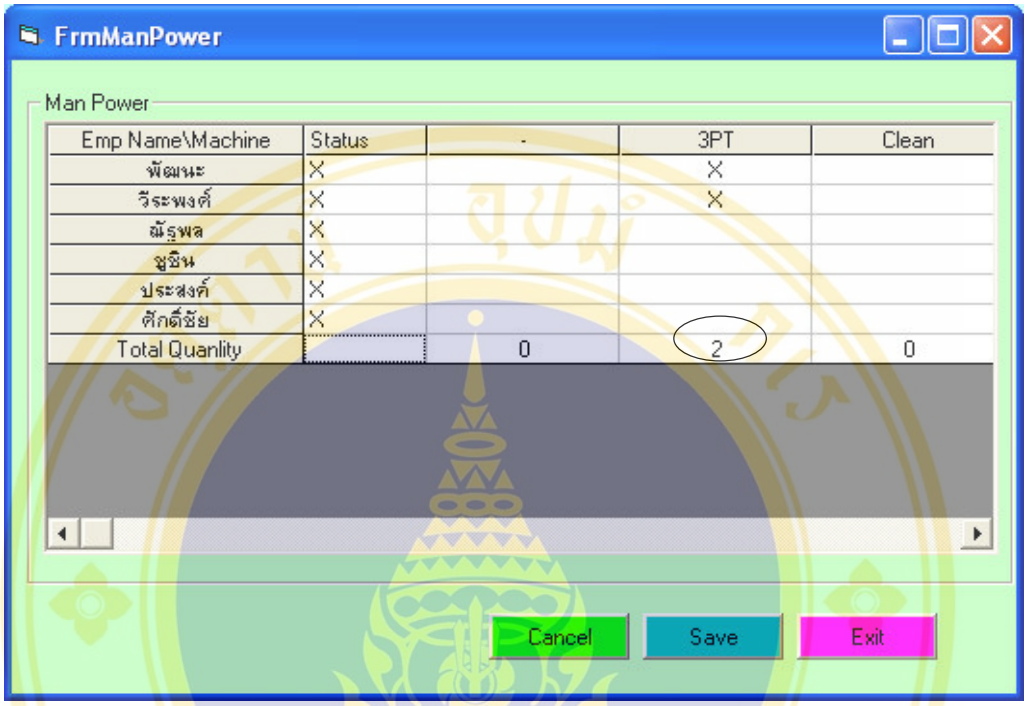

Figure C.10 Submenu Manpower. (1)

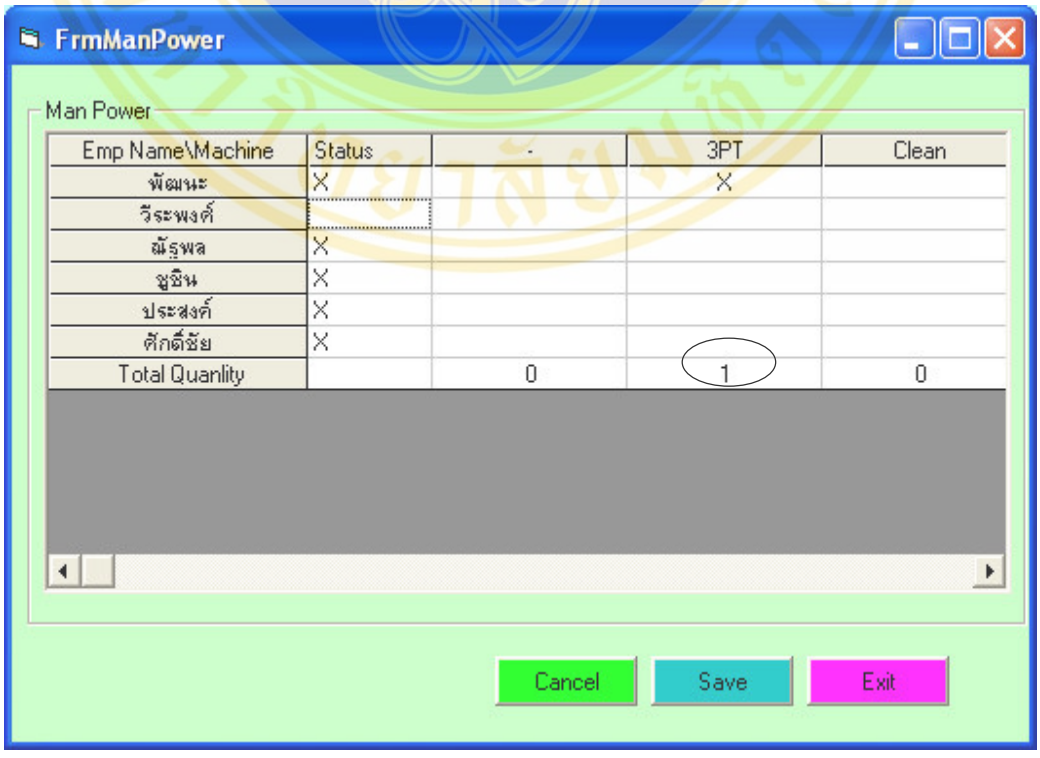

Figure C.11 Submenu Manpower. (2)

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Figure C.10 and C.11 compare between work of employee. In the figure, we will see that each employee will be determined a performance each day (Figure C.10), If any employee is absent, status will be changed by clicking status of employee. When status is modified, quantity of machines will be changed. In Figure C.10, if employee EMP! is absent, in Figure C.11 will be found quantity of Clean machine will stand 1 only which this data will be considered for production.

3) Menu Gantt Chart and Report:

This menu is to display various reports which can be divided to:

- Gantt chart.
- Report of Process Time.
- Report of Machine Capacity.
- Report of Job.
- Report of Employee.
- General Yearly Report.

Submenu Gantt Chart: "Gantt chart" is to display of total jobs in the system that which job in which process and during what time. Each job will be allocated color clearly and at top of the report will show dates which include Sunday so that user know that this is a holiday of a week which will be easy for setting scheduling. Moreover, for duplicated sections, this Gantt chart will show black color in order to notice easily. Figure C.12

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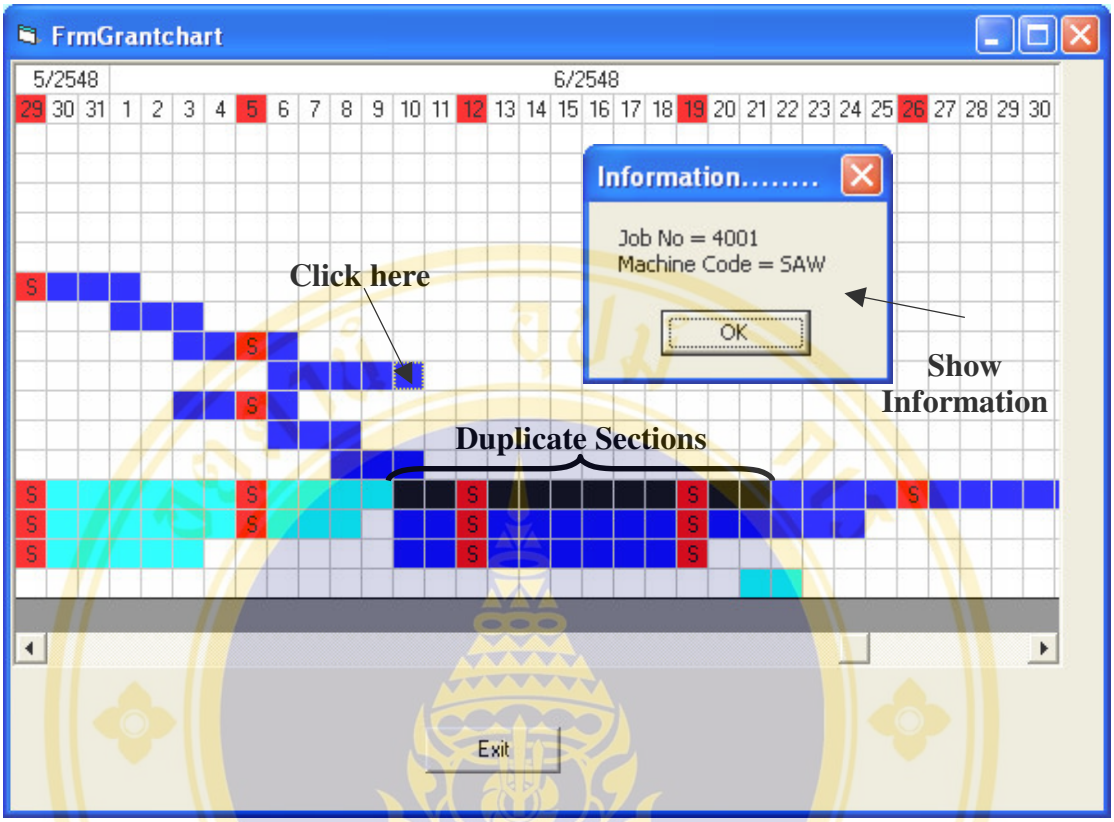

Figure C.12 Submenu Gantt chart.

In the picture, if right mouse is clicked at one color, a message box will pop up showing information of job which is job number and machine code.

Submenu Report of Process Time: "Report of Process Time" is to display result. Report will show process name and timing of production of each product size. Moreover, this display can specify the amount size in the report. Figure C.13

Figure C.13 Submenu Process & Time

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Form figure C.13 product size of 4,000 liter in year 2002 and of 2,000 liter in year 2004 will be shown. After clicking print button, the system will display report of fix sized product during time of production. Figure C.14 is an example of report of process & time.

Process & Time

	PROCESS	MACHINE	UNIT TIME	
			CEM-02-04-01	CEM-04-02-01
1	inner vessl nozzle welding	TIG	5.0	4.0
2	inner vessel welding	SAW	2.0	2.0
3	X-ray	SAW	1.5	4.0
4	inner vessel cleaning	clean	.0	8.0
5	inner vessel close	SAW	.0	4.0
6	x-ray #2	SAW	.0	2.0
7	pipe & leg	FCAW	.0	8.0
8	outer vessel dish /leg	VAC	.0	8.0
9	outer vessel welding	SAW	.0	4.0

Figure C.14 Example Report: Submenu Process & Time**.**

Submenu Report of Machine Capacity: "Report of Machine Capacity" is the menu for result details of machine in the system what the quantity of machine and machine name are. Clicking this submenu will show report as. Figure C.15

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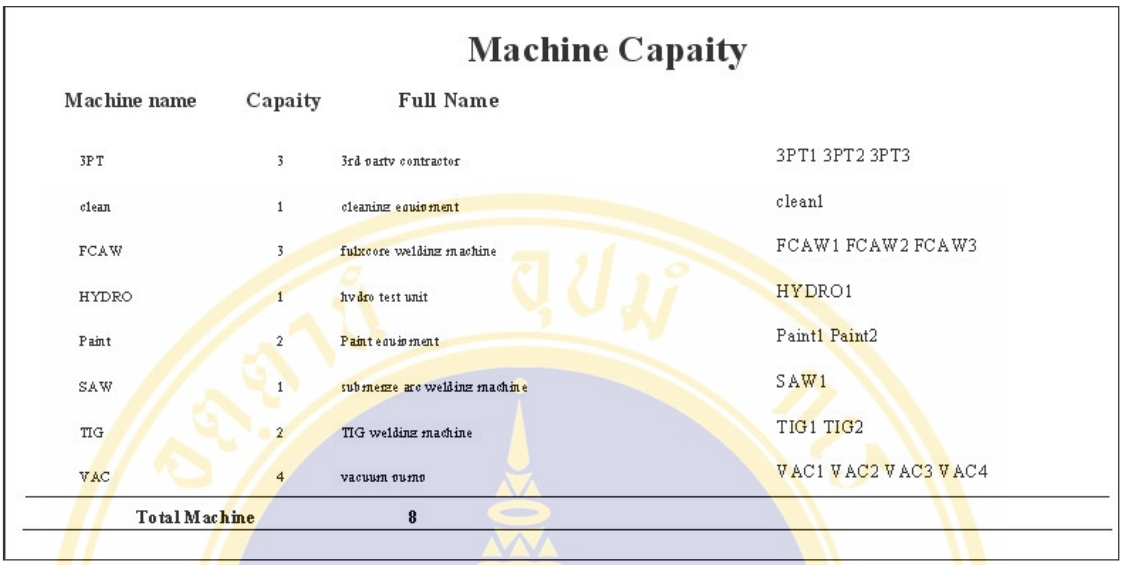

Machine Capaity

Machine name	Capaity	Full Name	
3PT	3	3rd party contractor	3PT1 3PT2 3PT3
clean	1	cleaning equipment	clean1
FCAW	3	fulxcore welding machine	FCAW1 FCAW2 FCAW3
HYDRO	1	hydro test unit	HYDRO1
Paint	2	Paint equipment	Paint1 Paint2
SAW	1	submerge arc welding machine	SAW1
TIG	2	TIG welding machine	TIG1 TIG2
VAC	4	vacuum pump	VAC1 VAC2 VAC3 VAC4
Total Machine	8		

Figure C.15 Example Report: Submenu Report of Machine Capacity**.**

Submenu Report of Job: 'Report of Job" is to show details of job when user wants to know how many processes, what processes, or the finishing process of that job. Figure C.16 shows the display of submenu report of job.

Figure C.16 Submenu Report of Job**.**

From example, if user wants the system to show data of job No. 001 after input data already, clicking print button will show figure C.17

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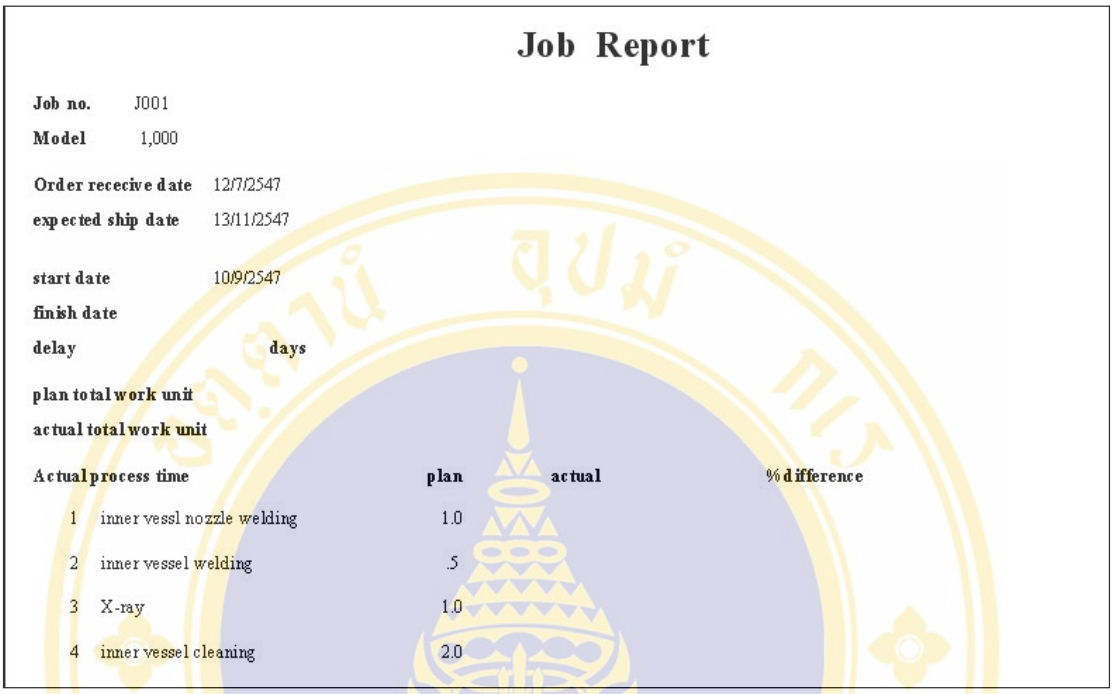


Job Report

Job no. J001
Model 1,000

Order rececive date 12/7/2547
expected ship date 13/11/2547

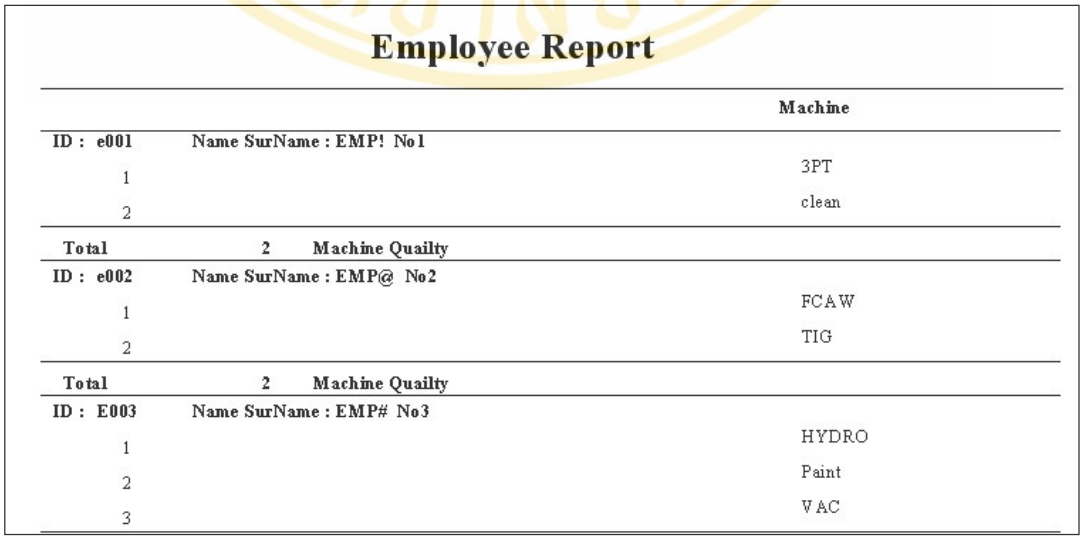
start date 10/9/2547
finish date
delay **days**

plan total work unit
actual total work unit

Actual process time		**plan**	**actual**	**% difference**
1	inner vessl nozzle welding	1.0		
2	inner vessel welding	.5		
3	X-ray	1.0		
4	inner vessel cleaning	2.0		

Figure C.17 Example Report: Submenu Report of Job**.**

Submenu Report of Employee: "Report of Employee" is the menu for checking employee information to see how each employee can use machine capacities. Figure C.18



Employee Report

		Machine
ID : e001	**Name SurName : EMP! No1**	
1		3PT
2		clean
Total	**2 Machine Quailty**	
ID : e002	**Name SurName : EMP@ No2**	
1		FCAW
2		TIG
Total	**2 Machine Quailty**	
ID : E003	**Name SurName : EMP# No3**	
1		HYDRO
2		Paint
3		VAC

Figure C.18 Example Report: Submenu Report of Employee**.**

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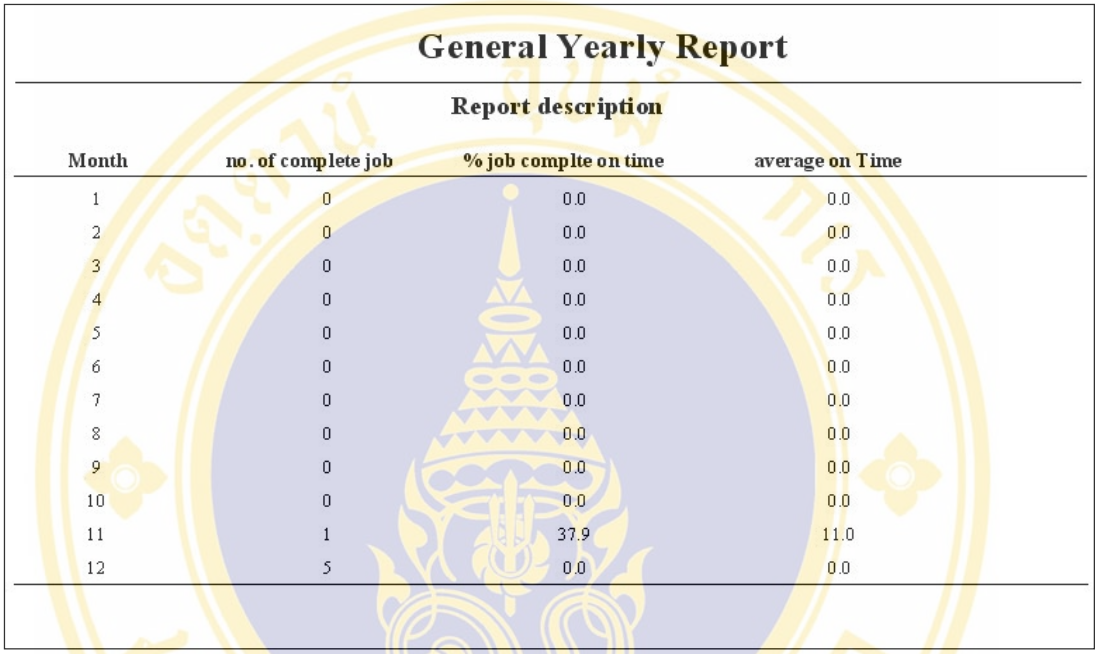
Submenu General Yearly Report: "General Yearly Report" is the report menu for summary monthly report by how the performance is. Example report is shown in Figure C.19



General Yearly Report

Report description

Month	no. of complete job	% job complte on time	average on Time
1	0	0.0	0.0
2	0	0.0	0.0
3	0	0.0	0.0
4	0	0.0	0.0
5	0	0.0	0.0
6	0	0.0	0.0
7	0	0.0	0.0
8	0	0.0	0.0
9	0	0.0	0.0
10	0	0.0	0.0
11	1	37.9	11.0
12	5	0.0	0.0

Figure C.19 Example Report**:** Submenu General Yearly Report**.**

4) Menu Configuration:

This is the main menu and heart of this system because using this program need to set other properties in this menu. Configuration menu will be changed less than other main menus, is which composed by the following submenu:

- Employee
- Production
- Process
- Machines
- Clear Job
- Set Password and Security

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Submenu Employee: "Employee" is the menu for setting function of basic each employee who uses which machine. This will have an impact to management of ManPower. Figurer C.20

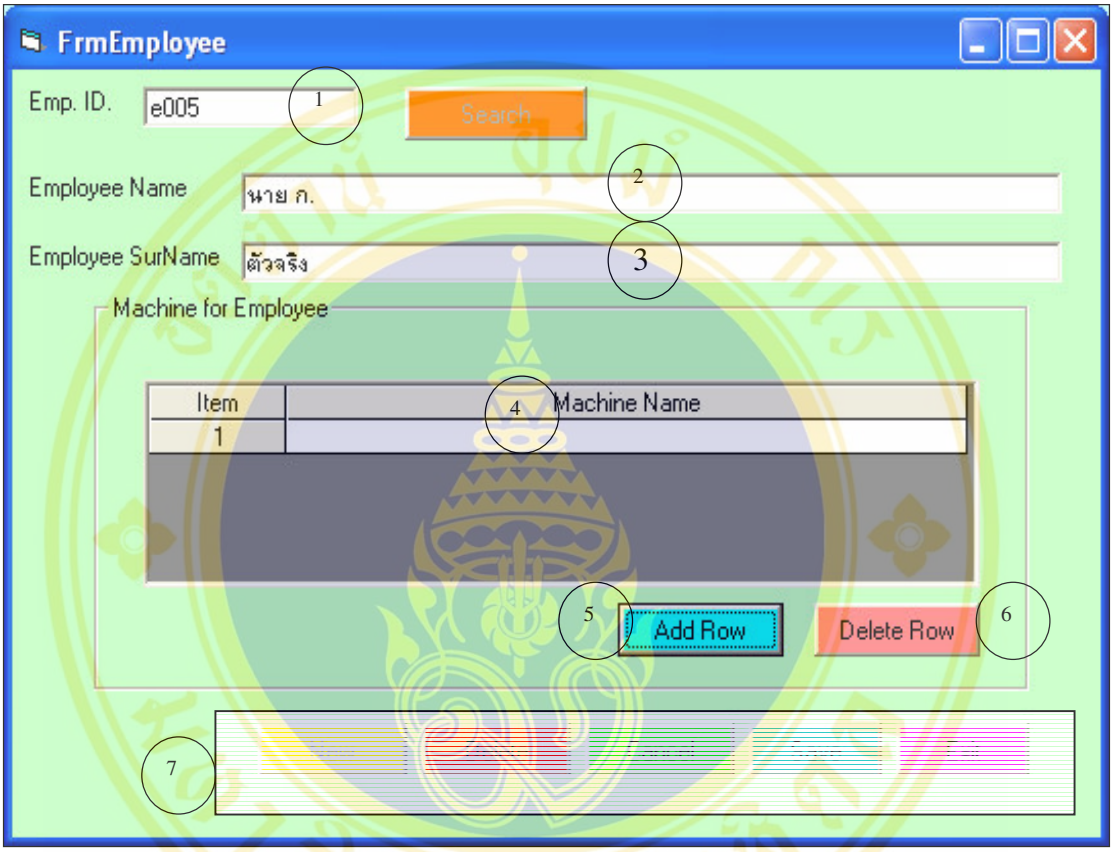

Figure C.20 Submenu Employee. (1)

When the program shows employee menu; user needs to input the following:

Number 1: Input Employee number and click Search in order to check the employee code.

Number 2: Input Employee name.

Number 3: Input Surname.

Number4: Internal fill which will appear after click "Add Row" (Number 5) and if user wants to delete row, user can click "Delete Row" button (Number 6), then the row is

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up. User can double click as white fill, it will show figure C.21

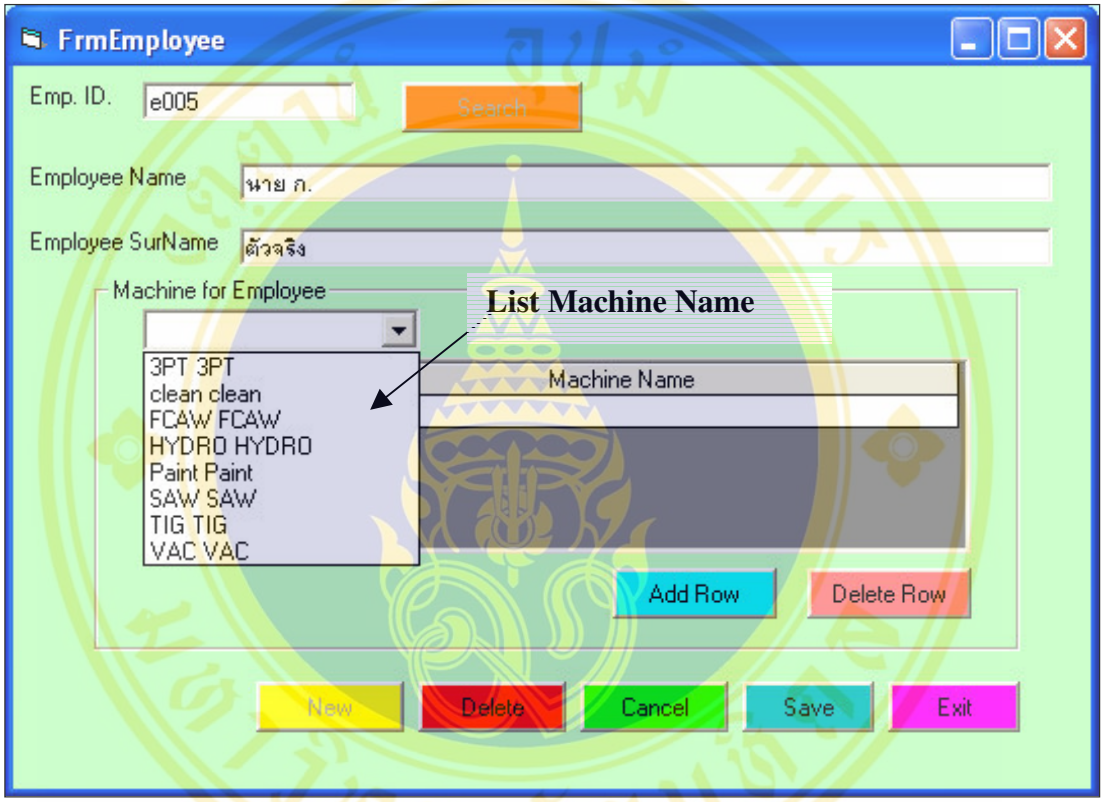

Figure C.21 Submenu Employee. (2)

Form figure C.21, if user double click mouse at white row, the total machine names will appear, user can select form this list. However, data in list will show only when user has already added machine names as submenu Machine.

Number 7: General function.

Submenu Production: "Production" is the menu for setting beginning in properties standard of product. Figure C.22

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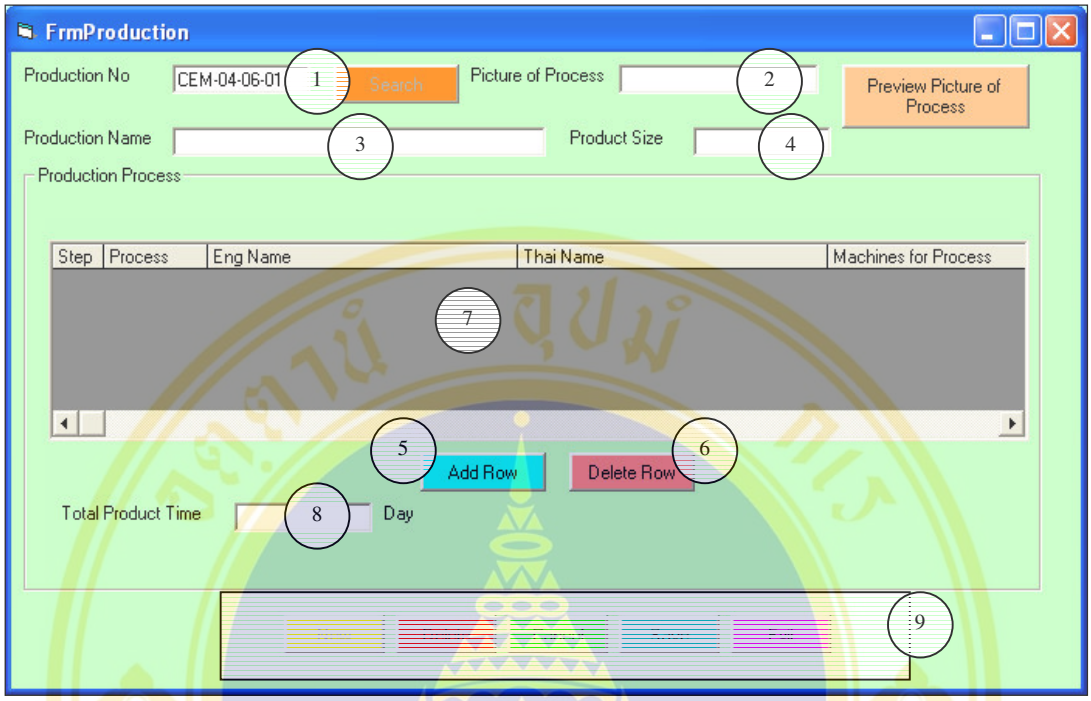

Figure C.22 Submenu Production. (1)

When the program shows a production menu, first thing which user will make.

Number 1: Input Production number.

Number 2: Input picture for showing standard of product (Fix).

Number 3: Production name.

Number 4: Product size.

Number 5: Click button in order to create a row for input steps of processes.

Number 6: Delete Row.

Number 7: This button will be related to Number 5. When clicking Number 5, this section will show a row (Figure C.23). After the row appears, user can double click at white part to fill in processes. The program will show process names in order to select as in figure C.24. Process names are from the set properties in submenu process in configuration menu.

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Number 8: Total time of production.

Number 9: General Function.

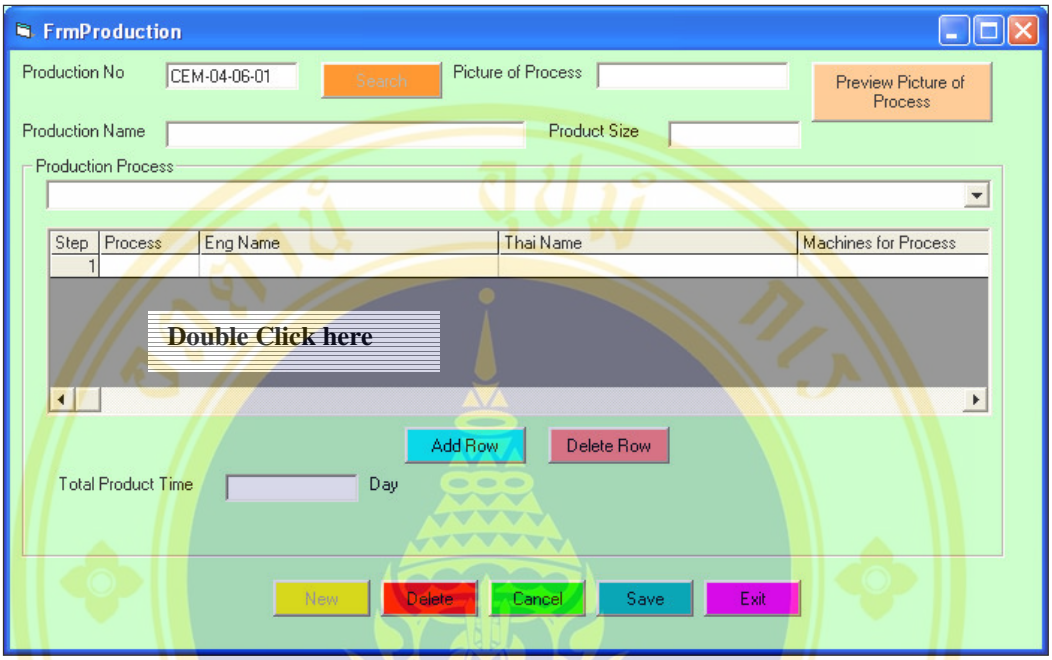

Figure C.23 Submenu Production. (2)

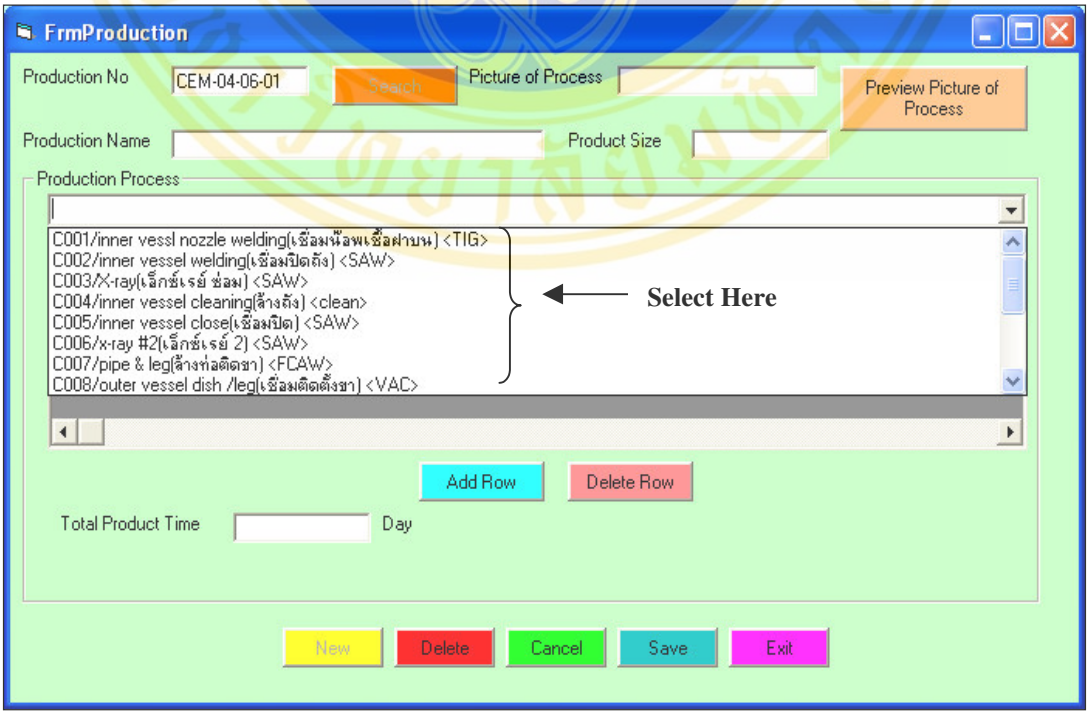

Figure C.24 Submenu Production. (3)

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Submenu Process: "Process" is the menu for setting standard of performance in part of processes which show process name and timing of each process. Moreover, this menu can list the machine names in each used production process. Figure C.25

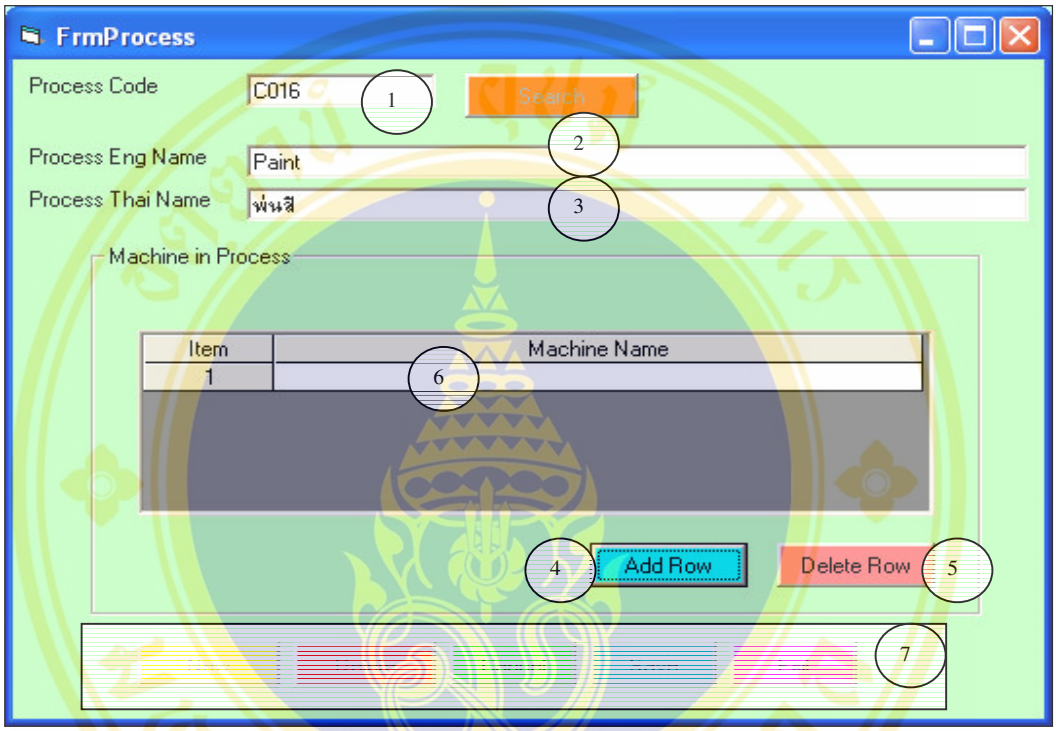

Figure C.25 Submenu Process. (1)

Start using:

Number 1: Input process code and click search in order to find if this process code exists or not.

Number 2: Input English process name.

Number 3: Input Thai process name.

Number 4: Click "Add Row" button to show row M achine in Process which needs input of machine name used in the process.

Number 5: Delete Row.

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Number 6: This is a table for input data of machine by double click in white fill of machine name. After clicking, the process names will appear for choosing. Figure B.26

Number 7: General Function.

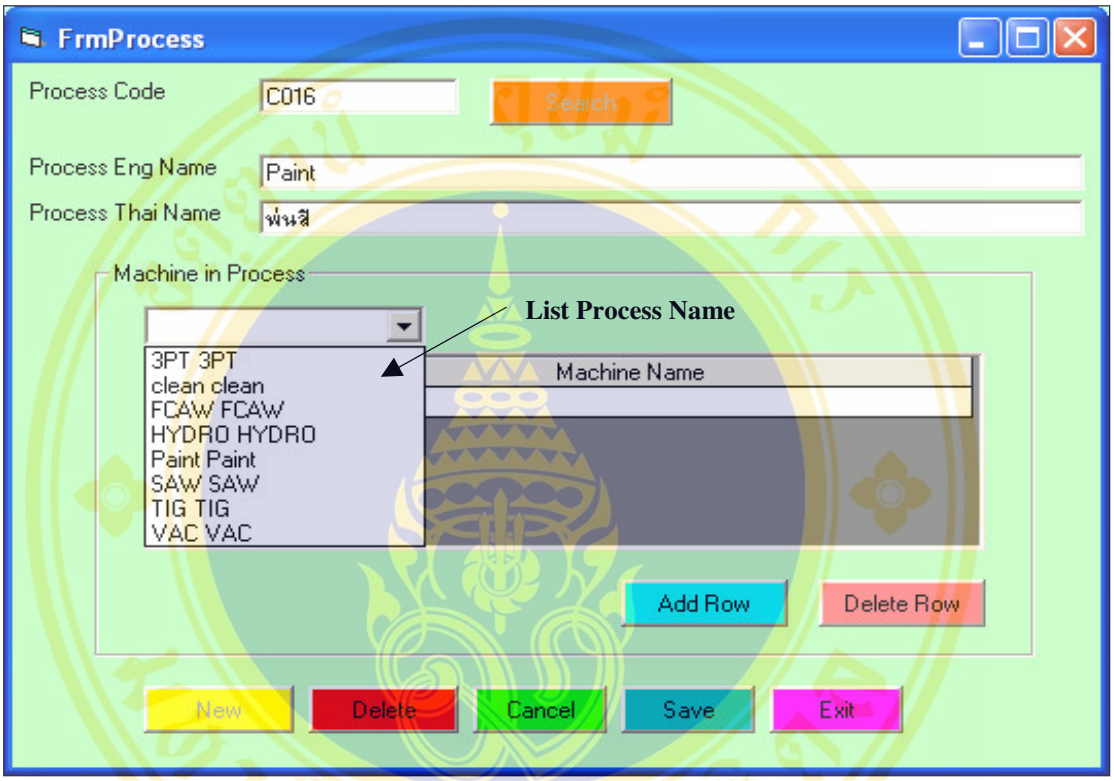

Figure C.26 Submenu Process. (2)

Submenu Machine: "Machine" submenu is for setting machines at the beginning of system. User can specify the details, machine name, quantity, etc., in this submenu and user can also change, delete, add, or modify data. Figure C.27

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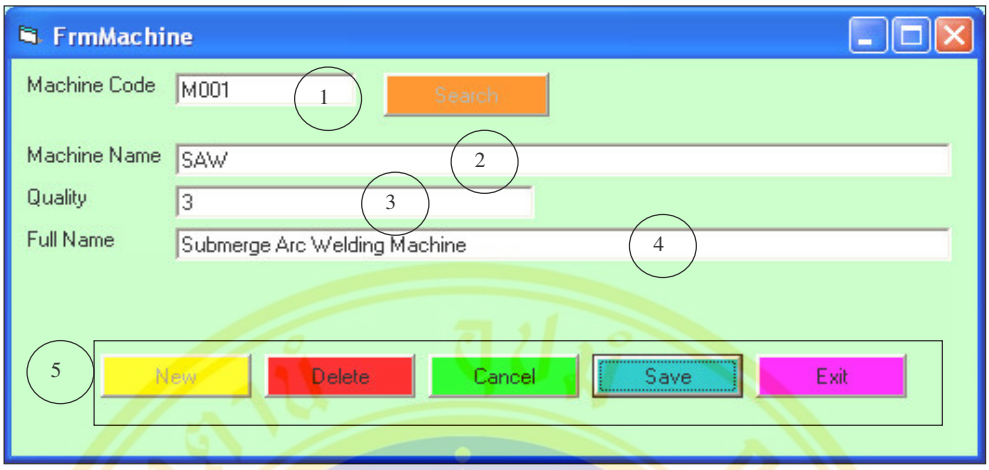

Figure C.27 Submenu Machine.

Start using:

Number 1: Input machine code.

Number 2: Input machine name.

Number 3: Quality of machine.

Number 4: Full machine name.

Number 5: General function.

Submenu Clear Job: "Clear Job" is the menu for clearing job in system. If any information has been saved during job implementing, after finishing, user should clear out from the system in order to decrease space in hard disk and help system process quickly and have more space for processing. Figure C.28

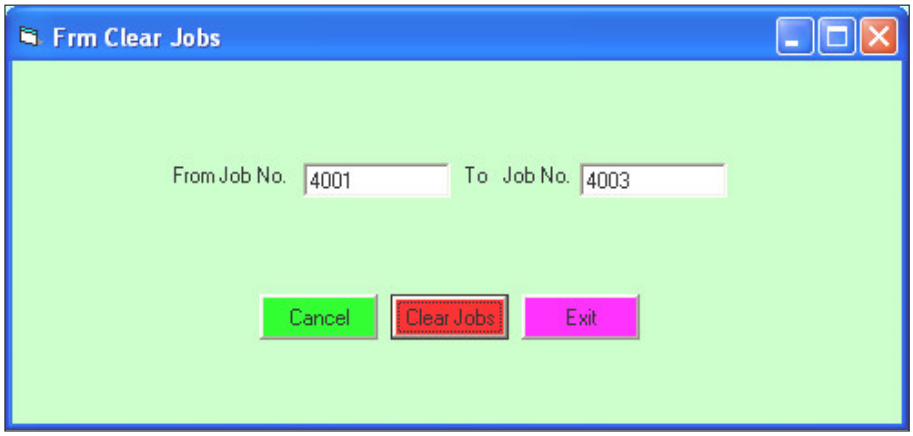

Figure C.28 Submenu Clear Job.

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Submenu Set Password and Security: ‘Set Password and Security” is important for privileging any employees who can access into the system. .To starts using for the first time; user can not log on into the system. User needs to set password and security in submenu menu configuration first to access next time. Figure C.29

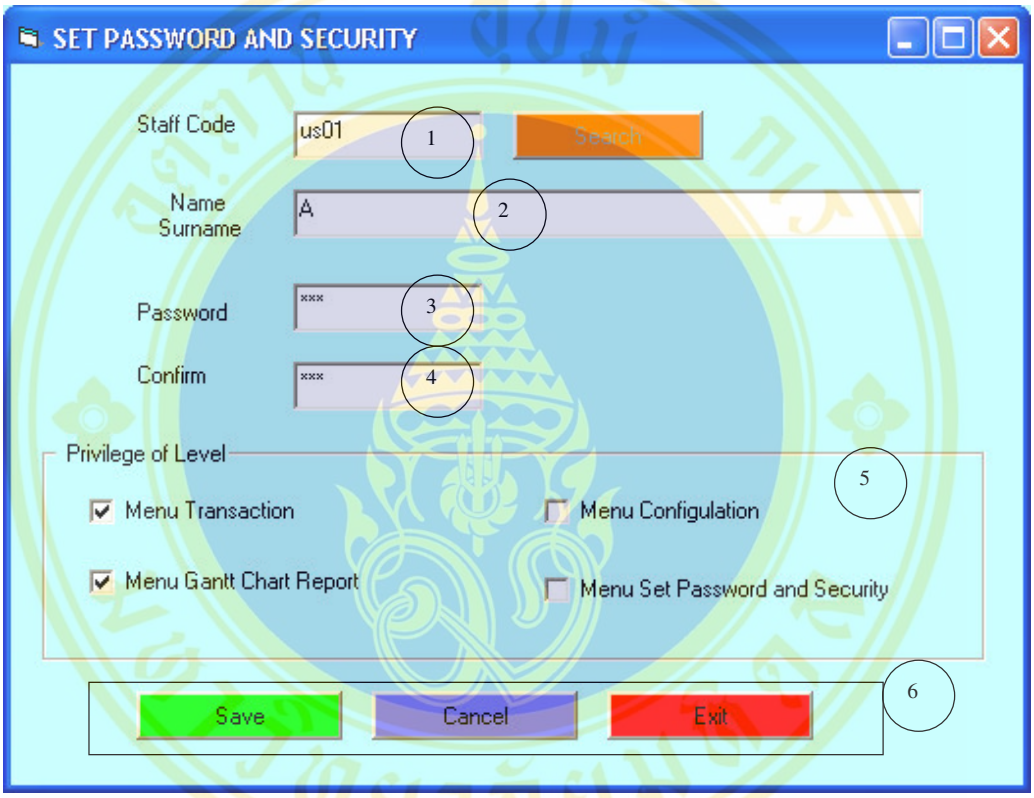

Figure C.29 Submenu Set Password and Security.

Start using:

Number 1: Input employee number.

Number 2: Input employee name.

Number 3: Input password.

Number 4: Input confirmed password again.

Number 5: Control privilege of user for accessing all main menu except set password and security.

5) Menu Exit

Exit program.

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