AN ANALYSIS OF A BUSINESS PROCESS IN AN INFORMATION MANAGEMENT SYSTEM FOR PRODUCTION PLANNING: A CASE STUDY OF A METAL PRODUCTS MANUFACTURER

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ABSTRACT

This research studied, analyzed, designed, and developed an information system for production planning using a case study of a metal packaging production factory to reduce the procedures and time required to plan and arrange a production schedule, and to make a production plan more effective. The research began by studying the overall business process and flow of information by using IDEF0 Diagram and the Swim Lane Diagram business flowchart. Then, analysis was performed to investigate the cause of ineffective implementation. This research, therefore, focused on solving these problems by using a Data Flow Diagram and an E-R Model as the tools used in designing the new system. The tools used for developing the system were Visual Basic 2005 and Microsoft SQL Server 2005.

From the results of using this information system for the actual planning of production, it was found that the system supported internal communication among departments. The production planning department was able to adjust production planning based on the situation effectively, conveniently, and quickly. This system also helped to reduce the procedures and time used for planning the production. According to the investigation, when comparing product information input of the original system and the newly developed system, the original system took 13.30 minutes, but the new developed system took 9.60 minutes, which was a reduction of 3.7 minutes or equal to 27.32%. In addition, when comparing time spent on calculating production between the original system and the newly developed system, the original system spent 21.1 minutes, but the new system spent 2 minutes, which was a reduction of 20.1 minutes, or equal to 90.95%.

KEY WORDS: BUSINESS PROCESS / PRODUCTION PLANNING / SCHEDULING / INFORMATION MANAGEMENT SYSTEM

116 pages

การวิเคราะห์กระบวนการทางธุรกิจเพื่อจัดการระบบสารสนเทศสำหรับวางแผนการผลิต
กรณีศึกษา โรงงานผลิตบรรจุภัณฑ์โลหะ
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บทคัดย่อ

งานวิจัยนี้ได้ศึกษา วิเคราะห์ ออกแบบ และพัฒนาระบบสารสนเทศสำหรับการวางแผนการผลิตกรณีศึกษา โรงงานผลิตบรรจุภัณฑ์โลหะ เพื่อลดขั้นตอนและเวลาที่ใช้ในการวางแผนและจัดตารางการผลิต และปรับปรุงแผนการผลิตให้มีประสิทธิภาพยิ่งขึ้น ซึ่งการวิจัยเริ่มจากการศึกษาภาพรวมของกระบวนการทางธุรกิจ และการไหลของสารสนเทศโดยใช้แผนภาพกระบวนการธุรกิจ IDEF0 Diagram และ Swim Lane Diagram จากนั้นได้วิเคราะห์หาสาเหตุที่ทำให้การดำเนินงานไม่มีประสิทธิภาพ และมุ่งเน้นแก้ปัญหาดังกล่าว โดยใช้ Data Flow Diagram และ E-R Model เป็นเครื่องมือในการออกแบบระบบใหม่ และเครื่องมือที่นำมาใช้ในการพัฒนาระบบ คือ Visual Basic 2005 และ Microsoft SQL Server 2005

ผลจากการใช้ระบบสารสนเทศสำหรับวางแผนการผลิต พบว่าระบบที่ได้จะรองรับกับการสื่อสารภายในระหว่างฝ่ายต่าง ๆ ที่เกี่ยวข้อง ฝ่ายวางแผนการผลิตสามารถปรับแผนได้ทันกับสถานการณ์ ได้อย่างมีประสิทธิภาพ สะดวก และรวดเร็วยิ่งขึ้น และระบบที่ได้นี้ จะช่วยลดขั้นตอนและเวลาที่ใช้ในการวางแผนการผลิตลงได้ ซึ่งจากการทดสอบและเปรียบเทียบการป้อนข้อมูลสินค้าของระบบเดิมกับระบบที่พัฒนานั้น พบว่า ระบบเดิมใช้เวลา 13.30 นาที ระบบที่พัฒนาใช้เวลา 9.60 นาที ลดลง 3.7 นาที คิดเป็นร้อยละ 27.32% ส่วนการทดสอบและเปรียบเทียบการคำนวณเวลาที่ใช้ในการผลิตของระบบเดิมและระบบที่พัฒนานั้น พบว่า ระบบเดิมใช้เวลา คำนวณ 21.1 นาที ระบบที่พัฒนาใช้เวลา 2 นาที ลดลง 20.1 นาที คิดเป็นร้อยละ 90.95%

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CHAPTER I
INTRODUCTION

1.1 Background and Problems statement

In the productive process of a factory, it is necessary to have a productive planning for each working unit to work consistently. Appropriating productive time resulting from a good production planning is one of many processes in de-capitalizing which can make a factory capable of competing in the market to meet the need of clients. The case study over a metal container manufacturing plant revealed its production to meet the product delivery schedule and the quality requirements. Production plan and table arrangement accordingly is necessary to reach the main operating target. However, the current diversified demands and a wide range of products have made the manufacturing process complex and unfortunately inefficient production table. In addition, collecting of important data for priority of production stages has been needed, not to mention that some portions of the data have not been made in writing, causing production errors. The production planning department sometimes cannot adjust the weekly production plan for an urgent work or more order or the customer request for faster output delivery than earlier scheduled despite the manufacturing department submission of the daily production report. This is because of the complicated production planning and adjustment process. The planning department can only put the data acquired into the weekly production plan, resulting in the production planning department receipt of false production data or predicament.

This research aimed to study, analyze, design and develop an information system for production planning so as to link the data between the production department and the production planning department with the aim for the latter agency to fetch production data to adjust the production plan in line with the real-time production situation. The information system acquired shall facilitate the alteration of the production planning and cut down the time of the production table arrangement as well as production plan adjustment for more efficient manufacturing planning.

1.2 Objective

To study, analyze, design and develop an information system for production planning for a metal productions manufacturer.

1.3 Scope of Work

This research merely studies on planning and production table arrangement of some exemplary factories involving the work operation as thus;

1.3.1 Order receiving system

1.3.2 Production planning system

1.4 Results

1.4.1 Information collection will be systematically arranged so that the production planning unit can use information from its base for planning immediately.

1.4.2 Available system will support intra-communication among other units involved by increasing competency of production information link of production planning system.

1.4.3 Other units involved can immediately know production planning to adapt planning in abreast of the situation effectively.

CHAPTER II
LITERATURE REVIEW

This chapter is classified as following:

2.1 Production Planning and Scheduling

2.2 Business Process Mapping

2.3 Modeling Tools

2.4 Technical Review

2.5 Related Research

2.1 Production Planning and Scheduling

2.1.1 Production Planning

The production planning can be divided into 3 levels, all of which aim to ensure that the harmony of the production process shall systematically comply with the organization targets. Those three levels are: (Saengplan, 2002)

1) Aggregate Planning or the planning of the production batches handles the production resource management in the 6-month or 1-year period ahead.

Aggregate planning is one of the key decision areas in the field of production and inventory management. Specifically, aggregate scheduling is concerned with determining production levels, employment levels, and inventory levels such that fluctuations in demand are economically satisfied (Shafer, 1991). Aggregate planning takes the forecast demand and capacity, and translated this into production plans for each family of product for the next concerned with individual products. Aggregate planning assumes the long-term demand has been forecast, and that planned capacity can meet that demand (Waters, 1996).

2) Master Scheduling or monthly or weekly production plan is the production table for each month or week as to what must be produced in how many quantity in that month or week and when the products are needed. The manufacturing

shall be carried out in compliance with the main production table and shall be measured by various means.

After obtaining the APP, the next step is to disaggregate them into a Master Production Schedule (MPS). An MPS is one of the key decisions of the production plan of the manufacturers. The MPS is established to manage the production plan for all end items. It is used to determine how much of each end item is planned and when it is needed. The MPS contains a statement of volume and timing of the end product to be produced. This schedule drives the whole operation in terms of what is assembled, what is manufactured and what is bought. It is the basis of planning the utilization of the labor and equipment and it determines the provisioning of materials and cash (Slack, *et al.*, 1995). The objective of the MPS is to determine what product to produce, when to produce and also how to produce in the way that will result in the demand satisfaction with the minimum relevant cost. There are many research works related to the topic of Master Production Scheduling (MPS). Two well known works are Johnson and Montgomery (1974), Hax and Candea (1984). There are many researches about the technique to solve the MPS problem. Bowman (1956) presents the LP technique in developing the MPS. Holt, *et al*., (1955) used the Linear Decision Rule. Moreover, there are a lot of researches that study the extended approach related to MPS. Gundogar (1999) presents a technique to develop the master production schedule for the multi-product firm. The rule-based MPS was performed by setting up many proper rules that specify "what-if" conditions. The objective of the model is to satisfy the customer order and control the stock levels for the finished products. Hill, *et al.,* (2000) improved the performance of MPS by using two-level MPS where the sequence-dependent set up and capacity constraints are involved. The results show that the proposed MPS can improve the process changeover time and delivery performance. Venkataraman and Smith (1996) use the goal programming technique to disaggregate the aggregate plan to a rolling horizon master production schedule when lot size requires minimum batch-size production. Lewis, *et al.*, (1992) presents a multi-objective master production scheduling model for assembly to order environment.

3) Detail Scheduling or the daily production plan is the arrangement of the activities to be undertaken in each day. The daily production table indicates who and

which machine and when to carry out the production of which product or parts in the quantity designated in the Master Scheduling.

Saengplan (2002) has designed the Master Production Scheduling (MPS) with the focus on two topics: the Master Scheduling and the Detail Scheduling.

The production planning of this research emphasized on the Master Scheduling and the Detail Scheduling as well under the objectives of planning the production conveniently and faster and adjusting the production correctly in order to make delivery as scheduled. Solutions are the adoption of information system to aid the production planning and adjustment, from which the results of the number of delivery delay days are measured.

2.1.2 Scheduling

Various researchers defined the meanings of the Production Scheduling as follows:

According to Prabhu and Baker (1996), production scheduling is the process of designating the starting and ending time of one operation for each machine.

Krajewski and Ritzman (1999), scheduling is short-term plans designed to implement the master production schedule. Scheduling focuses on how best to use existing capacity and taking into account technical production constraints.

Stevenson (1996), production scheduling is a decision-making process that exists in most manufacturing and production systems as well as in most information-processing environments, and has as a goal the optimization of one or more objectives.

Baker (1974) gave the meaning of Production Scheduling as the use of existing resources to carry out the assigned work in various situations.

Arranging the production schedule in any plant is complex but that can be done in various methods. The easiest way is to ignore the problems and prioritize the work heuristically.

Production scheduling is related to the allotment of the available resources for the undertakings upon the relevant time condition. It is the decision making produces that aim to make the best reply to one or various objectives. (Baker, 1974)

Seen from the academic and theoretical viewpoints, production scheduling is a complicated problem. Academically, there are (1) the prioritizing problem, which

needs the combinatorial optimization, and (2) the stochastic modeling problem. Practically, the application of the production scheduling theories has to be related with genuine problems (Pinedo, 1995). According to Lalitaphorn (2005), the three objectives of the production scheduling were (1), as most clearly seen, the attempts to increase the utilization of the working agency, which is the reduction in the working gap of the office in case of designating the definite work volume, (2) the decline in the work volume average pending in the waiting line while another work is being done, and (3) the diminishing of the work volume that finishes later than schedule or the endeavor to complete every work order within the scheduled period.

The objectives of the production scheduling are abundant and it is difficult to encompass all objectives in the complex production scheduling and there are many issues to consider (French, 1982).

Currently, there are many production scheduling methods. Geyik and Cedimoglu (1999) classified them into 3 main ones: the Analytical Approaches, the Heuristic Approaches and the Artificial Intelligence Approaches. Each method is shown in details in Figure 2-1.

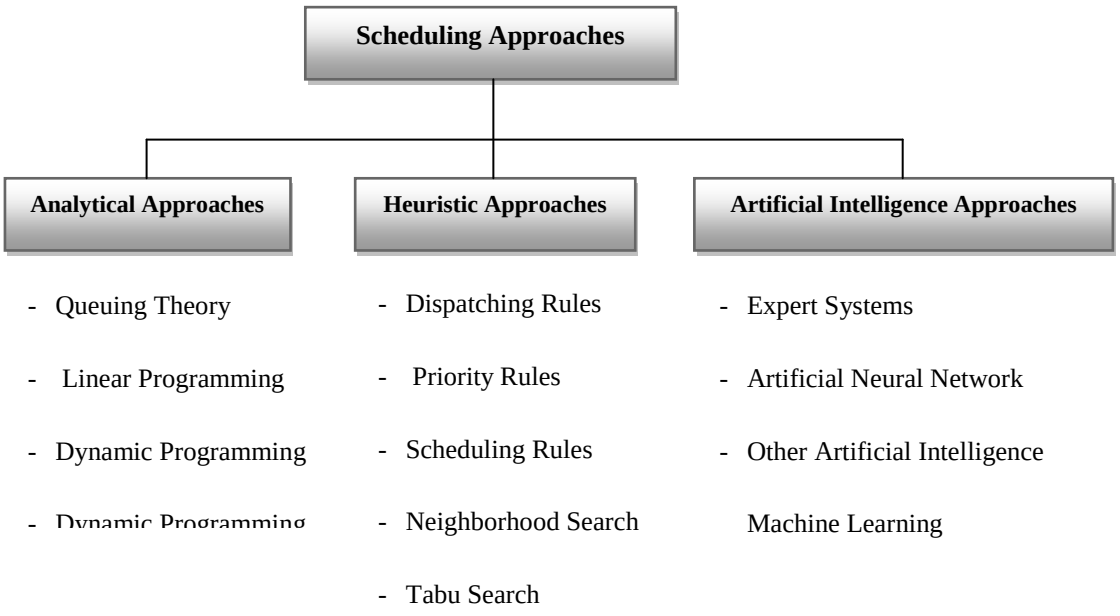


Figure 2-1 Production Scheduling Methods

The most popular production scheduling method is the Heuristic Approach. It may not roll out the best results but good enough and contain the reasonable yet practical solution means that need short time to solve any of the problems.

The heuristic approach using the dispatching rules is widely adopted in the production scheduling because the schedule arranger can make himself understand and apply those rules easily thanks to their simple calculation but it cannot guarantee that such calculations are the Optimal Solutions. The dispatching rules are many. Below are some famous ones.

1) FIFO: First Come – First Serve is the undertaking of the work first received in the office. That is to be followed by each subsequently accepted.

2) SPT: Shortest Processing Time is the undertaking of the work requiring least operating time prior to that needing longer work time.

3) LPT: Longest Processing Time is the doing of the work taking longest operating time first.

4) EDD: Earliest Due Dates is the undertaking of the work that must be delivered soon as possible.

5) MST: Minimum Slack Time is the doing of the work with least remaining working time first.

6) LCFS: Last Come-First Served is the executing of the work lastly accepted first.

7) LWKR: Least Work Remaining is the completing of the work with least remaining volume first.

8) STPT: Shortest Total Process Time is the undertaking of the work with least working period first.

9) SMT: Smallest Ratio by Multiplying Total Processing Time is the accomplishing of the work with least working ratio first.

10) MWKR: Most Work Remaining is the fulfilling of the work with most remaining operating time first.

11) MOPNR: Most Operation Remaining is the making of the work with most remaining volume first.

Other researchers proposed the dispatching rules that were in line with those under Heuristic Approach invented by Baker (Gere, 1966 and Panwalker and Iskander, 1971). Baker said that the aforementioned rules could not warrant the best results because of their different advantages and disadvantages as per the manufacturing conditions and surroundings. In one situation, one rule may give out good results towards one objective but bad outcomes towards another objective. The above rules were mentioned and used in combination to analyze the complex production scheduling problems (Baker, 1984).

Hall (1996) wrote some articles entitled the Scheduling Problems with Generalized Due Date that was printed in IIE in 1986. He stipulated the new method of the production scheduling for the products of which the due delivery date was fixed. The principle was proved to be practical in real situations and in theoretical realm. Following are details of his production prioritizing guideline.

Target 1: If wanting the best sum of the products of the delivery days least lately than schedule on the unequal production volume of each work and different delivery days, the short processing time should be used.

Target 2: If wanting the least sum of the products of the delivery days later than schedule upon the unequal production volume of each work and different delivery days, Moore J. M. wrote in the Management Science Journal in 1968 that the short processing time could best solve this problem and reproved the first principle mentioned above.

Target 3: If wanting to complete the high-valued work in compliance with the delivery days upon the different due delivery days, the linear equation should be used to analyses the problem.

This research is involved with the production scheduling as per the Job Shop. It studied the production process in accordance with the Make to Order. In order to make proper replies, the Branch & Bound method may be applied with the Heuristics Approach (Baker and Mcmahon, 1985) by using the Local Neighborhood Search (Spachis and King, 1979) to search for the production scheduling that is proper to the working environment that changes at all time.

2.1.3 Scheduling Models

The Scheduling Models can be classified by the machine arrangement and the work piece flows in the system Dileep (1996) and Chutima (2003), of which details are shown below.

1) The Single Machine Model comprises of one machine. Every work flowing into the system must work with this machine. Each work has the operating time in the production unit and the delivery schedule. The general objectives of the production scheduling are to prioritize the work for the machine so as to suffer the least fine of the delayed work.

2) The Parallel Machines Model consists of the machines for m units. They can work similarly and placed in parallel to another one. The work can be carried out by any machine of that m number. The Parallel Machines can be divided into 3 types: the Identical Parallel Machines, the Uniform Parallel Machines and the Unrelated Parallel Machines.

3) The Flow Shop Model contains machines for m number. They are different and placed in series. All works have the Unidirectional Flow. The Flow Shop Model is divided into 2 types: the Pure Flow Shop and the General Flow Shop.

4) The Job Shop Model has machines for m number. Each production agency has its own specific work directional flow as designated. The Non-Unidirectional Flow of each work permits the work to be carried out on any machine in that flow line for just one time only.

5) The Open Shop Model is similar to the Job Shop Model except that the repeat flows on any machine are possible depending on the flow of that work.

This research used the Job Shop Model together with the Open Shop Model because the production of each part had the specific flow path but there were repeated flows of the work to the machines as well.

2.2 Business Process Mapping

Business Process Mapping is the chart indicating the flows of the logistic and supply chain activities. Nonetheless, any work involving a large number of people and working processes is likely to generate problems about the overall picture of the working system or scope and who are responsible for which stage.

The making of the Business Process Map is one instrument that can help manifest the entire working system and facilitates the business process designer to estimate, adjust and lay down the business process much better. The Business Process Mapping, in this way, is like building the business process model that is based upon the IT applying abilities. Various predicaments of plenty of factors that influence the business procedure can be put into the model for the designing or improving of a new process in response to the change of customer needs and business environment.

For all businesses, the Business Process Mapping which shows the flows of data and raw materials in the organization can develops the logistic and supply chain systems and create understanding towards the overall picture of the entire business process.

Hunt (1996) mentioned that the Business Process Mapping is a managerial instrument that manages and helps all parties to grasp the business processes in one organization and that can be used to modify or even reengineer the structure of the business processes with the aim to satisfy the customers and better the services as well as the products and cut down the manufacturing and delivery time. A business process, on the other hand, means any procedure that requires an input and gives out the output.

Jare (2002) studied the components of the information flow of the business process and the movements of the tiles at the then predicament of an inventory department of the tile industry by using the business process map to analyses the causes of the management of the wasted products.

Chuejedton (2002) conducted a research by starting from studying the overall picture of the business process, the informational flows and the movements of the components of the excavator vehicle cabins by adopting the business process map.

Laongam (2005) created a business process simulation to model the customers' order filling process so as to exhibit the real time predicament. Aguilar, *et al.,* (1999) divided the business process simulation into 2 phases: As-Is and To-Be. The As-Is is the stage that builds the current working process simulation and then measurements and analysis on the efficiency of that process is made. The To-Be is the designing and developing stage of the future business process, for which the working structure must be recognized. An abundance of researches have been involved with the

business process mapping so as to learn about the overall picture of the working system and the current working process.

2.3 Modeling Tools

2.3.1 Gantt chart

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 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 (Durfee and Chase, 2004).

Charoentham (2003) developed computer software to lay down the planning and management of the demands for the aircraft parking hole. The result was the Gantt chart, which was used to designate the aircrafts to deploy the parking hole and its benefits. That was to plan and manage the existing yet limited parking hole in reply to the demands.

2.3.2 Entity – Relationship Model

The Entity-Relationship (ER) model is a way to unify the network and relational database views. Simply stated the ER model is a conceptual data model that views the real world as entities and relationships. A basic component of the model is the Entity-Relationship diagram which is used to visually represent data objects. Since Chen wrote his paper the model has been extended and today it is commonly used for database design for the database designer, the utility of the ER model is:

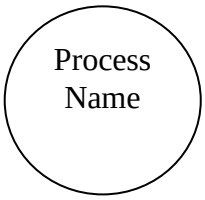
- It maps well to the relational model. The constructs used in the ER model can easily be transformed into relational tables.

- It is simple and easy to understand with a minimum of training. Therefore, the model can be used by the database designer to communicate the design to the end user.

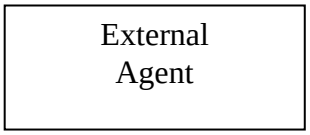
- In addition, the model can be used as a design plan by the database developer to implement a data model in specific database management software.

2.3.3 Data Flow Diagram (DFD)

Data Flow Diagram (DFD) is a tool that depicts the flow of data through a system and the work or processing performed by that system. There are four symbols are following: (Jeffey, *et al*., 1995)



The cycles represent processes or work to be done. Notice that they are illustrated in the process color from your information system framework.



The squares represent external agents that boundary of the system. Notice that they are illustrated in the interface color from your information system framework.

The open-ended boxes represent data stores of the system. Notice that they are illustrated in the data color from your information system framework.

The arrows represent data flows, or inputs and outputs, to and from the processes.

The Data Flow Diagram is an instrument used to develop the working system and show the relationships between the processor and the map-related data. The Diagram is a simple media that indicates the relationships between the sub systems and the entire one. The map also acts as a medium to make the integrated works between the system designer and the system users.

2.3.4 Integration Definition (IDEF)

IDEF0 (Integration Definition for Function Modeling) is an instrument that is used to make the business mapping to reveal the flows and linkage of the data and the raw materials within the organization. The survey of DISA (Defense Information Systems Agency) in 1995 discovered that 37.4 per cent of the organizations preferred using the IDEF0 technique to analyze and study the business processes.

Feldmann (1998) discussed about the working process mapping under the IDEF0 (Integrated Definition Function Modeling) to study and manifest the status of the current business process via the Block Diagram, which was the representative of the activity of the business. That was to use the arrow sign that enters on the left and the other one that exits on the right. The entry arrow represents the input and the exit arrow shows the output of the earlier and following activities. The entry arrow signs on the top and at the bottom show the Control and the Mechanism respectively as seen in Figure 2-2.

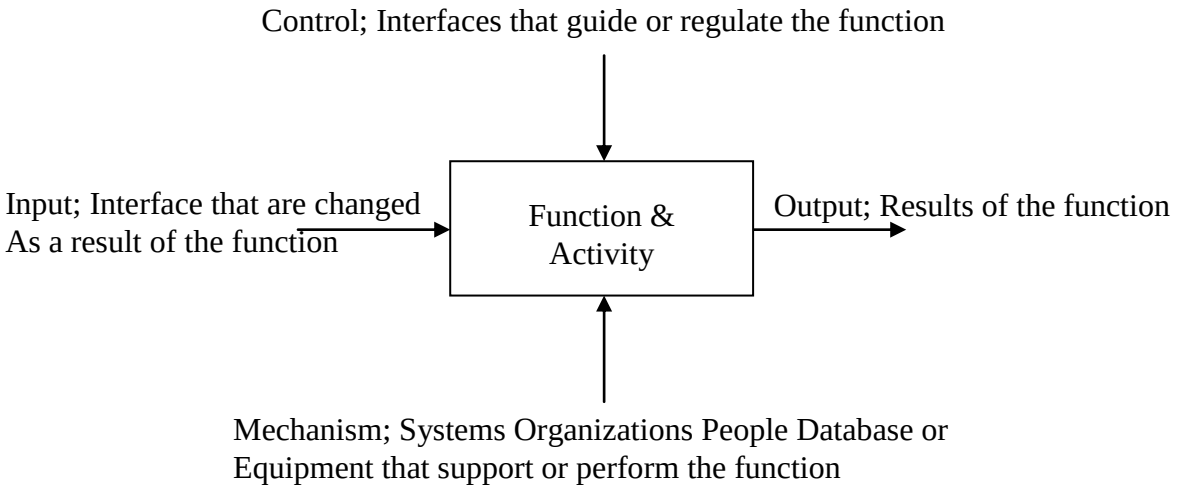


Figure 2-2 IDEF0 Schematic

Somboonwiwat (2003) provided the definitions of the term Integration Definition for Function Modeling (IDEF0) as follows:

- Activity refers to an action of a duty or an operation. An activity is shown by a rectangular sign.

- Input means a real object or data needed to carry out an activity. It is processed to complete an activity.

- Output is the results of the completion of an activity.

- Control is the direction or starting point of an activity that may be combined with the Input to create the Output.

- Mechanism is the designation as to how an activity is completed (such as by men, machine, system or any other means).

Jare (2002) studies the overall picture of the information flows of the business processes and the movements of the tiles in the inventory warehouse of the tile industry then by using the IDEF0 to analyze the causes of the management over the wasted tiles.

Chuejedton (2002) conducted the research on the overall picture of the business processes, the flows of the information and to movement of the parts of the cabins of the excavating vehicles by using IDEF. Various researches made the Business Process Mapping by using IDEF0 as an important instrument to portray the overall picture of the working systems and the current predicaments of the entire working processes.

2.3.5 Swim Lane Diagram

Swim Lane diagrams are essentially process maps. It provides a means of integrating steps in a process with the information and people involved. The "swim lane diagram" was originally developed by Lynn Shostack for use in designing services. It is basically enhanced flowcharts that incorporate additional information such as people involved, points of interaction, means of contact, and flow of information (Jacobson, Booch and Rumbaugh, 1999). The sample of Swim Lane Diagram is show in Figure 2-3.

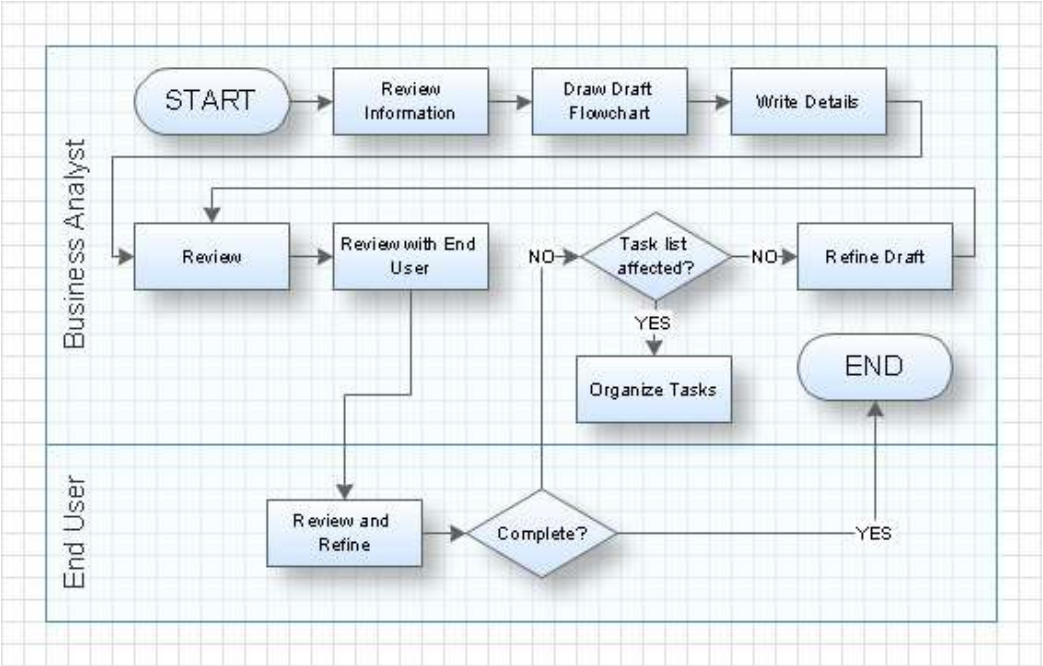


Figure 2-3 Swim Lane Diagram

Lao-ngam (2005) prepared Swim Lane Diagram to shows the flow of information and materials from receive order until delivery to customer with a case study of a textile company in Thailand.

Sirirattanachaiyakool (2005) describes the problem by Swim Lane Diagram to present the mostly problem of garment industry occur in second phase is not delivery on time.

2.4 Technical Review

2.4.1 Visual Basic 2005

Visual Basic 2005 is a computer language developed by Microsoft. It is used to produce various software under the Windows and Windows NT operating systems of that same firm. Visual Basic 2005 used Graphic User Interface (GUI) to draw pictures and lay down the components on screen. Such method in which programmers can see the developed results and make immediate corrections is called WYSIWYG (What You See Is What You Get). After the components are laid down on screen, it is the time to write the software by using Visual Basic (VB). Visual Basic

is a language, of which the structure is similar to that of Basic (Beginner All Purpose Symbolic Instruction Code), which builds the relationships between components on screen such as menus, forms, reports. The separate development of each part enables the fast software development. The reason behind the versatility of Visual Basic is its Modularity, which divides the operations of the software into parts and then links them together. The Form, for instance, that is designed and programmed to be used with one system can be utilized by another system. The developed screen interface and codes of the software can also be changed to suit one particular work increasingly. That saves the software developing time. The Windows operating system permits the picture communication between the user, computer and the software. Typing needs less currently. User can only draw mouse to click the needed order or icon. This concept is called the Object-oriented software development, which is the vision that sees each component in the software as one object. Each object has different properties. A button for example can be chosen by mouse. Keyboard can be used to fill in the data directly. The operations differ depending on the then situation. The new computer languages hence have to be developed under the Object-oriented concept and develop the Event-driven software; that is, using the then situation and environment to designate the demands for each Object to operate. Likewise, Visual Basic is a new computer language developed under such Event-driven concept.

Phuetphon and Santikulanond (1999) believed that the reasons behind the success of Visual Basic as the software developing language are:

1) Its simplicity for learning which suits the beginners with respect to the syntax and the working tools,

2) The popularity of the language, which might be say that Visual Basic (VB) is the language mostly studied and learned in the history of computers,

3) The continued development, the improvement of the language efficiency and the fast processing including other novel capacities like the connection with the databases and the internet networks, and

4) The development by Microsoft, which is one of the giants in the current computer industry and which leads to VB long term development and existence,

In short, Visual Basic (VB) is advantages in that it is a computer language that is programmer-friendly and widely used by a large number of developers. Its

endless development has creates as numerous benefits and capacities as other computer languages. Those strong points have led the efficient development of the software.

2.4.2 Microsoft SQL Server 2005

A large number of data problems have emerged increasingly, ranging from the needs for faster informational retrieval to the decision making based on data. Developers meanwhile have desired to work more at more flexible modes yet under the pressure of the IT budget decrease against the expansion of the basic infrastructures which has raised the demands.

SQL Server 2005 was designed to provide solutions to those barriers. It has made the organizational data and the analytical applications more secure and the systems more expanded in order to be ready to provide additional services whereby the data and application building, installing and management are simplified.

SQL Server 2005 is an updated yet healthier version of SQL Server 2000 thanks to its new managerial solutions and integrative data analytical capacities. Organizations of all sizes can use it and the researcher of this study used the database management SQL Server 2005 to manage the operations of the case study firm(s). Below are the efficiencies of SQL Server 2005.

- To generate, install and manage the enterprise applications so as to secure more safety and better expand and stabilize the systems.

- To increase the optimal outputs to the IT systems by cutting down the development stages and the database application services.

- To exchange data between a wide variety of application platforms and devices, hence making the easier connection in and outside the systems.

- To be cost effective without scraping the servicing, the system expansion capacities or the security system readiness.

SQL Server is data solution that will help all users in the organization to work efficiently by preparing the more secured and stable platform for higher productivity to serve the enterprise data and applications. SQL Server 2005, which is for every agency in all sizes, prepares caliber tools under the familiar interfaces for IT specialists and employees who use the data frequently. As a result, SQL Server

reduces the complexity of the building, management and utilization of enterprise data and analytical applications in plenty of platforms including mobile devices thanks to its complete functional sets which can work together with the existing systems and its automatic processing over the routine woks.

2.6 Related Research

Saena (1999) has studied the impacts of the 8 kinds of uncertainty arising in the production table arranging. They were the work increase, the work cancellation, the production volume addition, the production volume decline, the shortage of the raw materials, the work stop of employees, the postponement of delivery. Five measurements were used to assess the work efficiency: the flow time average of the work, the late time average of the work, the delay time average of the work, the work volume delay, and the rate of machinery use.

The research developed a Job Shop production table arranging software with the use of statistics to test the impacts of the uncertainties on the table arrangement and the application of the heuristic approach to manage the single machines and build the table arrangement system to accommodate the plant under case study.

Weng and Leachman (1993) have studied the production table arranging methods to make the least value of the WIP (Work-in-Process) at each station. Below are the 4 calculating modes.

1. MCR (Minimize Cost Rate) is to make the least cost amount of the gross products in that period so as to get the least queuing average of each station.

2. MBS (Minimize Batch Size) is to get the least batch size in the queue while there are a huge number of customers waiting for the service in each period, hence reducing the operating and total costs.

3. DBH (Dynamic Batching Heuristic) is the decision at the free time of the machines to increase the new production round for several single machines.

4. NACH (Next Arrival Control Heuristic) was developed from the minimize batch size method. It takes each approaching work in the following period only without waiting for the machine to have free time.

This research is useful to calculate the work-in-process in the production lines so as to fetch certain values and fastness for production scheduling.

Poonsuan (2007) has developed a scheduling module into an ERP software package called Microsoft Dynamic AX 4. Previously this ERP package did not have any scheduling module. Planners had to export data to perform a scheduling and then put it back to release jobs. This results in time consuming. This led to software owner tried to increase its efficiency by adding the scheduling module. By this module, the scheduling constraints can be customized based on what planners want so that the desirable performance will be obtained. After its implementation, it clearly shows that the scheduling module can be used effectively. It can reduce the planning time and can increase the accuracy of the scheduling as well.

Dulpinit (2002) has developed the software implementation issues of rescheduling tasks in flexible flow shop environment. The causes for rescheduling may come from one of the following scenarios, (1) a new customer order placed and executed within the same planning period, (2) an existing customer order withdrawn, (3) job due date changed, and (4) order release date changed due to changes in supplier delivery schedule. The newly generated schedule is evaluated in terms of mean flow time and mean tardiness. To distinguish the importance of various jobs, the production orders are classifier as, in the deceasing importance, foreign customers, domestic customers and inventory replenishment. With 3 levels of jobs and 4 rescheduling scenarios, 12 case studies are developed to illustrate the algorithm capacity. It has been show that the program developed, while using a large amount of computing time, is able to arrange and create a new production schedule with reasonable performance characteristics.

Jongprasithpron and Suwathananon (2004) have solved the problem of backlog of customer order and implement it to the job shop scheduling and sequencing method. A heuristic procedure for generating active schedule generation algorithm using branch and bound without backtracking using the proposed lower bound is presented and used. The schedulers plan the schedules manually use an intuitive approach based on their experience to plan the schedules unsystematically. The production type of the case study factory is making to order. The case study is facing the problem that many jobs are delivered to customers tardily. The objective of this

research is to obtain complete schedules, which minimize number of tardy jobs, total tardiness, and total lateness. The comparison of the proposed scheduling algorithm to the schedule generation approach of the case study factory is conducted. All the scheduling data used in comparison are the true production data. The results of the comparison indicate that the number of tardy jobs during that period decrease from 240 jobs to 40 jobs had lateness.

Pathumnakul (2007) has studied a problem in a supply chain management with purchase order uncertainty. In this problem, supplier plans its production follows purchaser production plan, which could be changed any time based on its sale. In this supply chain management, supplier could estimate or predict the changing probability of purchase order from the historical and real-time purchase sale monitoring date. Eight scheduling methods based on processing time and changing probability of each order are proposed to solve the problem with three objective functions mean flow time, make span, and standard deviation of make span. Simulation-based analysis approach is applied as a tool to investigate the relative performances of all proposed scheduling methods. The analysis shows that the scheduling method, which is the combination of schedule based on changing probability and job sequences based on minimization of make span in deterministic flow shop scheduling problem, provides the best performances in all objective functions and in various scheduling environments.

Chatkunpol (2007) has developed a software tool to assist planning of mold and die making process. The software tool is to capture customer orders and monitor the mold/die making process until they are delivered to the customers. The software contributes mainly 2 functions. First it provides the real-time tracking capability for the mold making process, from order receipt by marketing department to finally assembly. Each department reports the work progress on a daily basis so that marketing can track and respond to customers' inquiry promptly. Secondly, the software assists the scheduling of part routing process. It makes the planning department see better which machines are overloaded, which parts are slowing down the mold assembly schedule.

Santayanon (2002) has studied the problems of the production table arranging problems of electronic plants. He used computer to lay down the plans and

designate the operations. The research studied the comparison between the 3 work arranging methods: work prioritizing by manpower experiences, work prioritizing by using Microsoft Project and work prioritizing by using software developed by Delphi language which was based on the 3 work prioritizing methods, namely, EDD, SPT and RANDOM. The research found that work prioritizing by using software developed by Delphi gave out the best results and also other advantages: the ability to track the production results in details and vividly, the reduction of the free time of the machines and the collection of necessary data for production prioritizing in the form of database that could be increase, modified and erased.

Buchayaanand (2007) has solved the production table arranging problems for the parallel production unit in the motorcycle choke cylinder production line with the objective of getting the least work average of the late delivery and the least overall machine adjustment time. The research used 4 heuristics methods: MST (Minimum Slack Time), CR (Critical Ratio), SPT (Shortest Processing Time), and LPT (Longest Processing Time). The results aimed to cut down the work average of the delay delivery and the machine adjustment time.

CHAPTER III
MATERIAL AND METHOD

3.1 Step of Research Methodology

In this research, This research employ system development life cycle supporting information system development for production planning by dividing proceeding into 5 phases as shown in Figure 3-1 as follows;

Phase 1: Project Planning Phase

Phase 2: Analysis Phase

Phase 3: Design Phase

Phase 4: Implementation Phase

Phase 5: Maintenance Phase

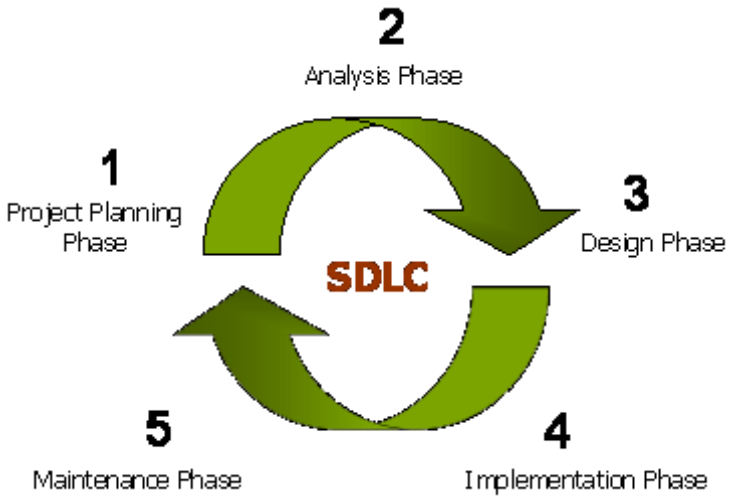


Figure 3-1 Steps of Research Methodology

3.1.1 Project Planning Phase

Project planning is the fundamental process on the realization why a new system must be created? In this research will consider how can proceed upon creating a new system by fixing Project Initiate from interviewing former system users. Project planning phase can be summarized as thus;

3.1.1.1 Problem Definition

In this research will have studied business problems investigating working problems that from which units have defects originated? And at which step have working problems been delayed? And observed worker behaviors that are more or less satisfied? What are the documents that involve with this proceeding from the beginning to the end?

3.1.1.2 Feasibility Study

In the feasibility study, the research has investigated the conclusion and problem limitation by studying 3 principal feasibilities that include;

- Technical Feasibility

This feasibility is a technical risk analysis so as to obtain the answer of the question that whether can it be developed? So we have analyzed readiness of users for learning a new system, readiness of learning technology and readiness of contributing a new instrument to support a new system by checking up existed instrument that is there co-existence between hardware and software instrument that can be well operated and workable?. From such checkup, it can be sum up that a case study- factory is ready to cooperate and support in providing a new instrument both hardware and software.

- Economical Feasibility

This feasibility is the study of cost-benefit analysis by fixing financial cost and benefit received from developing a new system. Concerning the study of economical feasibility I just focuses on cost and benefit by fixing cost and analyzing cash flow. The conclusion is that a new system that will be developed is less capital comparing with benefit that will enhance operational efficiency.

- Operational Feasibility

We found that whether or not a new system that will be can develop present correct information and satisfy the users' needs, and studied raw data

being sent to the system and information sent by the system which really satisfies the users' needs. The developed system should support organization strategy with 3 dimensions as thus;

- On productivity: it supports extra-production rate
- On differentiation: the developed system gives rise to the difference by comparing from former operational system or from the rival.
- On management: a new system can support operation capability to executives effectively.

3.1.2 Analysis Phase

In this research will have brought problems received from project planning phase to re-analyze so as to obtain real problems with the following methods;

3.1.2.1 Requirements Gathering

We used the users' needs by studying of the operation of former system, the documents used at present, the observation of the operation behavior, and most important of all is interviewing the system users by communication that make them understand more. We have upholds the trend of managing a person concerned. This includes the question who, what, when, why and how, that is to say, we must know that who is involved in this system, what is the role of each person who gets involved and who is the real person in the requirement of a new system. Besides, it must be recognized that what is the happened problem, how a new system developed has operational function, and there must be calculated that when will it be installed, where will the system be checked up and which place will be used for the operation. The most important of a new system development is the question ability why must a new system be developed and when a new system has been developed how should it be functioned? Is there any limitation? All is studied and collected through the users' needs.

3.1.2.2 Requirements Analysis

Having known real problems and the users' needs, we have collected those needs through requirement analysis so as to have complete requirement specification written down in a documentary form to be very helpful at the step of software development.

3.1.3 Design Phase

It is a phase using a data collected from the former step for designing information system by correcting system input design, input and output model diagram in monitor screen and other reports, moreover, it still includes data flow diagram (DFD) to show operational process of a new system that will exhibit relation between process and data involved. Data in diagram will make us understand where is the origin of data and where are stored. Other than data flow diagram, data base design must be made using data model called Entity Relationship diagram or ERD to collect documents in the system, and the users can use it later.

3.1.4 Implementation Phase

After finishing analysis and design phase, something received is Data Flow Diagram (DFD) and Entity Relationship Diagram (ERD) that will be used to the fourth phase. This phase will cause system output by creating the system. Thus, we have brought such diagram to create the system by the following method;

3.1.4.1 Coding

We have created the system writing program with computer language: Microsoft Visual Studio.Net 2005 by writing program in accordance with the standard determined at analysis and design phase

3.1.4.2 Testing

It is the testing of program used in the system whether it operate correctly or not before installing the system for real using. In testing the system, we have produced operation crisis, and has recorded data into the system by using real data in order that the system will be tested effectively.

3.1.4.3 Installation

After the system has been developed and already checked up, the next step is the system installation which will be operated by replacing developed new system into former system. Such process is held complicated, overriding, and risky. Therefore, we tried to install the new system not canceling operation of the old system, for the users may take some time in studying the operation of a new system. We has the Parallel Installation to install the happen operation system both old and new until the users can understand correctly of the operation of a new system. Having

understood, the old operation system has been cancelled by using merely the present system or the new system.

3.1.4.4 Documentation

We have provided documentation for a new system to have the users understand of the new system.

3.1.4.5 Training

Other than providing documentation to the users we have provided the new system training to the users to be able to use program more effectively and for questioning and doubting in using the system.

3.1.4.6 System Evaluation

We have evaluated the system results using time watching technique in production planning before using program and after using production planning and comparing time that happens.

3.1.5 Maintenance Phase

After the system being installed and operated, the users may find some problems: program error or the users have something new in the system to suit the changing situation. We have prepared at this phase by contracting for the system perseverance to be operated as usual and can add operational function if the users need it.

3.2 Research Tools

3.2.1 Hardware used for application development

- Database Server

CPU	: Intel Core 2 Duo Processor 800MHz
Main Memory	: 2 GB or Gather
Hard Disk	: 250 GB SATA II (7200 rpm)
Monitor	: Graphic Card READON HD4350 512 MB DDR II
Network Adaptor	: 1 GB Transfer

- Coding and Client Testing

  CPU : Intel Core 2 Duo Processor 800MHz
  Main Memory : 1 GB
  Hard Disk : 250 GB SATA II (7200 rpm)
  Monitor : Graphic Card READON HD4350 512 MB DDR II
  Network Adaptor : 1 GB Transfer

3.2.2 Software used for application development

- Server

  Operating System : Microsoft Windows XP
  DBMS : Microsoft SQL Server 2005

- Development

  Operating System : Microsoft Windows XP
  Programming Language : Visual Basic 2005
  Editor : Visual Studio.Net 2005

- Client

  Operating System : Microsoft Windows XP

3.3 Time schedule for this study

Table 3-1 Gantt chart of research time

Activity	Month											
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
1. Project Planning Phase												
2. Analysis Phase												
3. Design Phase												
4. Implementation Phase												
5. Maintenance Phase												

CHAPTER IV
A CASE STUDY ON INFORMATION GATHERING

4.1 The Overview Organization of Business

The metal production company has been founded in 1982. During 20 years of foundation, it has experienced on printing, metal shaping, and can production to satisfy the need of the clients. At present, this company produces products from tin enameled metal with a variety of design and size: sphere, square, hexagon, and other designs. The company comprises of a variety of production: metal -made pencil box, flat sphere shaped-can, square shaped-metal box, and plastic glass with different sized etc., which is the repeat order from clients once a year having 85% of regular clients and 25% of irregular clients. The company of factory is located on 4 rais of land adjacent to the Phetchakasem Rd., accommodating goods transportation in Bangkok and nearby areas.

By 1999, the company added plastic production focusing on Tin Wall Plastic Spraying Technology and Offset System Plastic Molding which was one of alternatives for containing supply.

4.2 General View

4.2.1 Purchasing Order Receipts

Due to the fact that the product is considered is a kind of repeat order, when goods in the warehouse has been decreased, sale department will ask clients about purchasing order, if goods are needed, the work order will be open to the production planning department for furthering production planning.

4.2.2 Raw Material Purchasing

Raw material purchasing can be divided into 2 kinds;

- General raw materials purchasing order (lacquer, box, color) will be determined by the production department and purchasing offer will be sent to the purchasing department to order raw materials.
- Steel arranging department will inform remained steel to the company executives, then they will decide to order and consider possibility of steel cost at each time as well as financial status of the company in which supplier will come from the country itself and abroad. Steel purchasing order data will be sent through the internet to formerly investigate if the steel remains, if the remaining steel is responded by the supplier the factory are determined to order it later.

4.2.3 Production Planning

After the production planning department receiving order from the sale department the production planning department will investigate products data from File Maker Program and brings steel data obtained from the steel arranging department to calculate production time of each order so as to summing the weekly grand total of production and brings the weekly grand total of production to making production planning into the weekly production planning.

4.2.4 Production

Metal production has the following steps;

1) Steel plate is enameled for the first time.

2) Steel plate enameled for the first time is brought to colorization along with the amount of color that appears on a can

3) Steel plate is enameled for the second time

4) Steel plate is brought to cut

5) Bring cut steel plate to be shaped along a can shape.

4.2.5 Goods Keeping and Goods Transportation

In keeping goods in the warehouse, goods will be first checked up before bringing them into the warehouse. For goods transportation, the warehouse department

will bring goods transportation data received from job order to making clear order and transporting them together with adapting grand total of goods, and the warehouse department will inform the remaining goods to the sale department after transporting goods.

4.3 Logistics mapping

The case study is the factory producing goods concerning molding, metal shaping, and can production. There are a variety of products in the factory such as caramel cup, metal -made pencil box, flat sphere shaped-can, square shaped-metal box etc., in which business process mapping is used by a tool called IDEF0 (Integration Definition for Function Modeling) to exhibit the flow and connection of data as well as raw materials within the organization. Business process mapping of the case study is shown in Figure 4-1

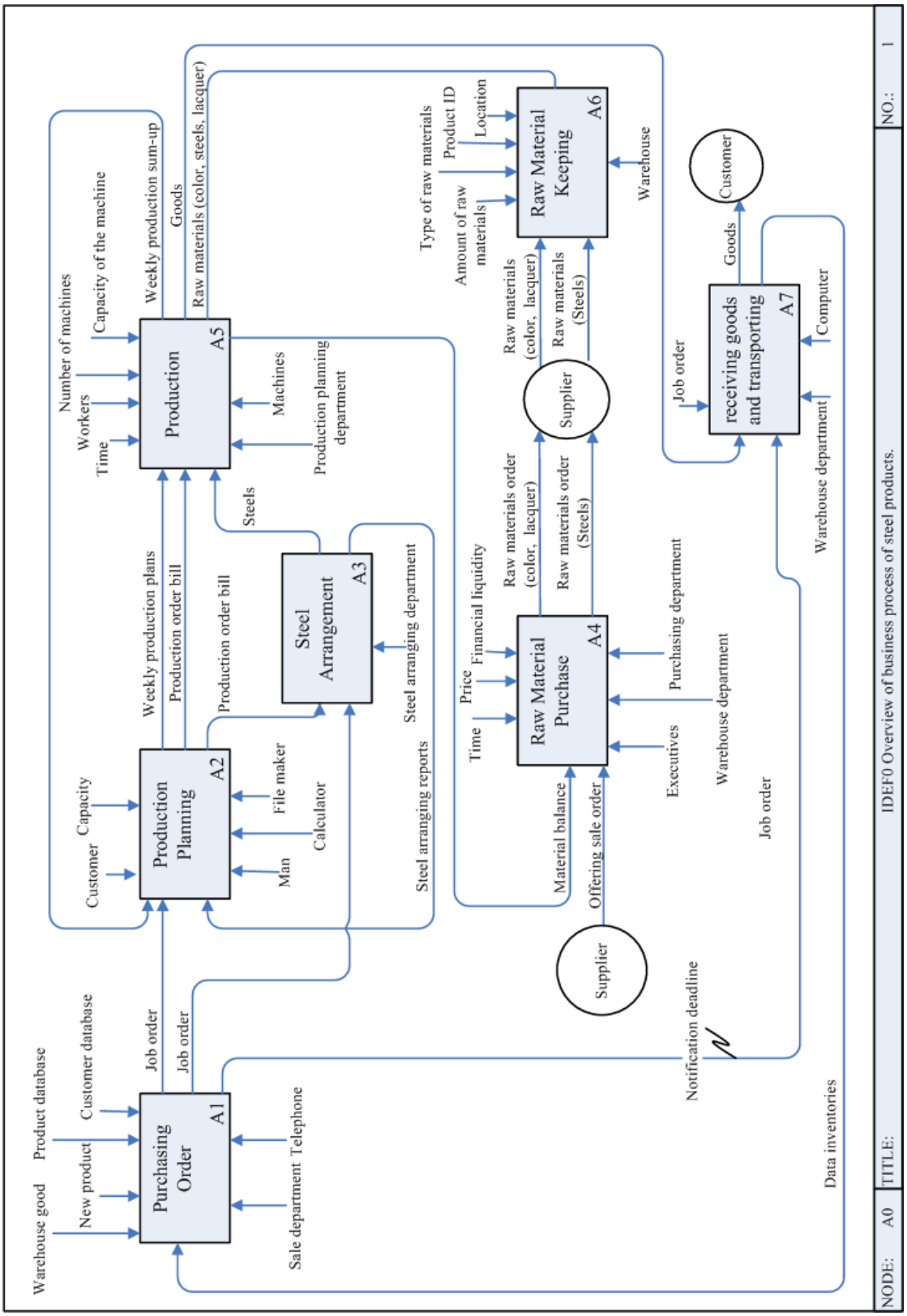


Figure 4-1 IDEF0 Overview of business process of steel products

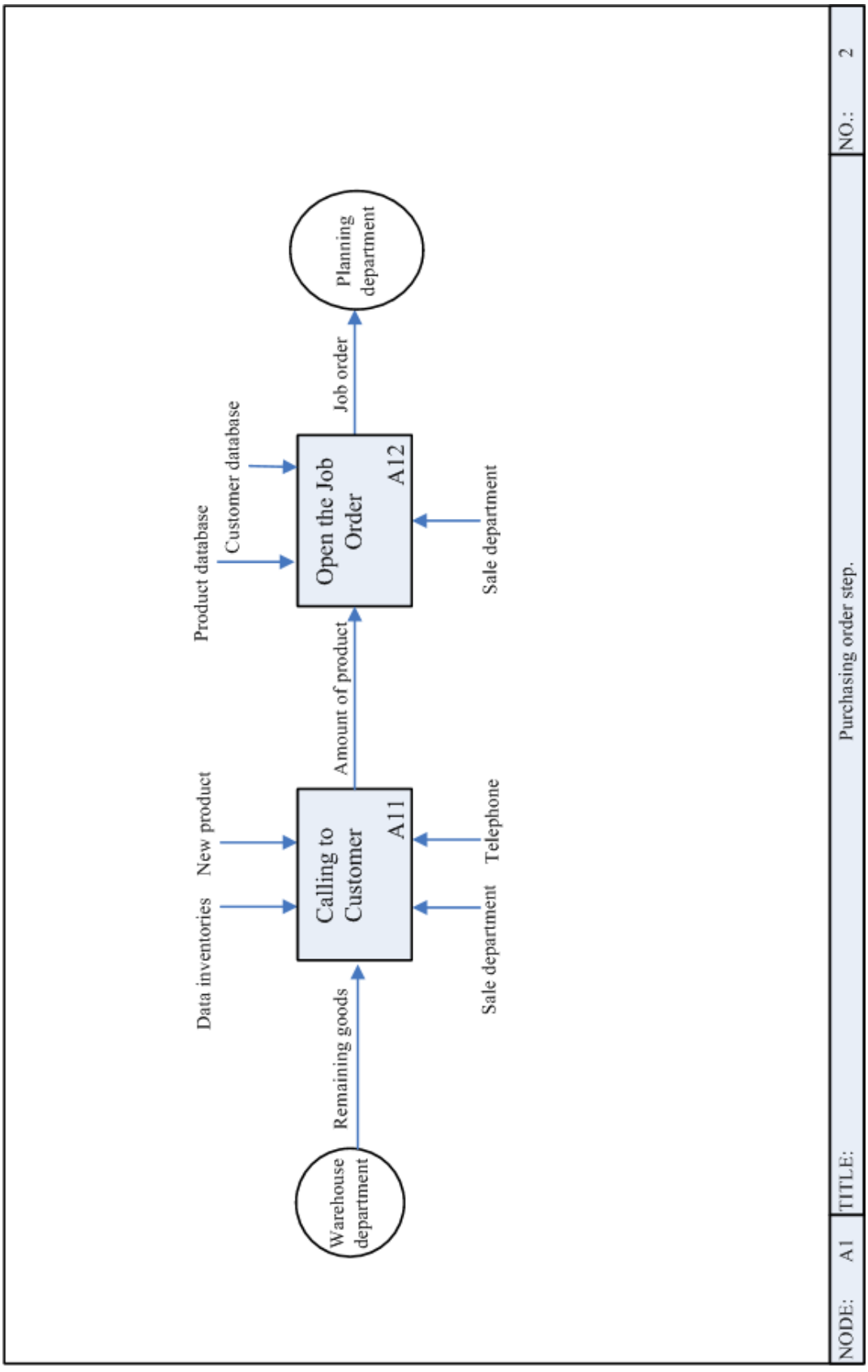


Figure 4-2 Purchasing order step

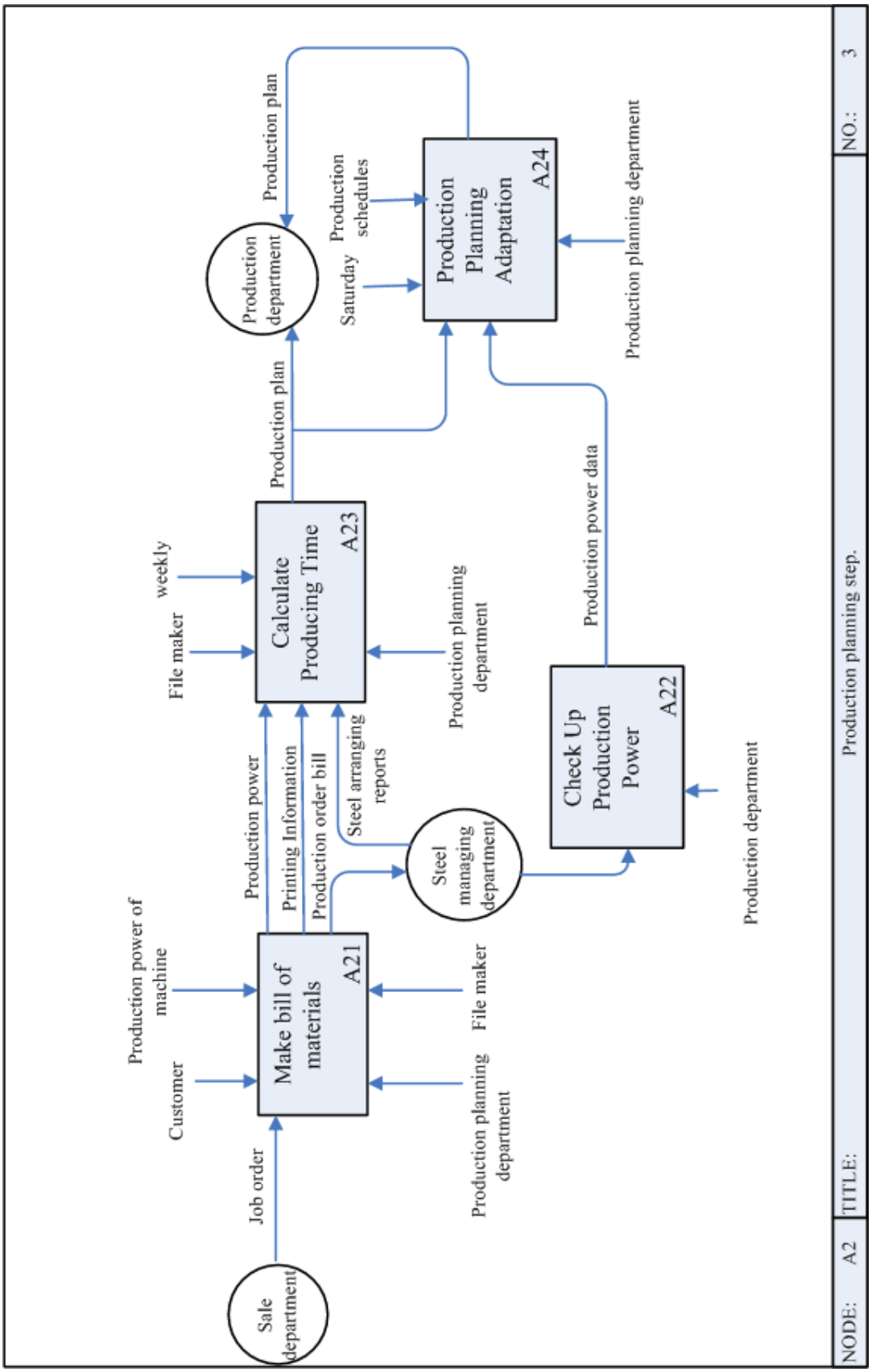


Figure 4-3 Production planning step

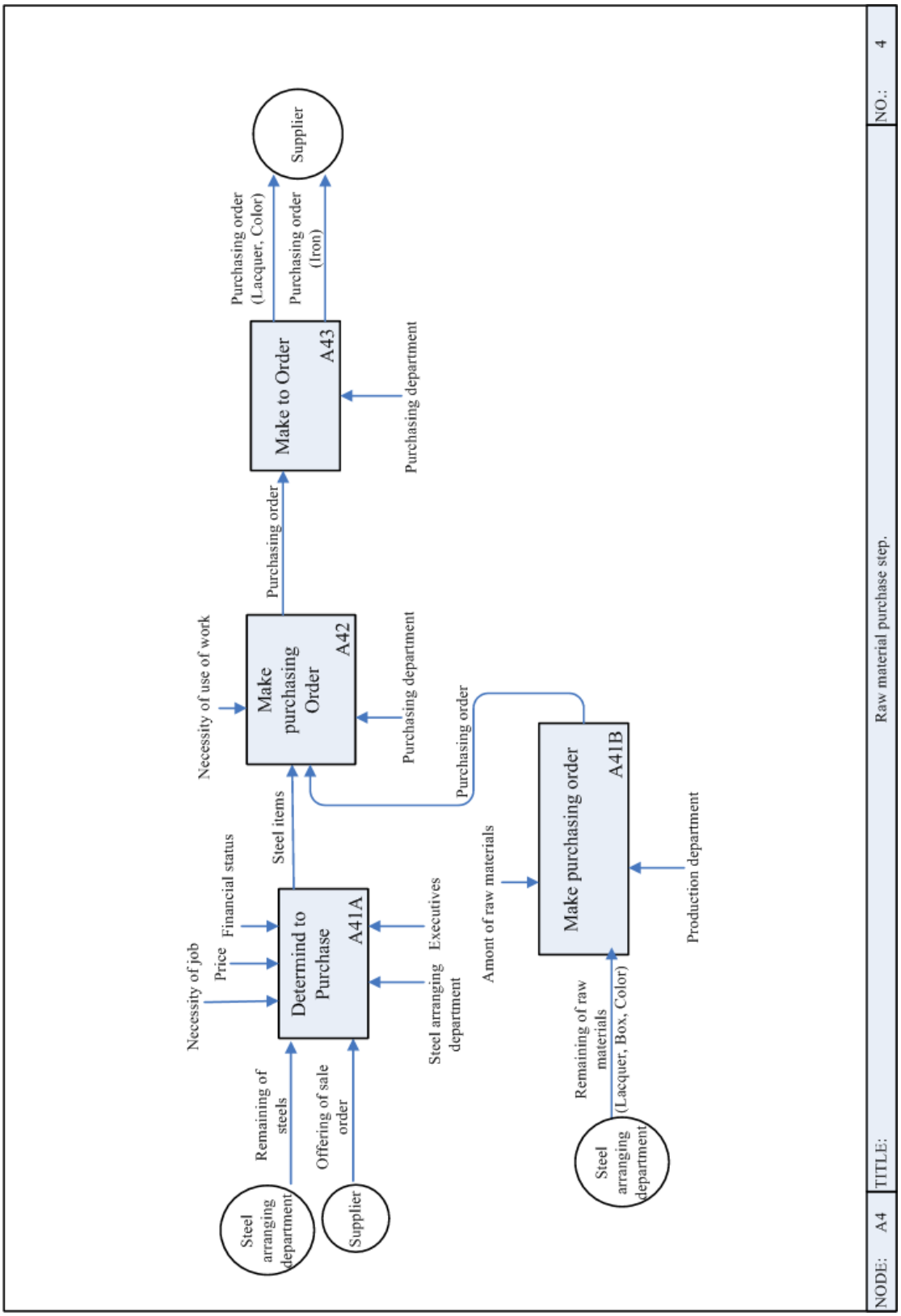


Figure 4-4 The step of raw materials purchasing

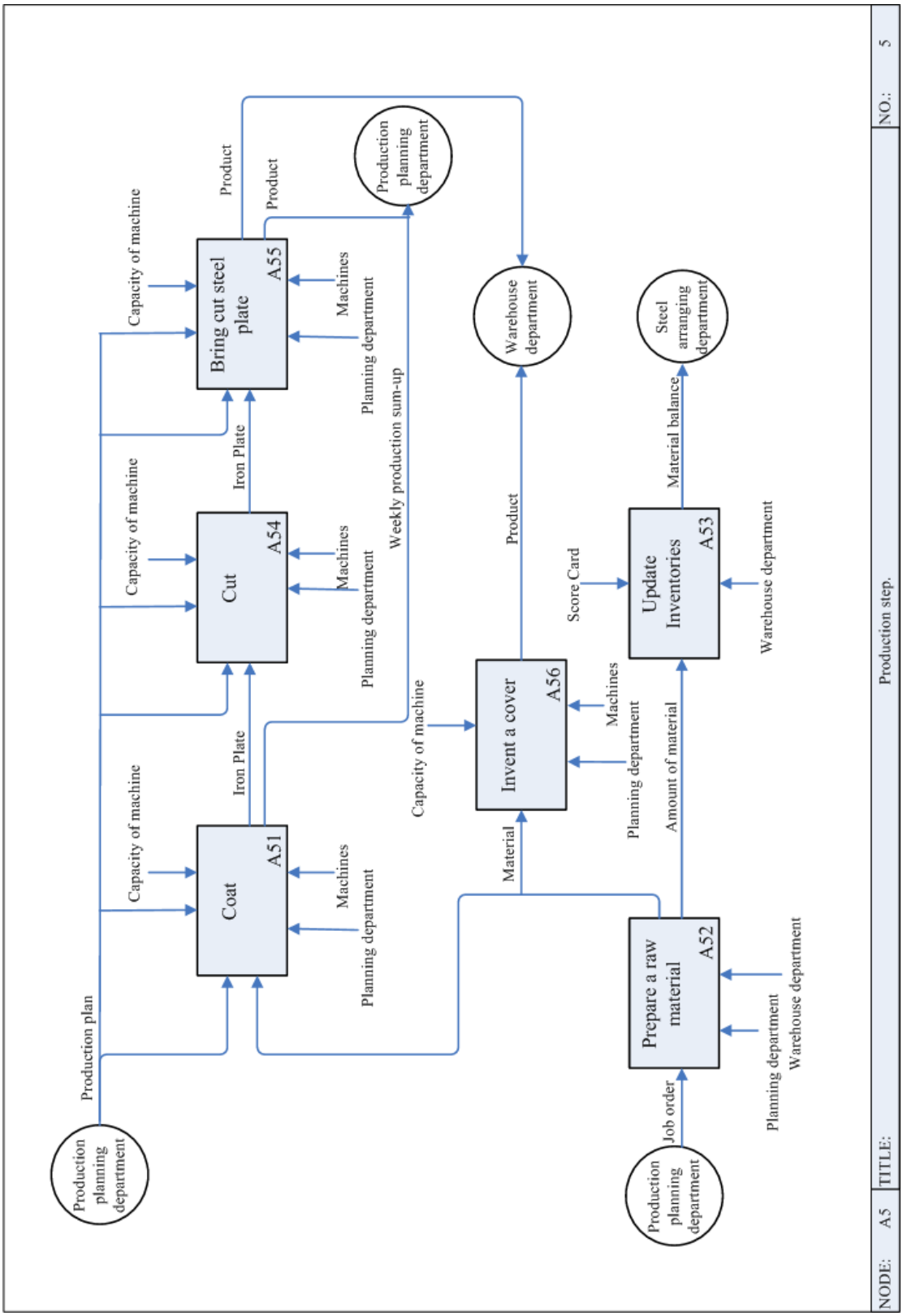


Figure 4-5 The step of production

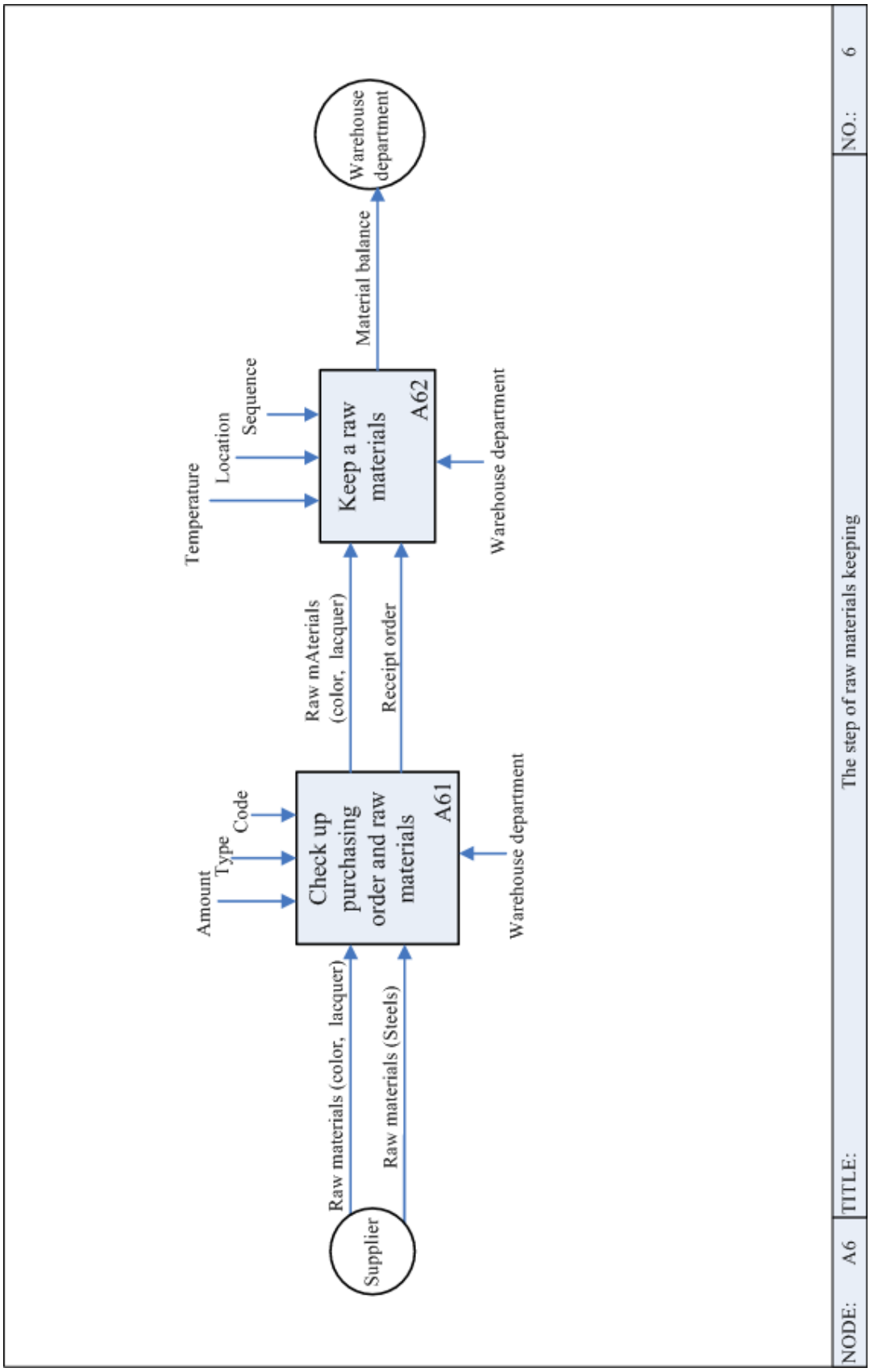


Figure 4-6 The step of raw materials keeping

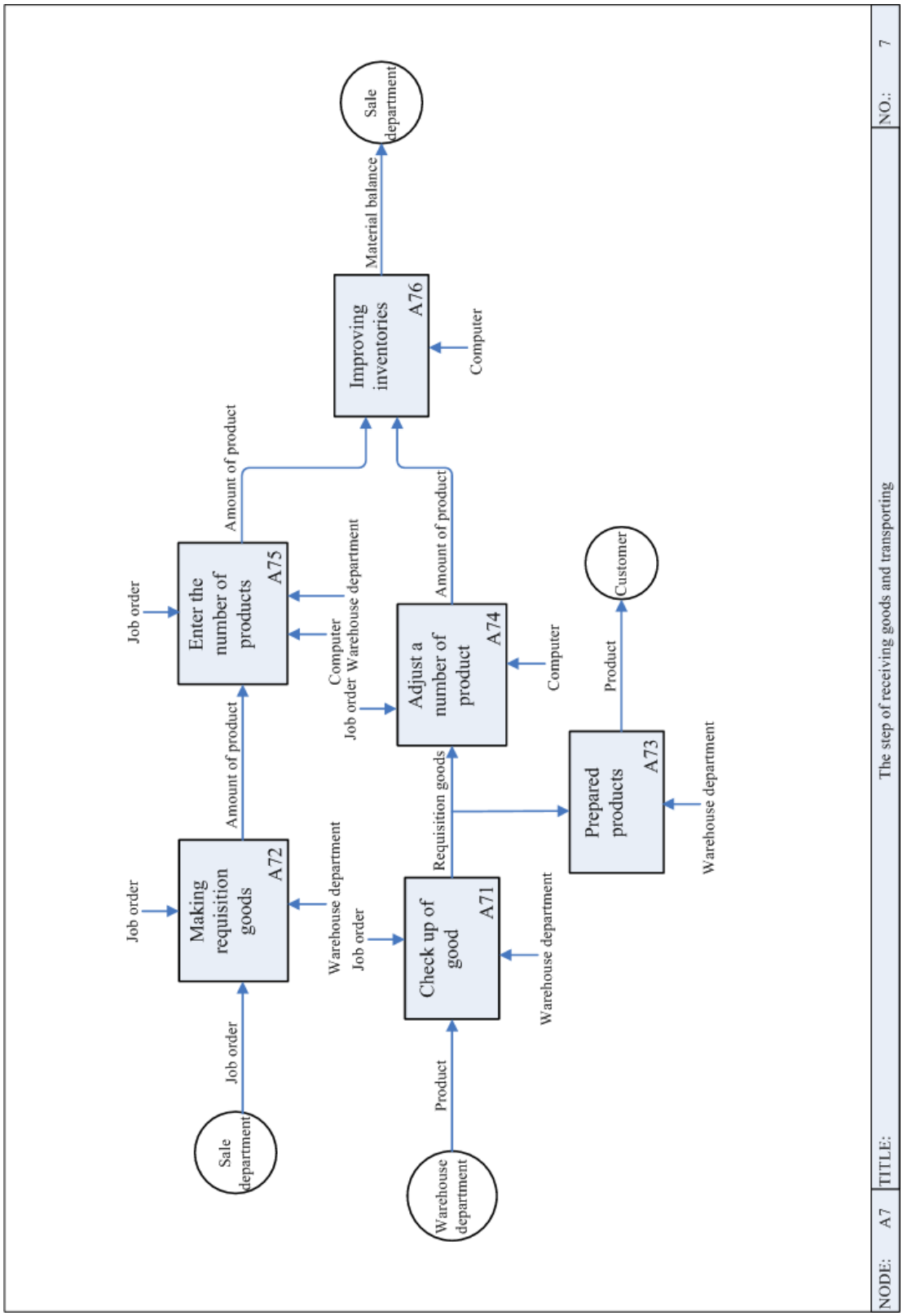


Figure 4-7 The step of receiving goods into the warehouse and transporting to the clients

From Figure 4-1, IDEF overview of business process of steel products from the step of purchasing order, production planning, planning, steel arrangement, raw material purchase, raw material keeping, and receiving goods into the warehouse and transporting. The mapping will show that the sale department will ring up the clients of the company to know their demands, if they do, the sale department will open job order in order that the production planning department will make bills of materials to specify details of tools used in producing goods, and sending received data to the steel arranging department to finding steels. For the production planning department has to keep waiting steel arranging reports and weekly production sum-up from the production department to plan the production weekly. When the production planning has been already done, weekly production plans and production order bill will be sent to the production department. And the steel arranging department will send them to the production department in order that the production department will produce goods. In case raw materials are not enough, the warehouse department will have the purchasing department ordered raw materials for keeping goods into the warehouse, and when the products have been already finished production by the production department, goods will be sent into the warehouse and will be transported to the clients on time.

From Figure 4-2, exhibits purchasing order step, so that it has been found that the sale department has received data of remaining goods from the warehouse As goods have been decreased at one level, the sale department will ask for the clients about their demands of extra goods, if they need, the sale department will open job order and sends it to the planning department for furthering the plan.

From Figure 4-3, exhibits production planning step. Having received job order from the sale department, the production planning department will make bill of materials to specify the details of tools used in producing goods, and send data of goods materials to the steel managing department. After that the production planning department will check up production power so as to calculate producing time along production lines into production planning to the goods production department which production planning adaptation will be made every week by the production planning department.

From Figure 4-4, exhibits the step of raw materials purchasing. Raw materials purchasing has different classification as thus;

- Steel, the steel arranging department will inform the executives about the remaining of steels and the executives themselves are determined to purchase. They will consider the necessity of job, price of steel at each time and financial status of the company in which supplier will come from the country itself and the abroad.

- General raw materials purchasing order (lacquer, box, color) will be determined by the production department and purchasing offer will be sent to the purchasing department to order raw materials.

From Figure 4-5, exhibits the step of production. The planning department will send production plan and production order to the production department that can be sub-divided into the department of enamel, the department of designs making, and then sending it to the steel cutting department, and next to the steel shaping department. At the same time, there will be a cover making by combining it in shape and transporting combined goods to the warehouse department for keeping and to the clients later.

From Figure 4-6, exhibits the step of raw materials keeping. Having received raw materials, the warehouse department will check up purchasing order and raw materials by checking up amounts and code of raw materials. If they were steels, there will be the release of receipt order. There will be raw materials keeping according to the whereabouts of each kind of materials.

From Figure 4-7, exhibits the step of receiving goods into the warehouse and transporting to the clients. In keeping goods into the warehouse, there will be the total check-up of goods before keeping into the warehouse. For the transportation of goods, the warehouse department will bring data of transporting goods obtained from job order for making clearing order, and transport goods together with the adaptation of goods price. After that the warehouse department will report the remaining goods to the sale department after goods have been already transported.

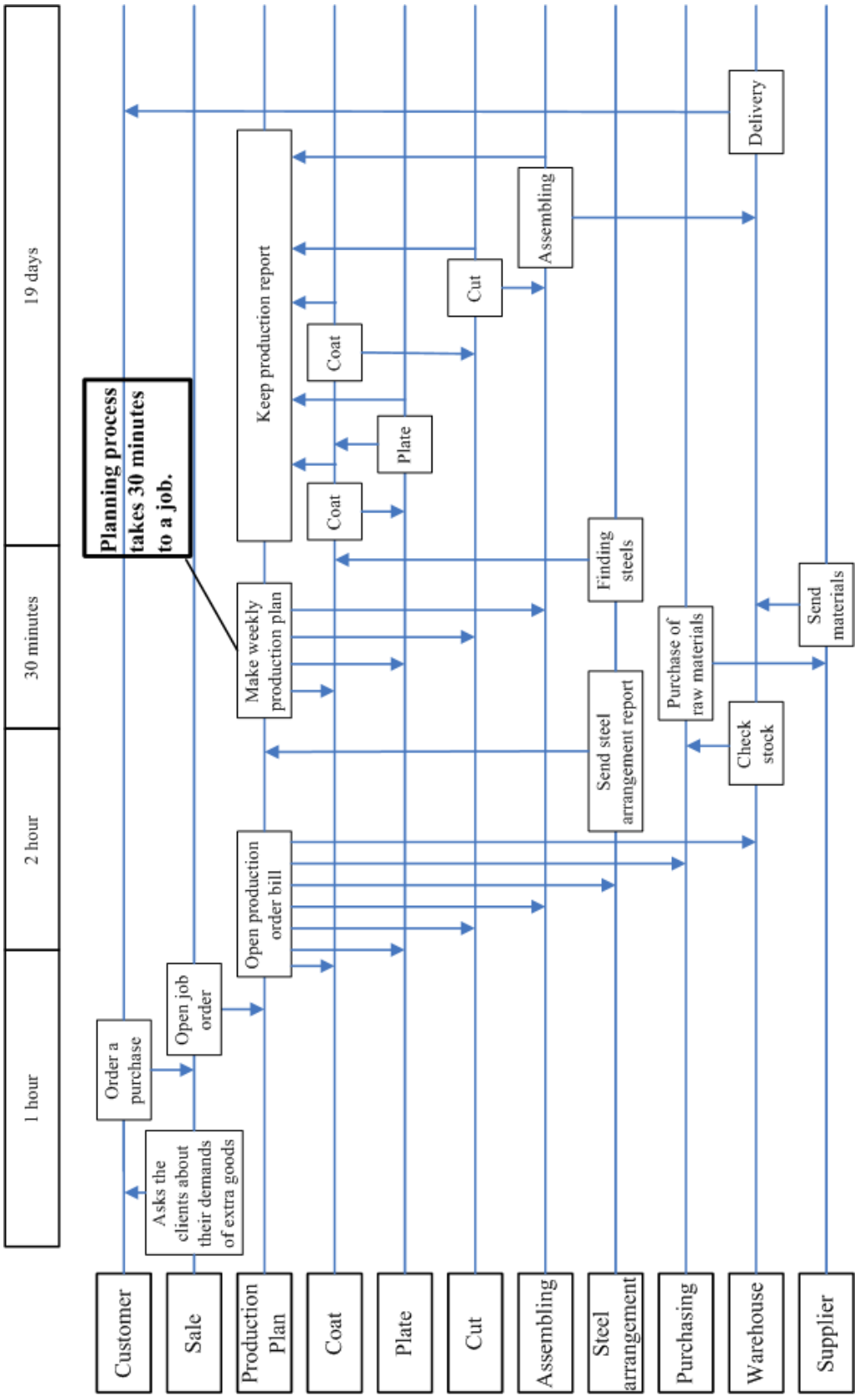


Figure 4-8 Swim Lane Diagram Working Process of the case study

From Figure 4-8, it shows Swim Lane Diagram Working Process of the case study company. The sale department asks the clients about their demands of extra goods, if they need, job order will be launched to the production planning department. The production planning department will plan the production weekly and bring production plan obtained to the department of molding, the enamel department, the shaping department, the steel arranging department, and the warehouse department. The warehouse department will again check up if raw materials are sufficient for producing goods, if not sufficient, it is the duty of the purchasing department to purchase goods. After goods have been produced, they will be kept and transported step by step.

4.4 Conclusive Problems

From the problems analysis, it has been found that most of the problems originated from the production planning system as following:

1) At present, the factory has received purchasing order and kept bill of materials (BOM) in the File Maker Program without keeping it in the database, so that the finding of goods data for production planning is prolonged.

2) Production planning department will report a weekly production sum up. Thus, production planning department can not adjust the plan to keep up the situation that occurred.

From the structure of purchasing order of the clients, of planning and controlling production to solve planning problems that cannot adjust production planning in time, there must be the connection of production planning information effectively, rapidly, and luxuriously so as to decrease time and increase the efficiency of data connection in production logistics in the factory. Thus, program being made in the factory can be mostly divided into 2 parts;

1) Order receiving part

2) Production planning part

4.5 Trend of solving problems

Having recognized after amassing data by observing practicality, an interview, the purchasing department, the production planning department, the production department and the warehouse department, together with logistics mapping, it has been concluded that business process of metal products of the case study-company comprises of principal problems such as;

1. The production department does not report products to the planning department every day, it is reported weekly. So production planning must be made weekly.

2. Production planning arisen from the latter that makes it not present, if the plan is necessarily needed, there will be lacking of planning adaptation that can give rise to the difficulties.

3. For File Maker Program, data gathering pattern has not been kept as database, so it is very difficult to be sought data at the later time.

In order to solve these problems the case study-company should adjust working process and making logistics mapping of the new system after each problem has been solved.

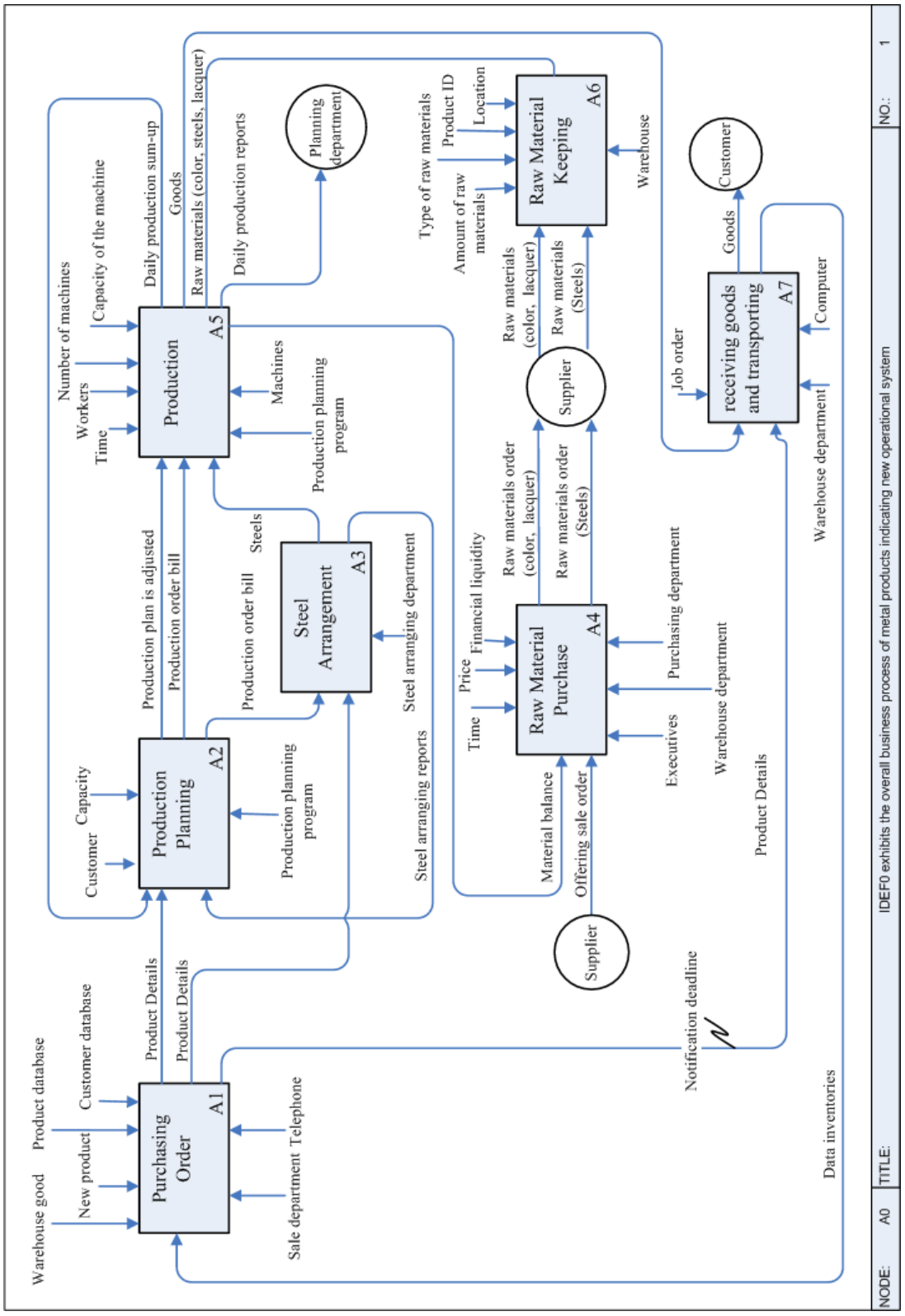


Figure 4-9 The overall business process of mental products indicating new operational system

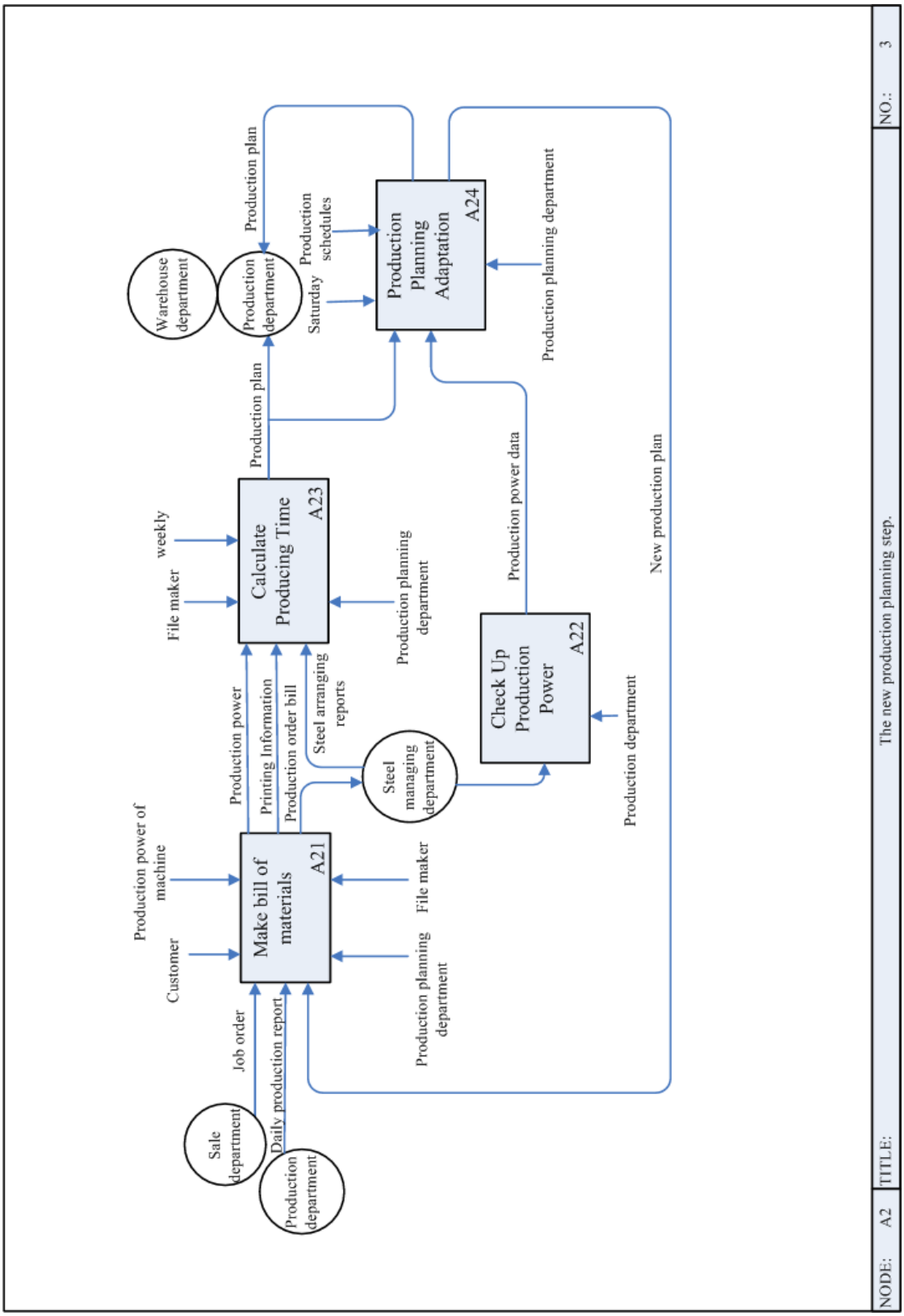


Figure 4-10 The step of new production planning

From Figure 4-9: IDEF0 shows the overall business process of metal products indicating new operational system, and its activity can be divided such as the activity of purchase order, of production planning, of raw material purchase order, of raw material preservation, of production activity, of metal arrangement and products checking as well as products exportation. At each activity, there will be the connection beginning with purchase order from customers to purchase order and production planning that will be used by the call for purchase order, thereafter, products data and the amount of products will be sent to the production department. For the production department will receive daily production data from the production department including metal data from the metal arrangement department and data of remaining products from the products warehouse department. After production planning has been finished the production planning will be sent to the production department so as to making products. Having finished production, products will be sent to the warehouse department for checking, keeping and sending. Besides, the production department will check the remaining raw material, if there will be purchase order or lack of any raw material for the production, the data will be sent to the purchase order department for purchasing raw material.

From Figure 4-10, IDEF shows the step of new production planning: when the planning department receives job order from the sales department and the daily production report from the production department, it will bring data for calculating the time used in production in the production planning program. For this kind of planning can decrease the time used in searching goods and production planning, for data collection as the database has been kept.

4.6 Design of the new system

4.6.1 Analyzing main production planning program

Main production planning is the item ordered by the customers to enumerate production amounts that should be produced each day. For the analysis of business process, main production planning can be divided as follows;

4.6.1.1 Fundamental data of main production planning system is needed such as products items and products models produced by the factory.

4.6.1.2 Holidays data for setting the day that will not produced the product.

4.6.1.3 Machine data or production line including production power of machine.

4.6.1.4 Products items data ordered are the customers; goods items, goods amounts, the day of goods order

4.6.1.5 Method of production planning standardized be the factory is as follows;

1) EDD (Earliest Due Date): choose the earliest due job, but if there is the earliest due job at the same day more than one, both jobs should be brought and arranged according to the shortest operation

2) LPT (Longest Processing Time) : choose time that has the longest processing time, if any work that has equal processing time , equal processing time should be primarily brought and arranged according to due date.

3) Production Timetable Arrangement Process: the step of calculating the amounts of days to produce goods can be divided into varnishing step, molding step and shaping step. These steps can be described in detail;

Varnishing step

Step 1 receiving report bill of steel arrangement and investigating the amounts of steel used in vanishing.

Step 2 calculating the time used in molding by the following equation;

(S*V) / Vs

S = steel amounts

V = varnishing speed amounts

Vs = varnishing speed.

Step 3 calculating machine adjustment time;

Machine Settings: 20 minutes each time

Change Anilox: 10 minutes each time

Wash machine: 30 minutes each time + 30 minutes

Step 4 adding up the time of varnishing to machine adjustment time (step 2 and step3)

Molding step

Step 1 receiving report bill of steel arrangement and investigating the amounts of steel used in Molding.

Step 2 calculating the time used in molding by the following equation;

(S*M) / Ms

S = steel amounts

M = molding speed amounts

Ms = molding speed.

Step 3 calculating machine adjustment time;

Machine Settings: 20 minutes each time

Change plate: 10 minutes each time

Wash machine: 30 minutes each time + 30 minutes

Step 4 adding up the time of varnishing to machine adjustment time (step 2 and step3)

Assembling Step

Calculating the amounts of days used in assembling by equation;

A/C

A = amounts of ordered goods

C = capacity of the machine

Therefore, amounts of days used in producing any kind of goods will equalize the total of varnishing step, molding step and assembling step.

4.6.2 Component and operation of a new system

In designing the information system for the arrangement of production timetable, operational proviso is that production timetable received can be put in when urgent job has occurred, production timetable must have the inter-connection with the information data effectively, the production department must report production trough set up- system, if there is a job that cannot be operated according to the planning, the production planning department will receive data and adjust production planning immediately. The information system can be divided into 2 sections;

4.6.2.1 Purchase Order System

For purchase order system, the step of operation is the production planning will receive metal producing order, metal proof order, goods grouping documents, and drawing from the sales department, after that the planning department will purchase order recording the clients of data and goods into the system, and the system will show order bill to the warehouse department, steel arranging department and the production department, thereafter the steel arrangement department will send steel arrangement report into molding to the production planning department. Then the warehouse department will report the amount of goods in the warehouse to be used as production planning.

4.6.2.2 Production Planning System

For production planning system, the production planner must choose production order bill required for arranging production timetable by choosing through the system, then the system will calculate the amount of days used in production of each job order.

Production planning monitor will detail on production of each chosen job, the time used at each step, the time of transporting goods to the clients, and the production line. Each day the production department will report goods production status when any job that cannot be produced according to production planning, the production planning department can next day adjust new products, and when urgent and significant job has occurred , production planning will been adjusted either.

4.6.3 Data flow diagram of the new system

In the development of the system, we employ Data Flow Diagram for designing the new system due to the fact that such diagram can indicate data from analyzing the former system and add the need of the new system users. Besides, it still makes the background of the data and process within the new system that indicating the detail involved in writing data flow diagram as shown in Figure 4-11.

List of Process

1. Main information improvement
   - 1.1 List of goods improvement
   - 1.2 Component improvement
   - 1.3 Job Order improvement
   - 1.4 Production planning improvement
2. Purchasing order
   - 2.1 Goods and customer searching
   - 2.2 Information saving
   - 2.3 List deleting
   - 2.4 Job order printing
3. Steel arrangement report
4. Production planning
   - 4.1 Production scheduling
   - 4.2 Check weekdays and weekends
   - 4.3 Production scheduling printing
5. Production reports
6. Add/edit login password
7. Printing

List of External Entities

1. Production planning department
1. Production department
2. Steel arrange department
3. Warehouse department
4. Executive

List of Data

1. Product
2. Customer
3. Department
4. Machine
5. Weekend
6. UserLogin
7. JobOrder
8. JobPlan
9. Scheduling
10. Base
11. Body
12. Cover
13. Other
14. Color
15. Skin
16. Iron
17. IronStrong
18. Box
19. Package
20. Delivery
21. IronReport
22. CoatReport
23. Print1Report
24. Print2Report
25. CutIronReport
26. AssamblyReport
27. Print1
28. Print2
29. Print3
30. Print4
31. Print5
32. Print6
33. Print7
34. Print8
35. TypeProduct

Figure 4-11 Lists of External Entities, List of Data and List of Processes

From Figure 4-11, we have brought the detail involving with the development of the new system to write as data flow diagram level 0 or Context Diagram as shown in Figure 4-12. And from Context Diagram, we has also brought data to write in Process Decomposition diagram to show the process of Data Flow Diagram at each level clearly as shown in Figure 4-13.

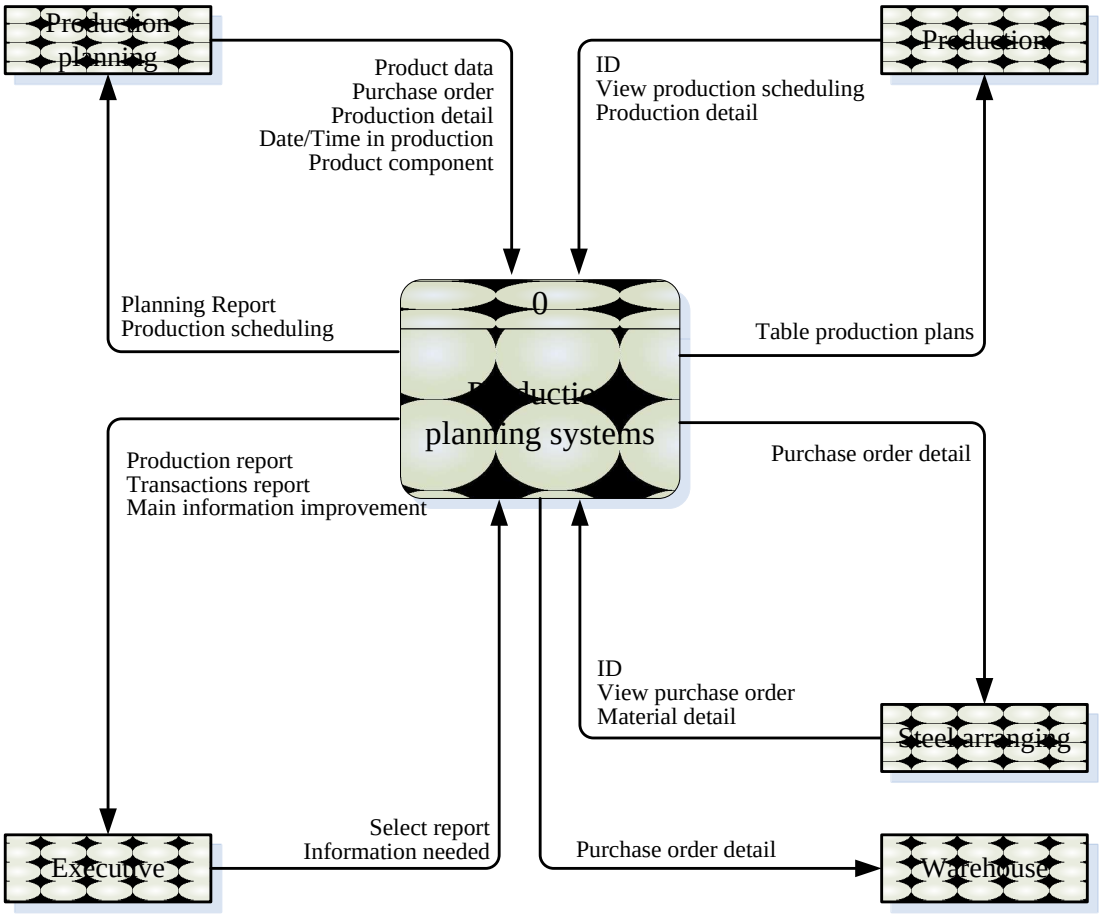


Figure 4-12 Context Diagram (DFD Level0)

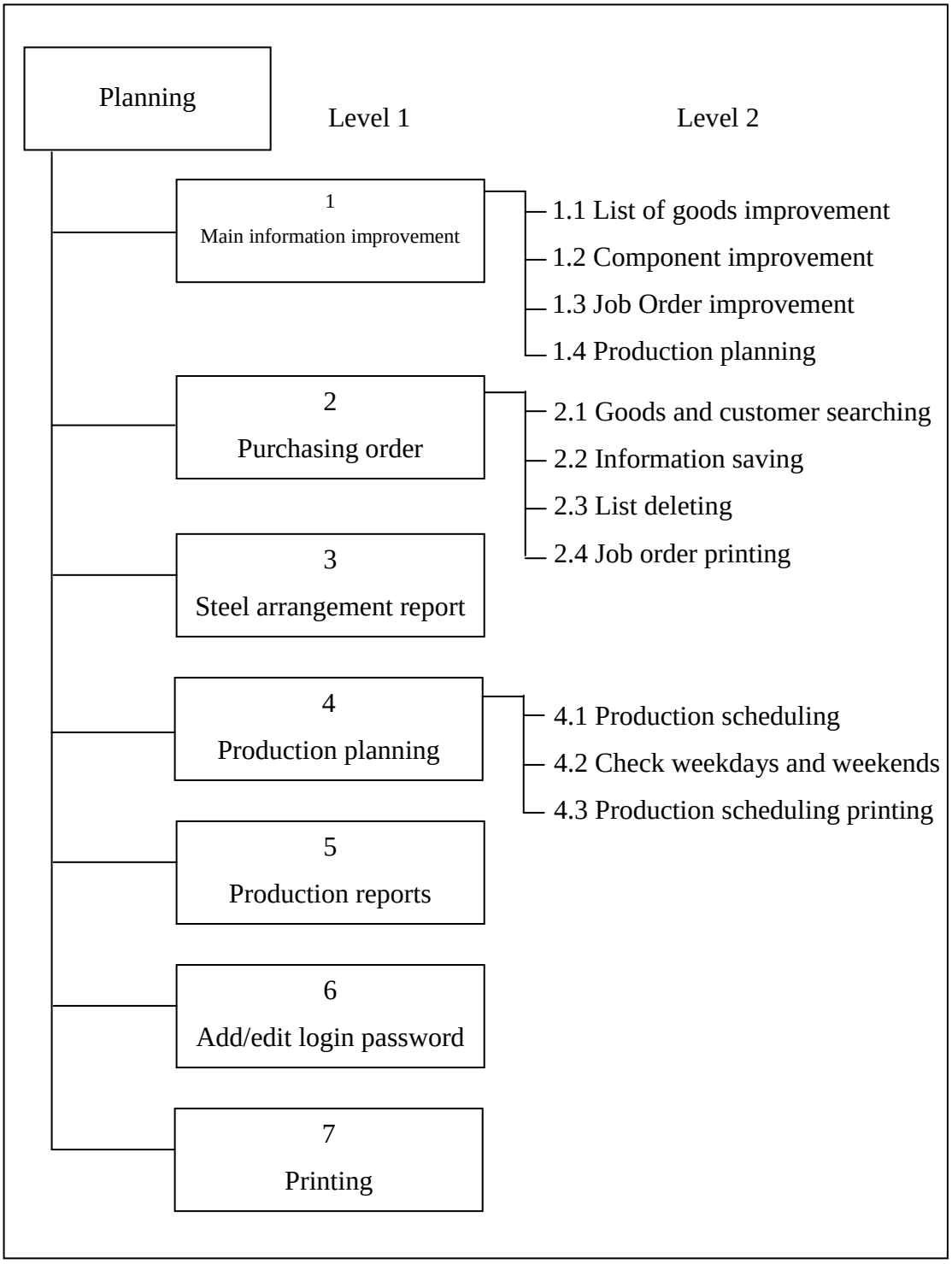


Figure 4-13 Process Decomposition Diagram of Order receiving system and Production planning system

From Process Decomposition Diagram of purchase order and production planning system, we has brought it to be written as operation process of all activities such as 1) main database adjustment 2) purchase order receipt 3) production planning 4) steel arrangement report 5) production report 6) add/ correct users passwords 7) report model expressing DFD Fragment of all activities as shown in Figure 4-14 – 4-20.

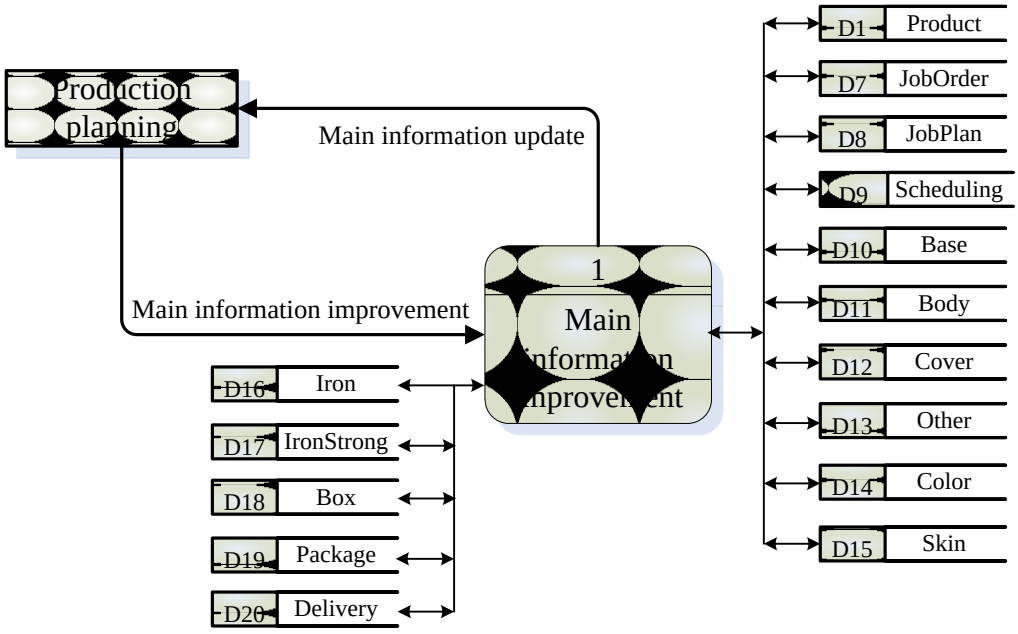


Figure 4-14 DFD Fragment 1: Main information improvement

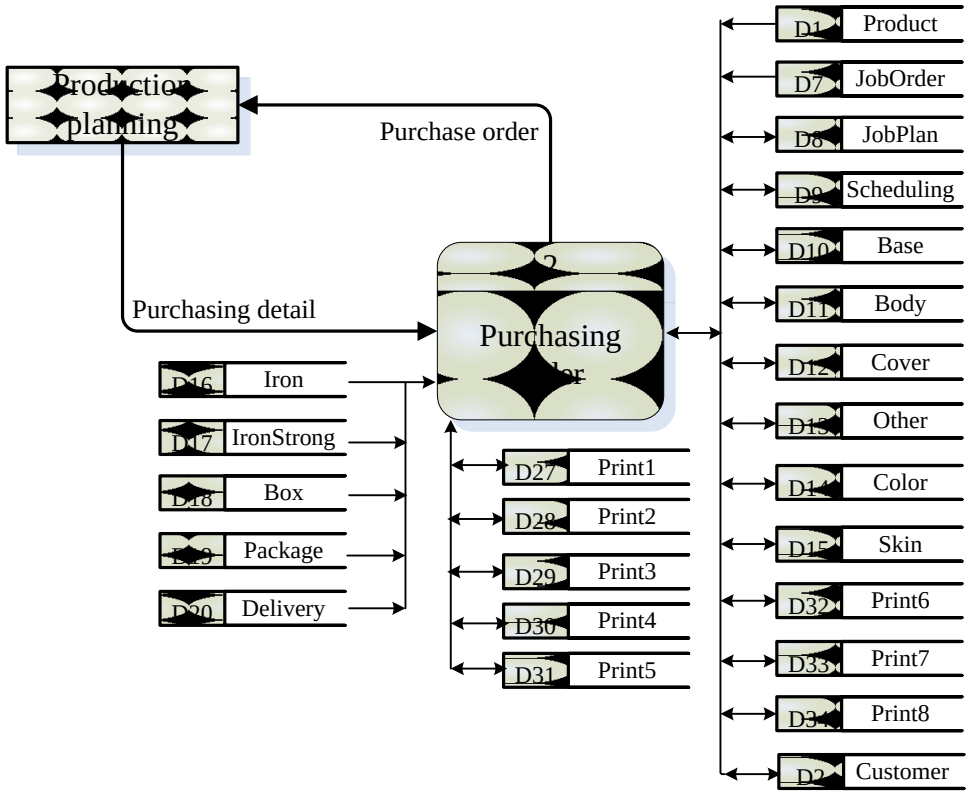


Figure 4-15 DFD Fragment 2: Purchasing order

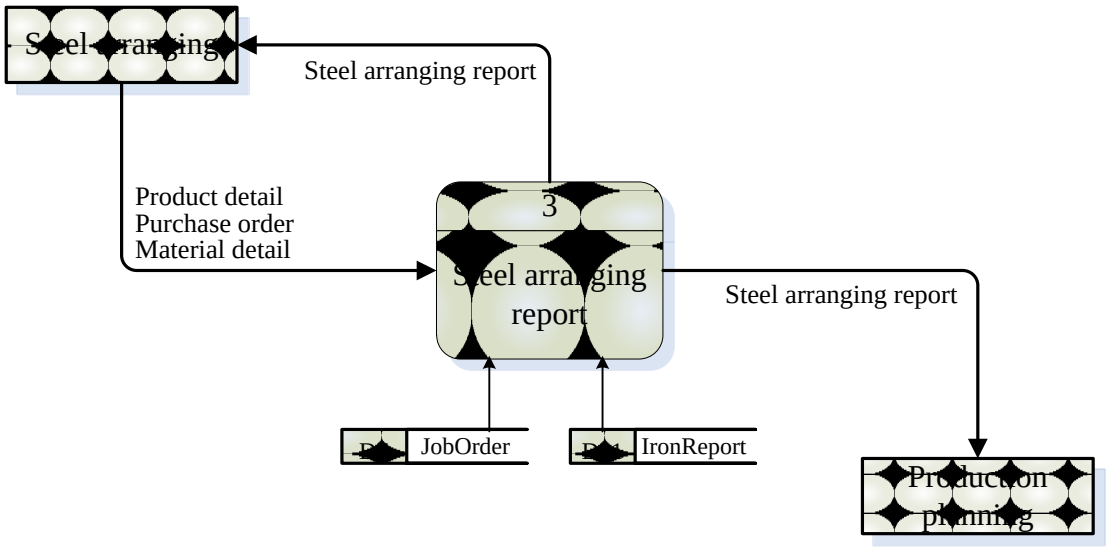


Figure 4-16 DFD Fragment 3: Steel arrangement report

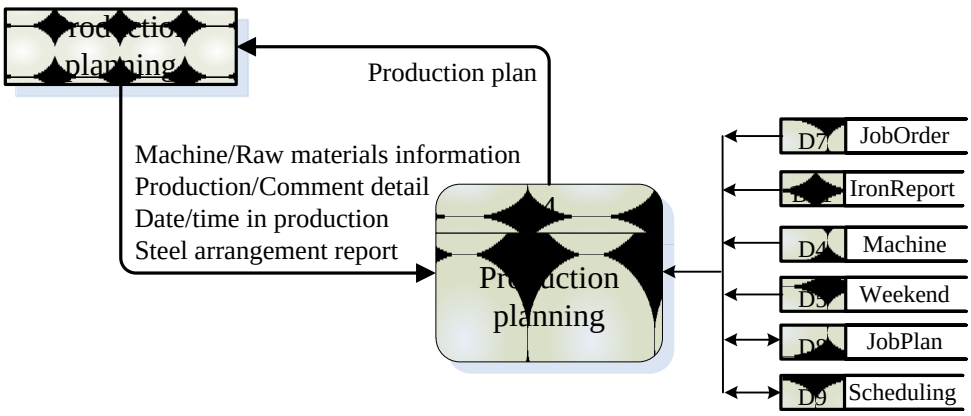


Figure 4-17 DFD Fragment 4: Production planning

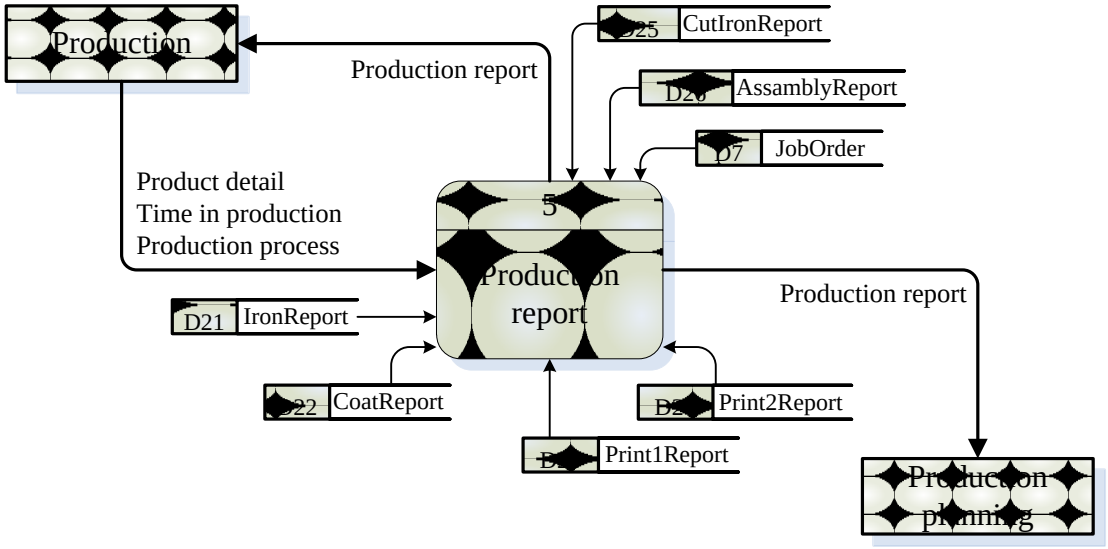


Figure 4-18 DFD Fragment 5: Production reports

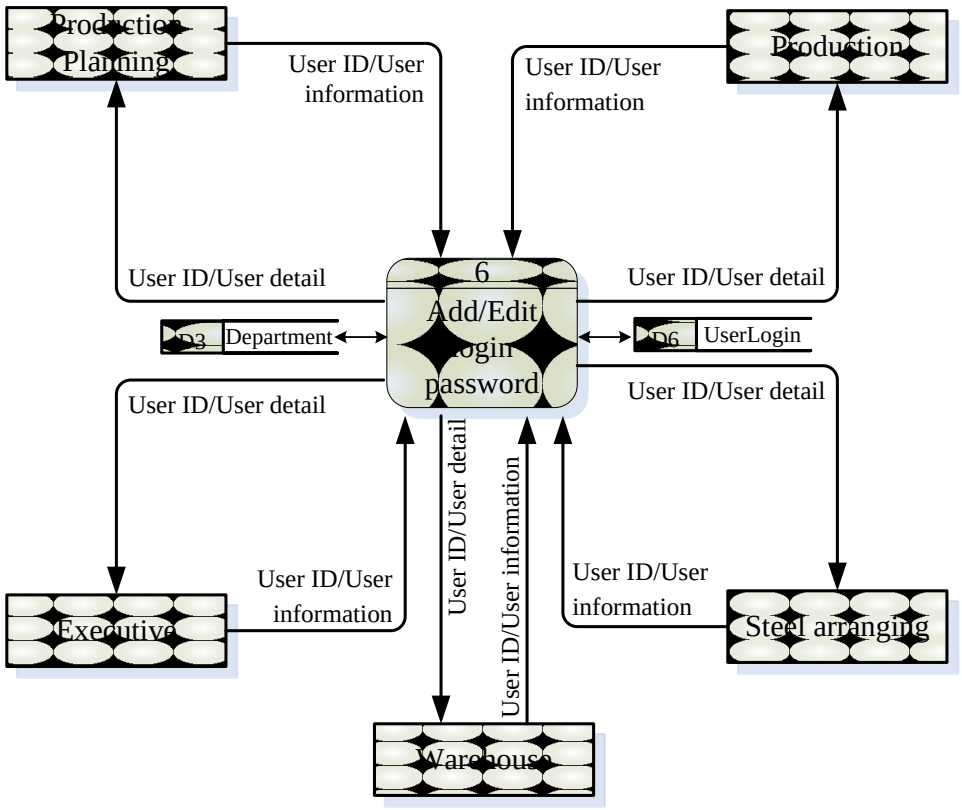


Figure 4-19 DFD Fragment 6: Add/edit login password

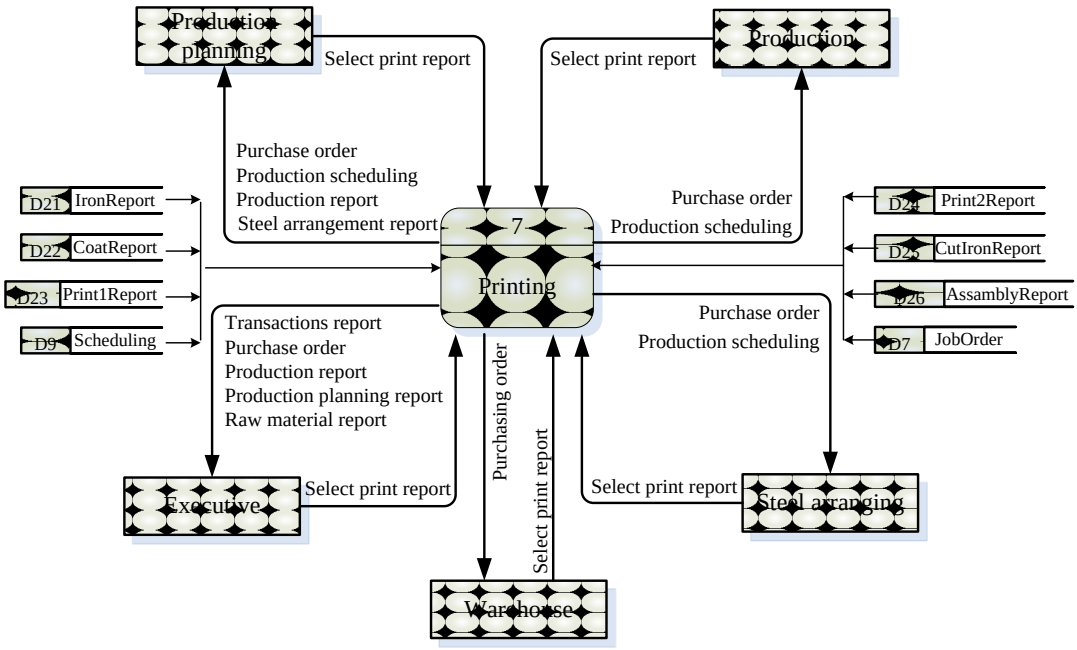


Figure 4-20 DFD Fragment 7: Printing

From seven activities DFD, this research has taken every activities combination as shown in Figure 4-21.

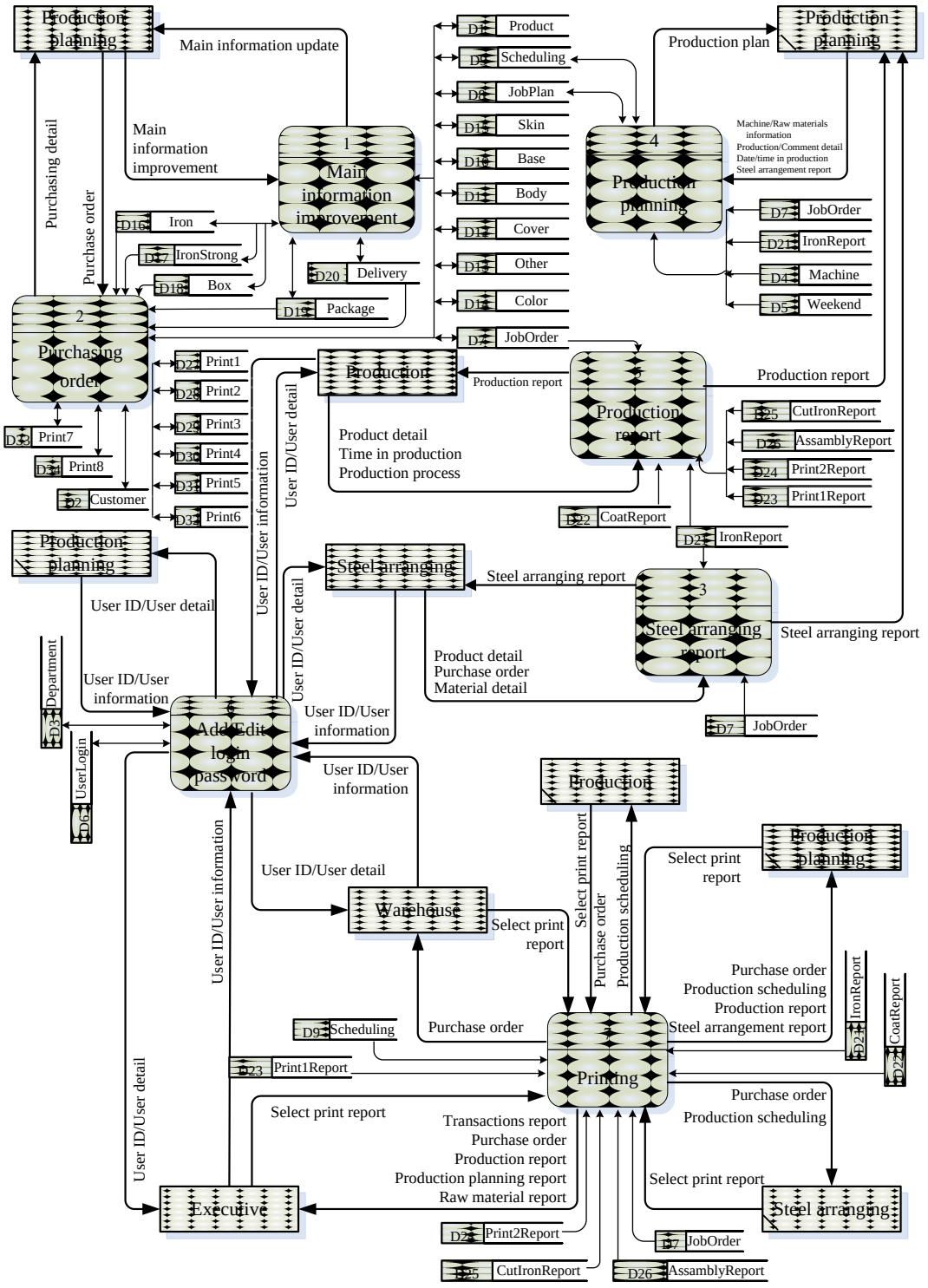


Figure 4-21 DFD Level1

In data flow diagram level2, this research showed the performance of sub processes, of data flow diagram for showing the sub activities of three main activities : 1 file data improvement 2 purchase order receive and production planning as shown in Figure 4-22 – 4-24.

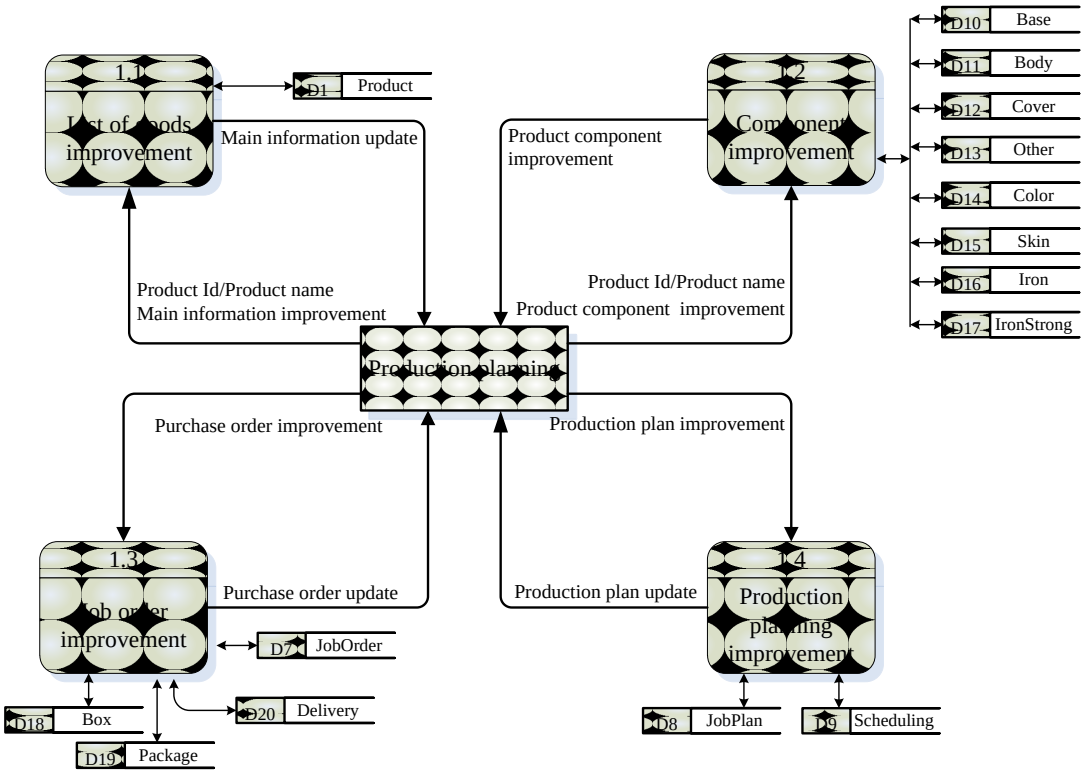


Figure 4-22 DFD Level2: Main information improvement

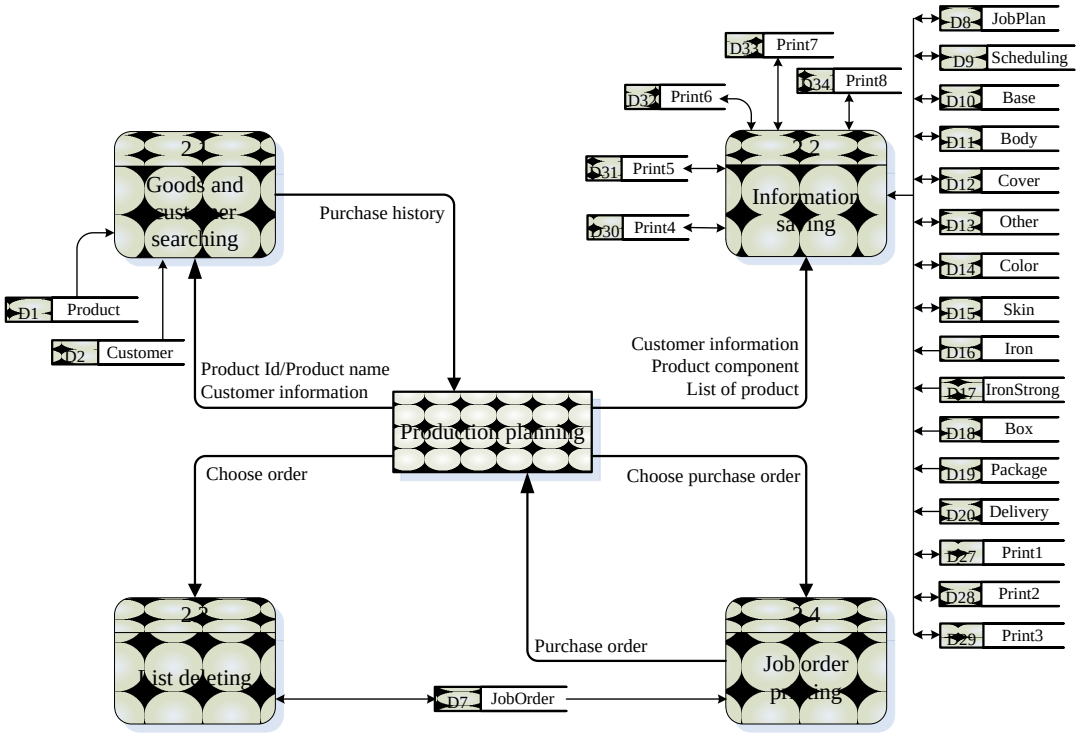


Figure 4-23 DFD Level2: Purchasing order

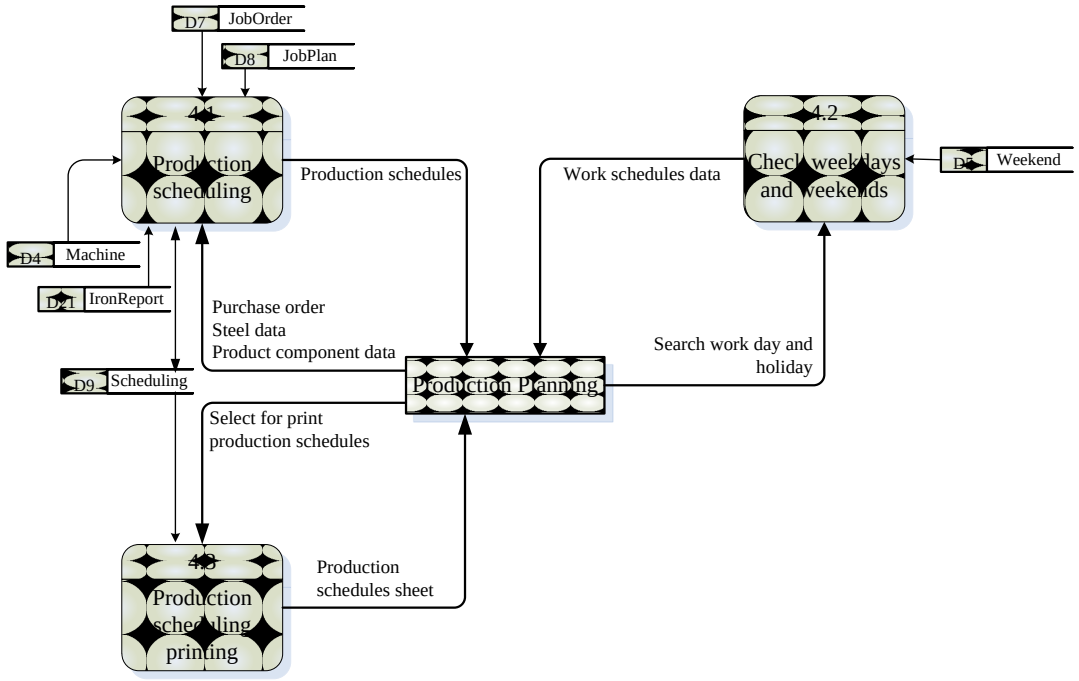


Figure 4-24 DFD Level2: Production planning

4.6.4 Entity Relationship diagram of the new system

This research store the information by Microsoft SQL2005 that simulate the information in storage by using ER-Diagram that compose the tables Microsoft SQL server 2005 and every tables show the relationships entities as shown in Figure 4-25.

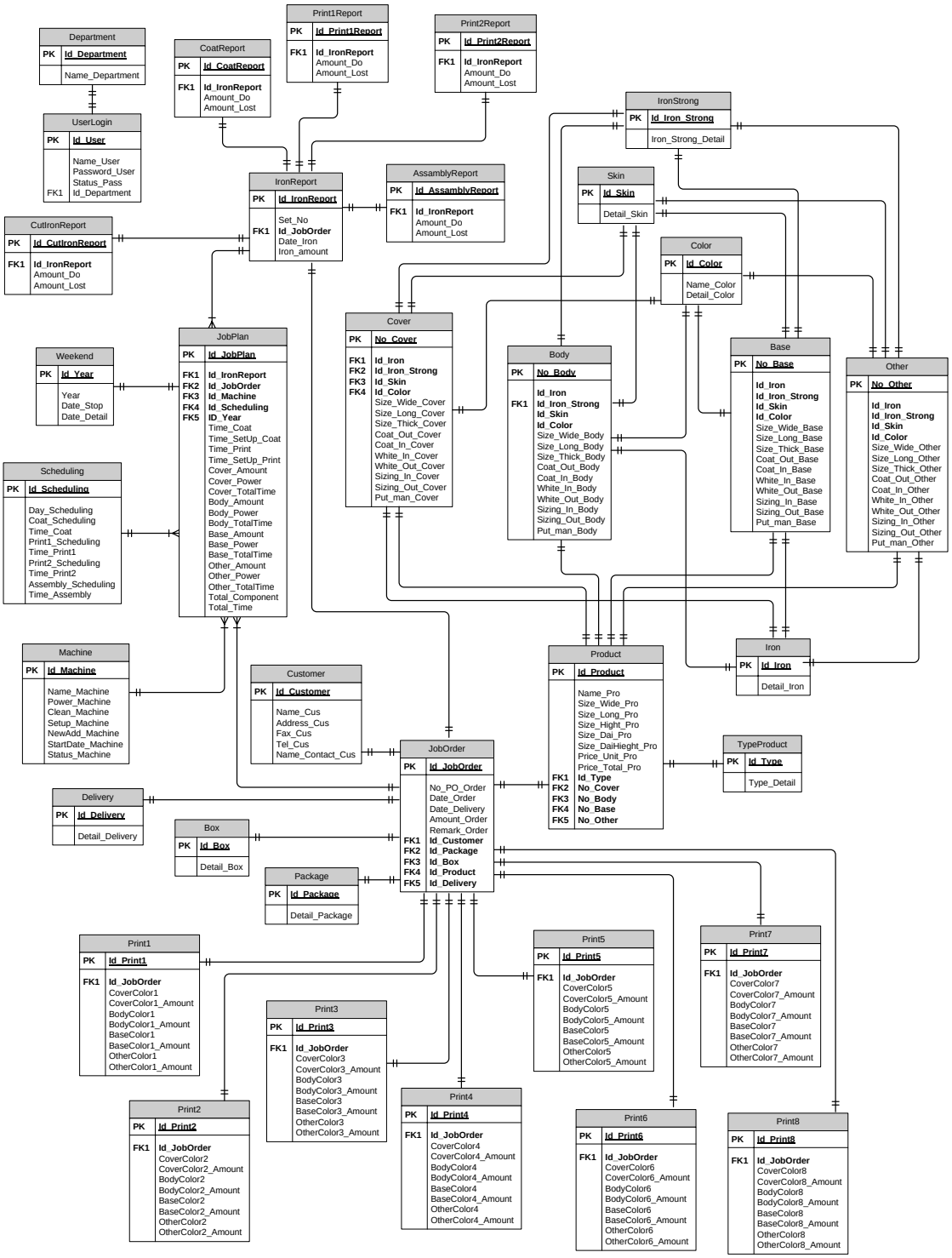


Figure 4-25 E-R Diagrams

4.6.5 Architecture of the new system

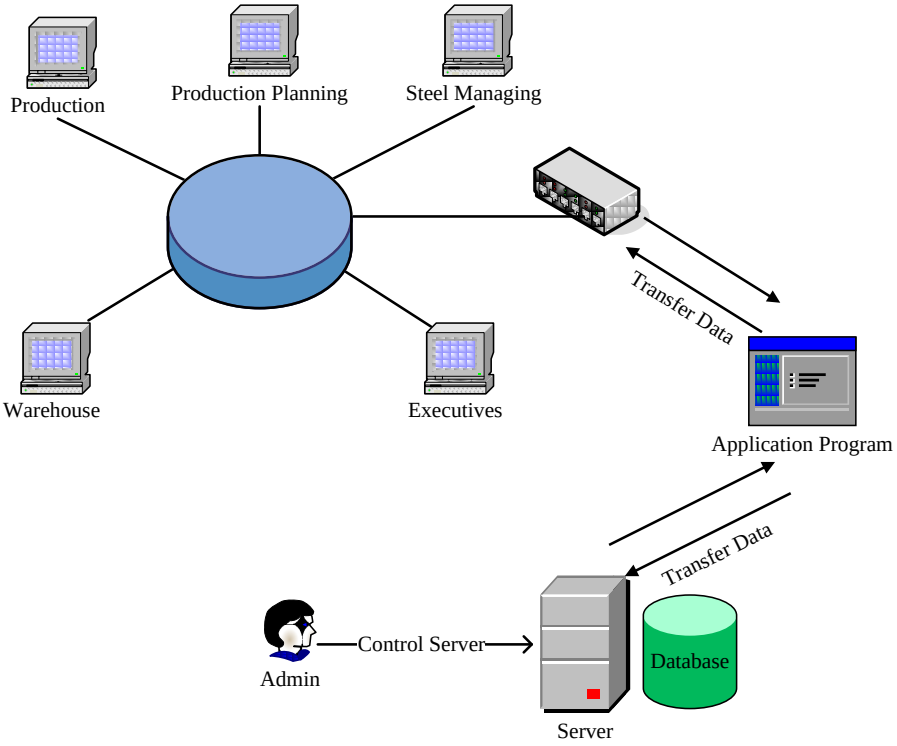


Figure 4-26 Architecture of the new system

This research develops the network system based on local area network (LAN) that has five divisions: production division, planning production division, iron arrangement division, warehouse division and executive. In addition to the administration maintain the network and database management. Every division can access every database by login. Every divisions have own limit. This research used server and client for reduce duplication of information.

CHAPTER V
RESULTS

This chapter divides the results into the following parts.

5.1 Result of the Software Development

The developed production planning system/software comprised of two portions, namely, 1) the Order Receiving System and 2) the Production Planning System.

The Order Receiving System collects the data about the products from the customer order. Such work was relevant to the production planning department. Once receipt of the order from the sale department, the production planning department recorded the entire data about the products. In case the products were same kinds of those in the earlier orders, the system could show the product data having already been stored. Then the production planning department sent the information via the system to other relevant departments.

The Production Planning System arranged the production schedules. After passing the Order Receiving System stage where product data were recorded, the production planning department calculated the production time of each kind of products and made the production planning as per the work lines.

5.2 Results of the Data Accuracy Test

This stage tested whether the system worked correctly in line with the user's demands and tried to find the errors possible to arise. This research used Alpha Testing to test the system acceptance by making a simulation of real situations and environment and using Balck Box Testing to test the needed operating functions of the system that wanted to know what result to come after the data were inputed into the system with concern on the accuracy of the data but without paying attention to the working details.

5.3 Results of the Comparison of the Working Stages of the Software

This stage tested the uses to compare the working processes of the former planner and the newly developed software so as to show the less working time of all process when utilizing the developed software.

5.4 Result of comparison of using information across departments before and after bringing new developed system to use

This step will present the data in matrix form (Information-to-Actors Matrix) in order to present information networking within the organization, to examine overall information issued during production planning process, and to compare information before and after bringing new developed information system to use.

5.1 Results of the Software Development

The information system for the production planning and scheduling had the main menu, divided by users as shown in Figure 5-1.

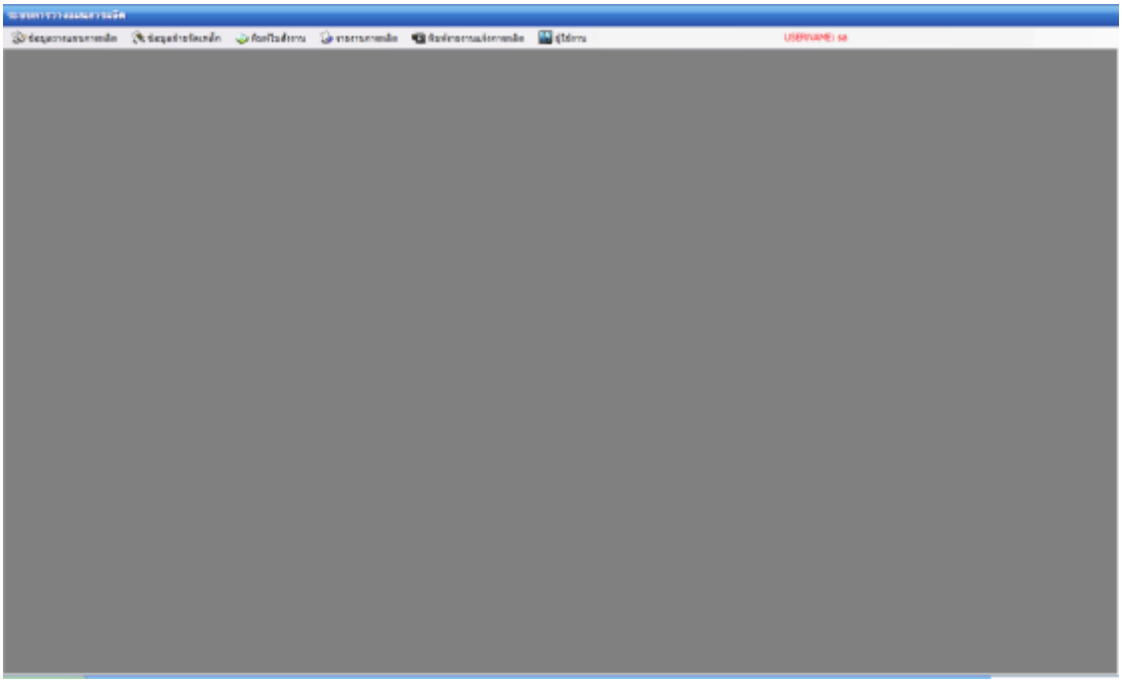


Figure 5-1 Main program form.

The overall working of the software was divided into the two parts: the Order Receiving System and the Production Planning System.

5.1.1 Order receiving system

The Order Receiving System is the process of receipt of the purchase order data and details of the products into the system. The production planning department fed the input data as seen in Figure 5-2.

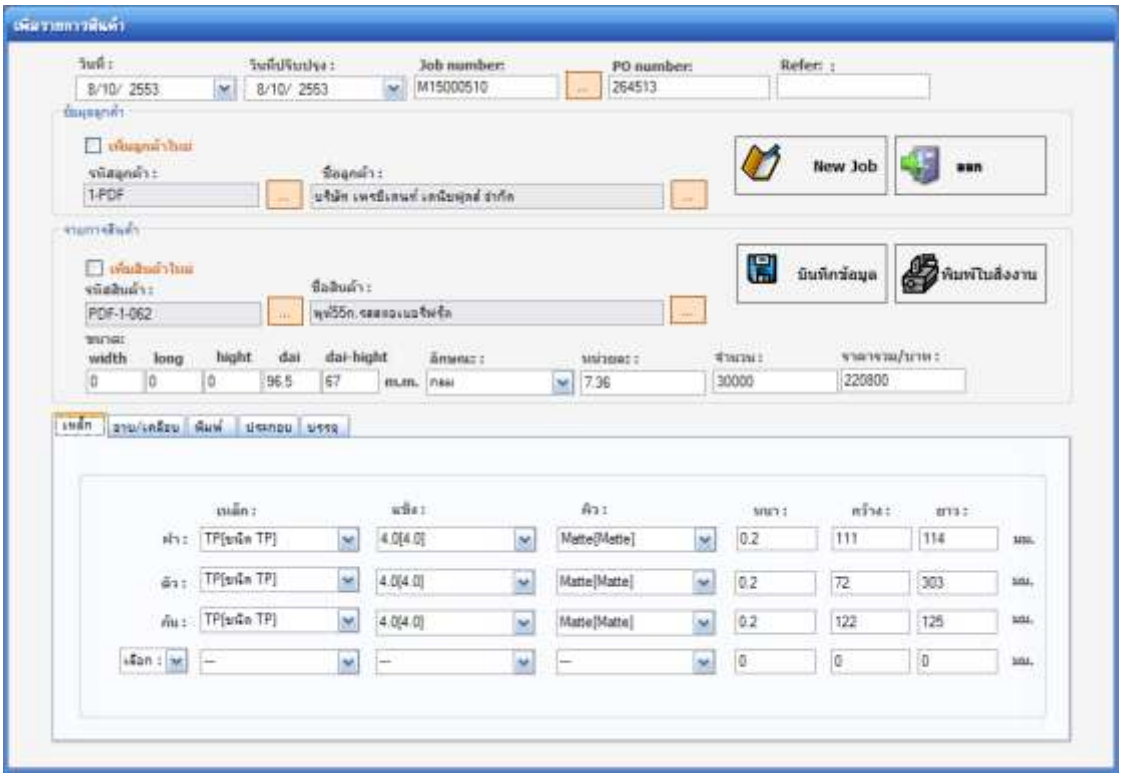


Figure 5-2 Order receiving form.

The data of the purchase orders and products were sent to all relevant departments, which were the steel arranging department, the production department and the warehouse department. The system user was required to enter into the work order printing menu and choose the product item, of which the work order was to be printed. Details are indicated in Figure 5-3.

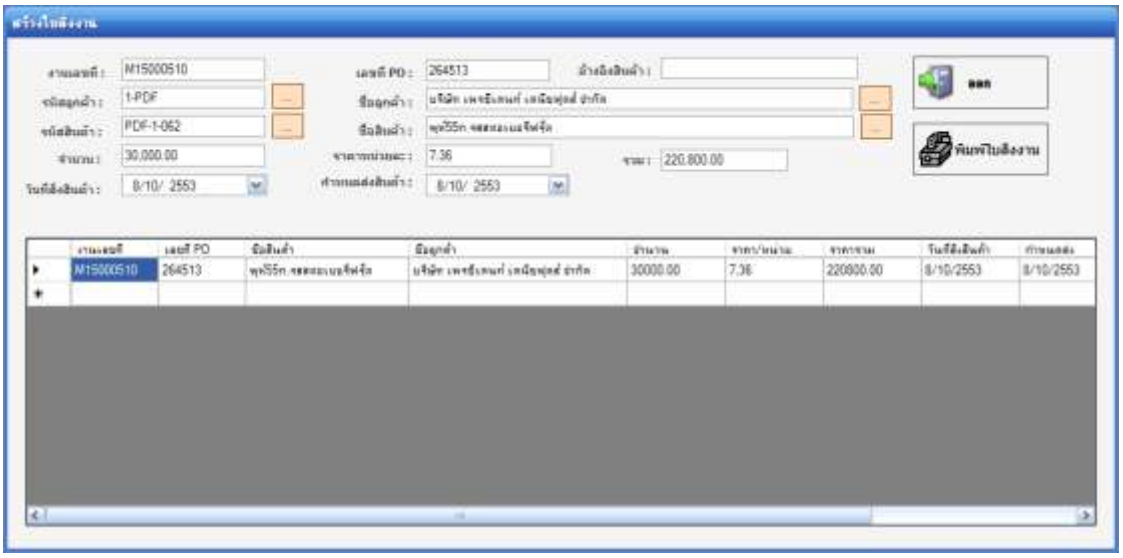


Figure 5-3 Create job order form.

5.1.2 Production planning system

When a new work order arrived, the production planner typed in the data of the work order and steel arrangement and then made calculation about the production time, as seen in Figure 5-4 and 5-5.

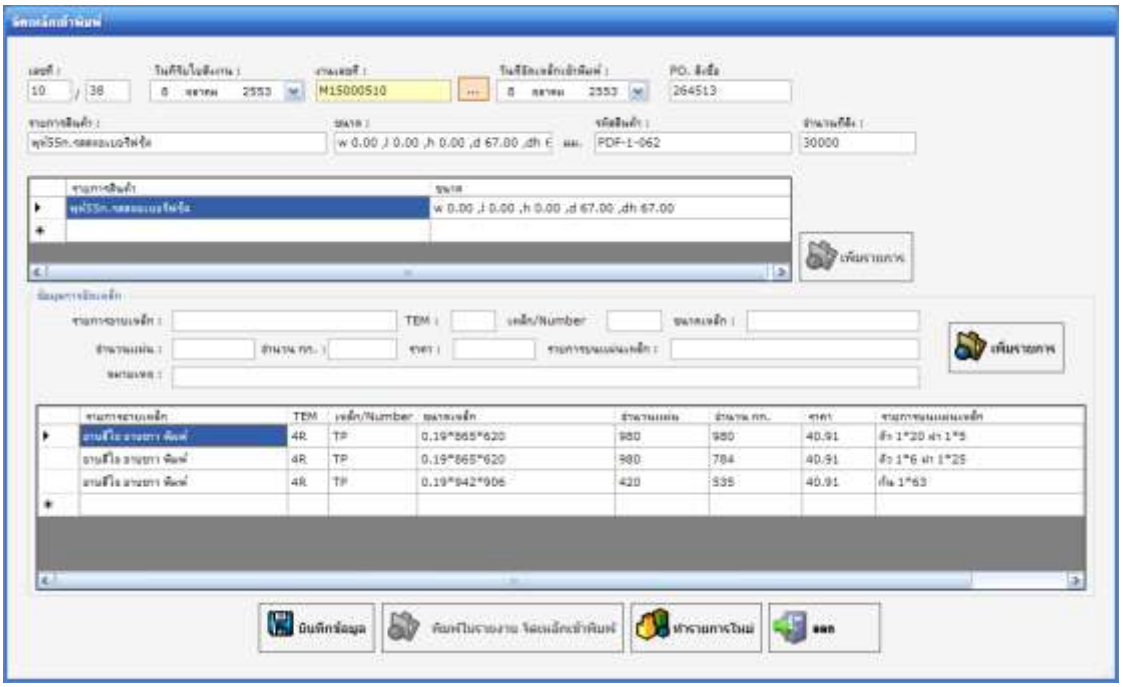


Figure 5-4 Steel arrangement form.

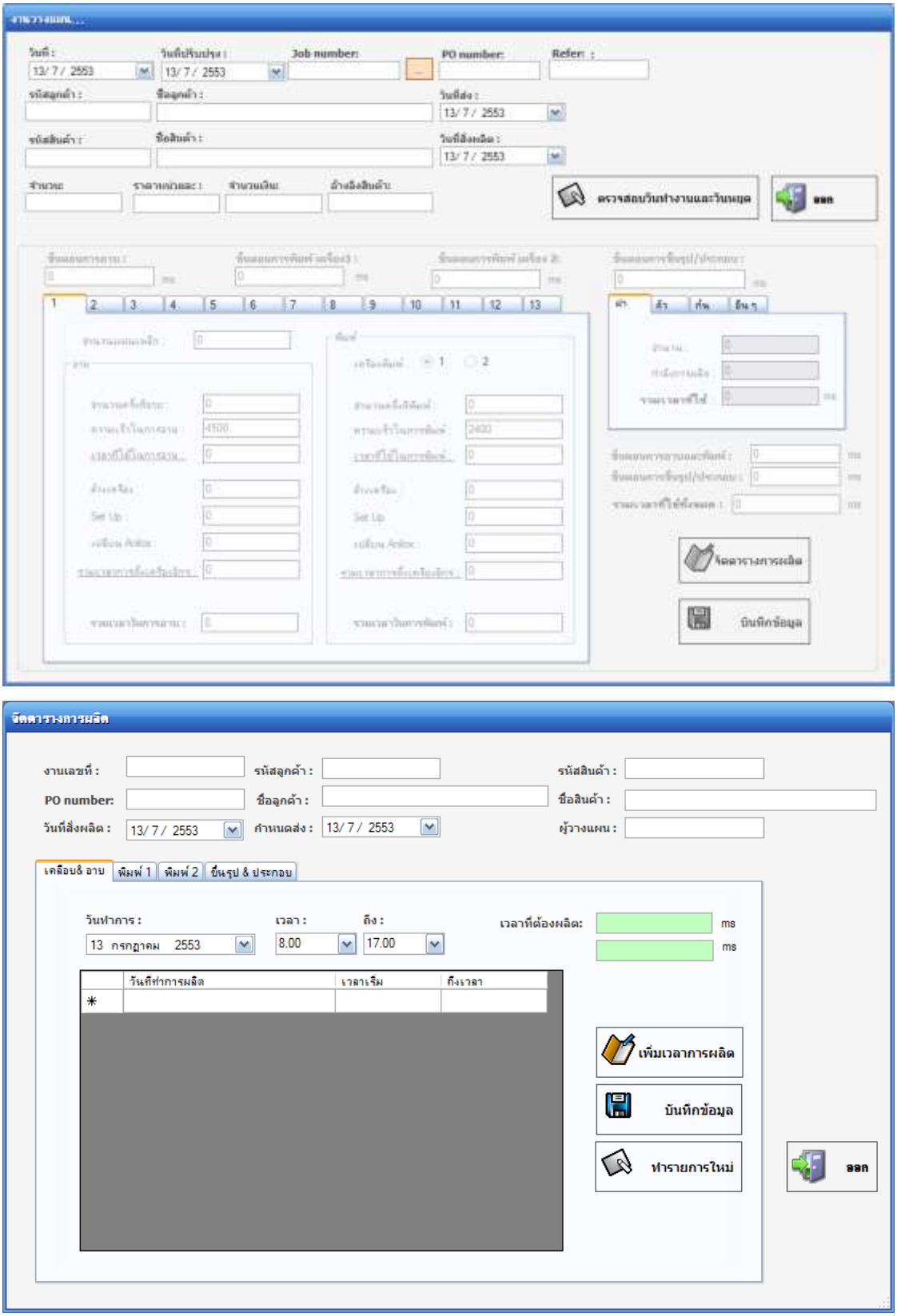


Figure 5-5 Calculation about the production time form.

The change of a production plan was made at the discretion of the planner, as manifested in Figure 5-6.

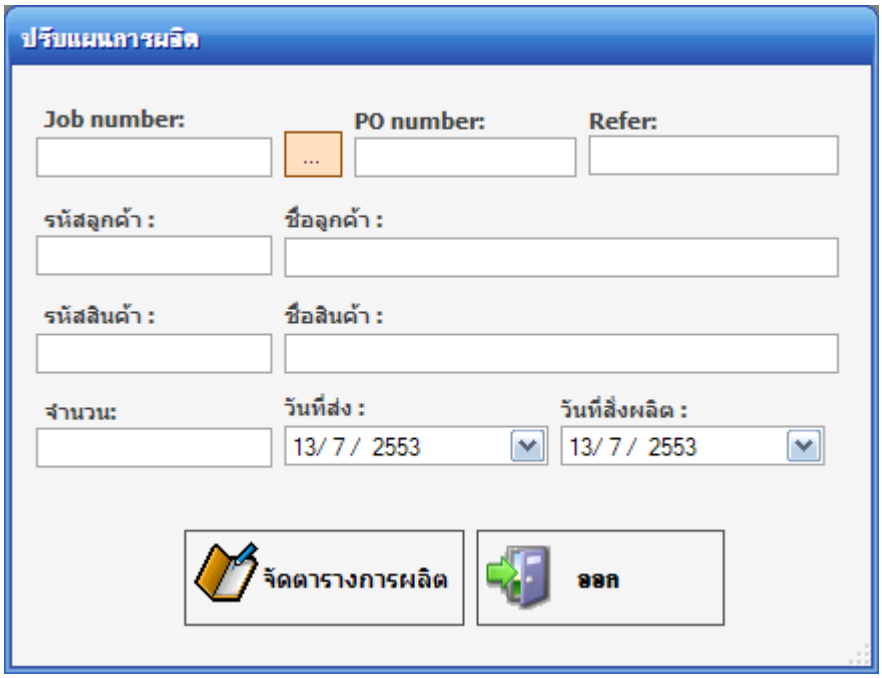


Figure 5-6 Production plan adaptation form.

Each day, the production department had to make the daily production report for the production planner to adjust the production plan so that it could cope well with the real situation. The screen of the production report is shown in Figure 5.-7.

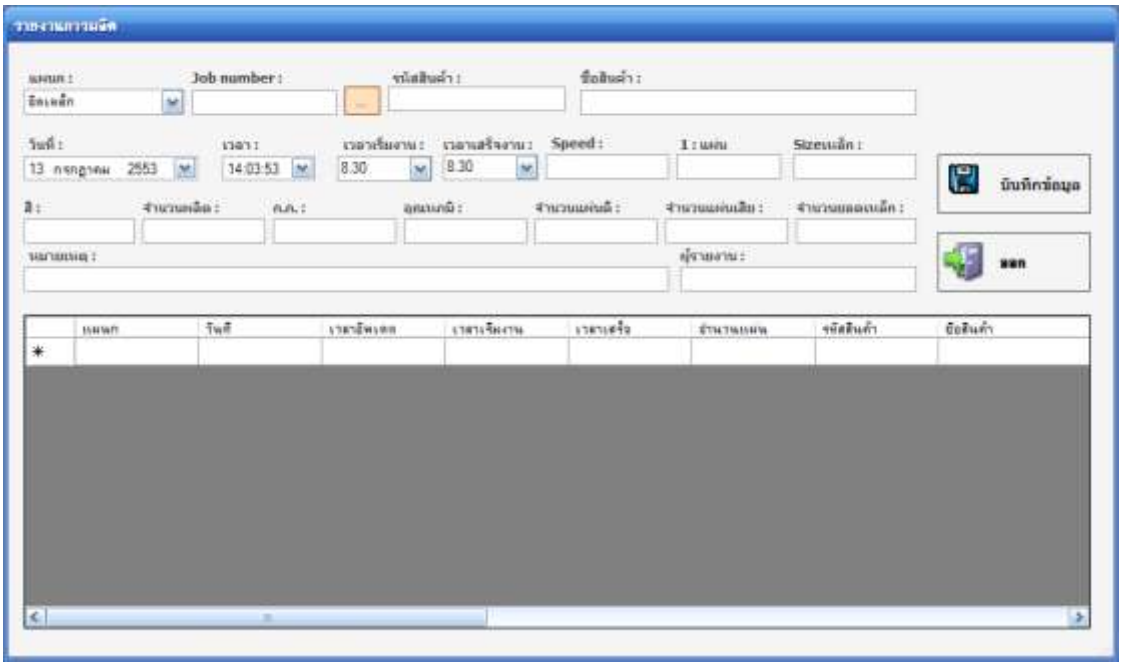


Figure 5-7 Daily production report form.

The software development designated the system access rights of each department. The system administrator could create new user accounts and stipulate such rights by stipulating, changing and cancelling the passwords, as revealed in Figure 5-8.

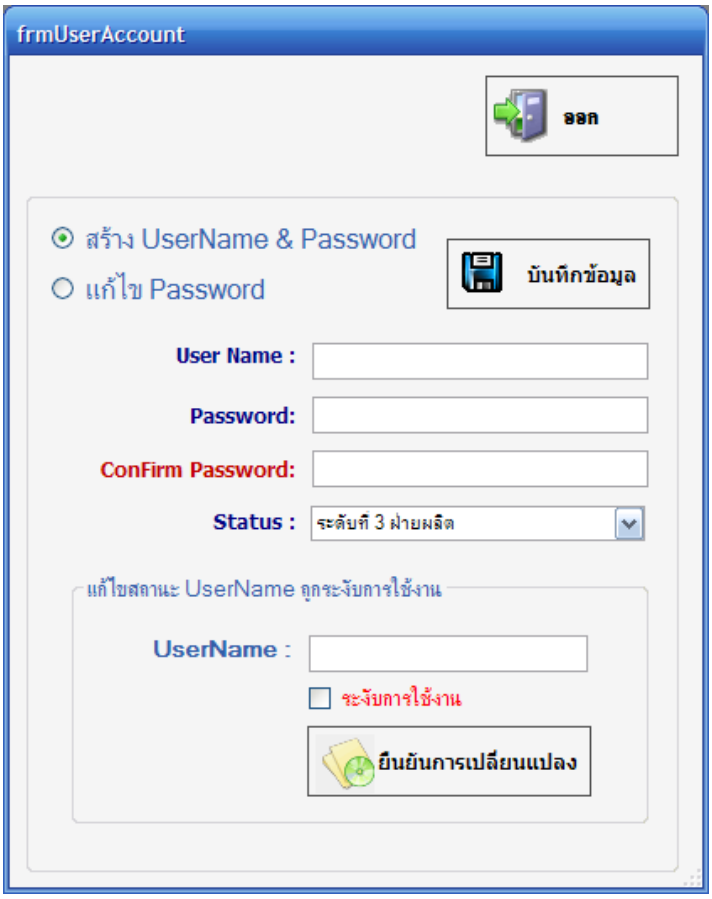


Figure 5-8 User account form.

5.2 Results of the Data Accuracy Test

This stage used Alpha Testing to test the system/software acceptance. This was conducted by making a simulation of real situations and environments and using Black Box Testing to test the working functions of the system. Below are the test results.

5.2.1 The system could store the data fed in and retrieve them correctly.

5.2.2 In the simulation, the system could correctly generate and print the work orders on screen by using the stored product data as shown in Figure 5.9. The calculation of the production planning time revealed the same result as that calculated by the planner, as shown in Figure 5-10.

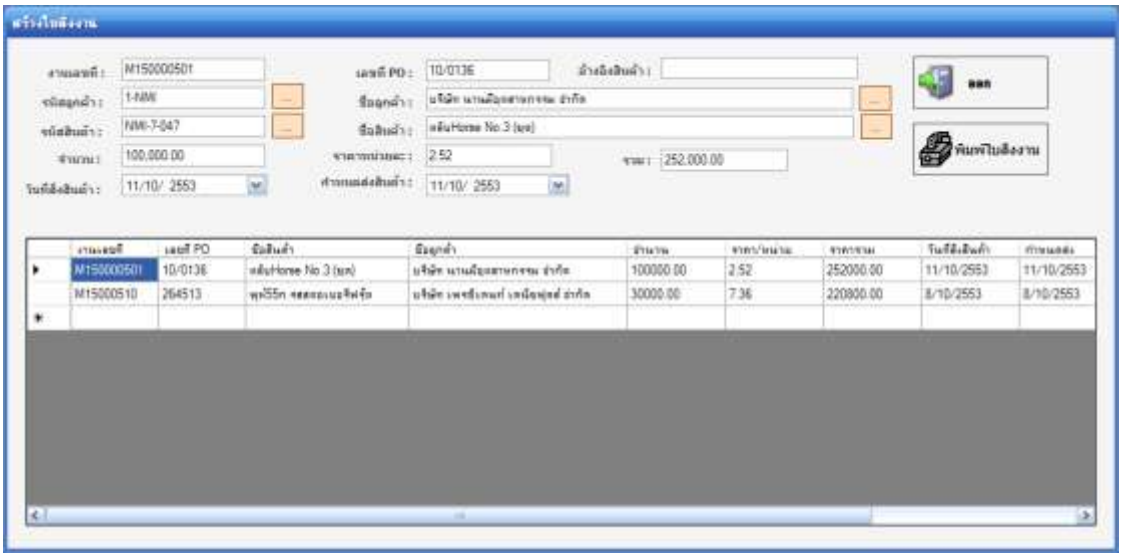


Figure 5-9 Order form.

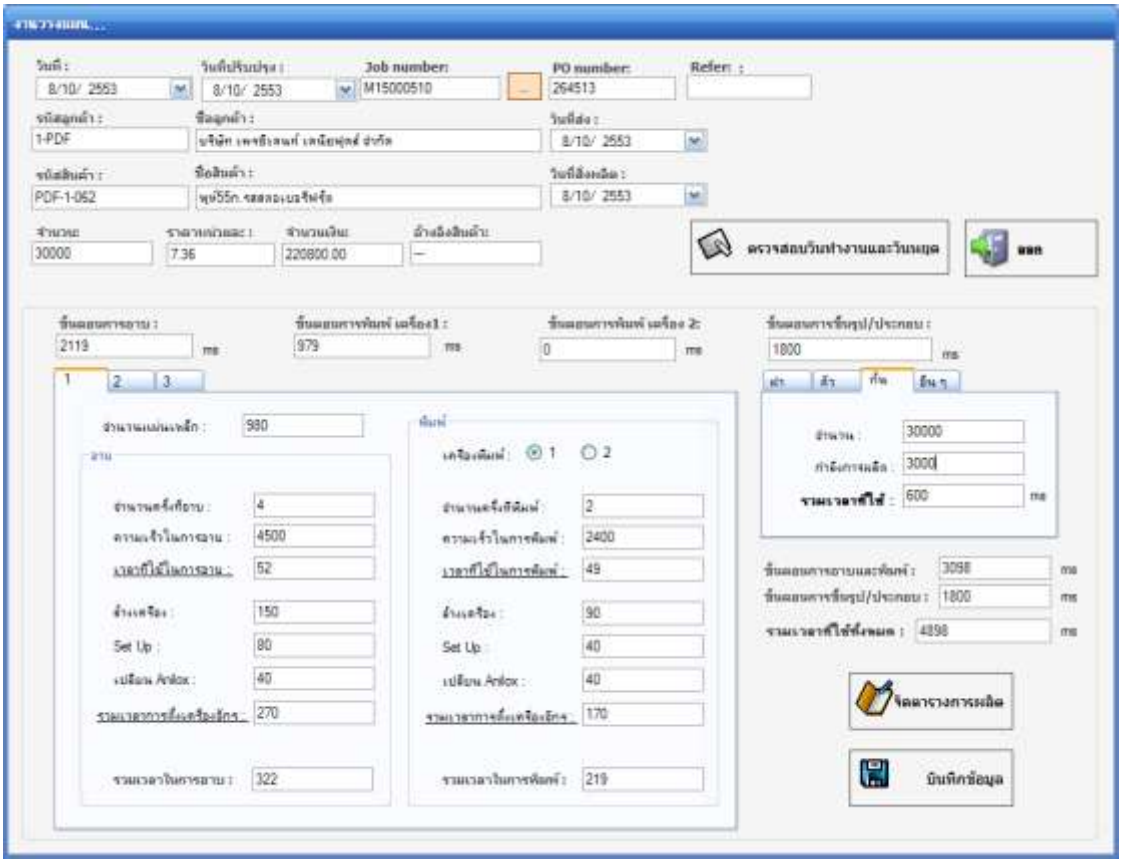


Figure 5.10 Calculation of the production planning time form.

5.2.3 The system could retrieve the data correctly, which were the manufacturing schedules, reports work orders as manifested in Figure 5-11 – 5-13.

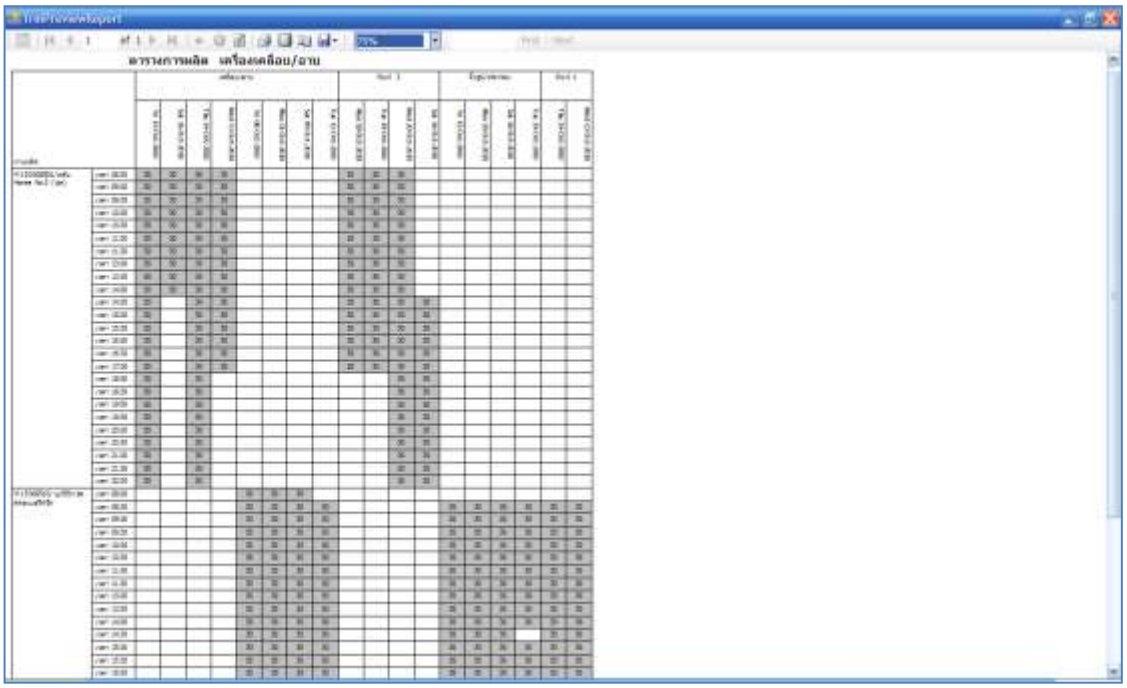


Figure 5.11 Production table form

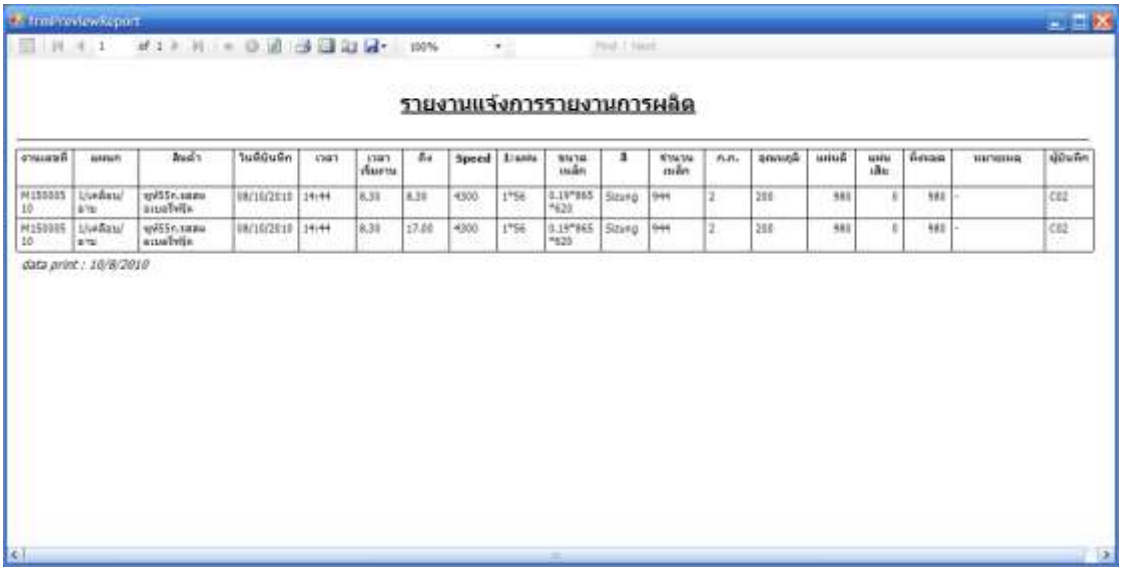


Figure 5.12 Production report form

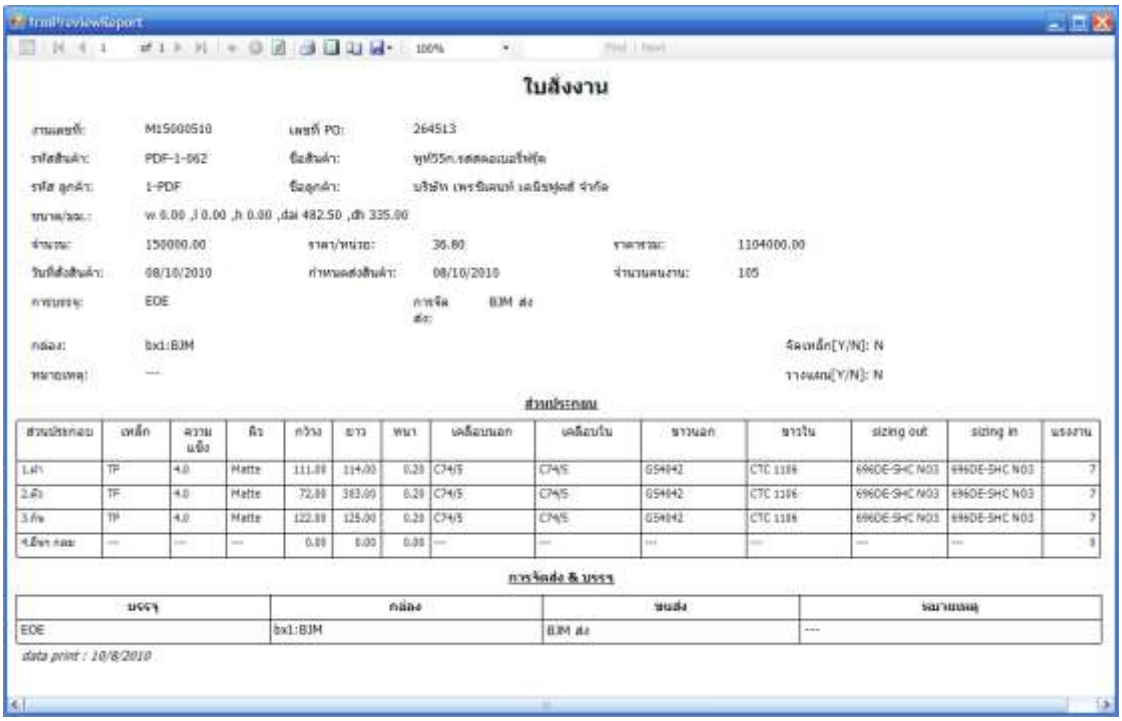


Figure 5.13 Order form.

5.2.4 The data entry accuracy was checked. In case of numerical data, the system would refuse to accept the letters and in case of wrong data input, warning shall alarm, as exhibited in Figure 5-14 – 5-15.

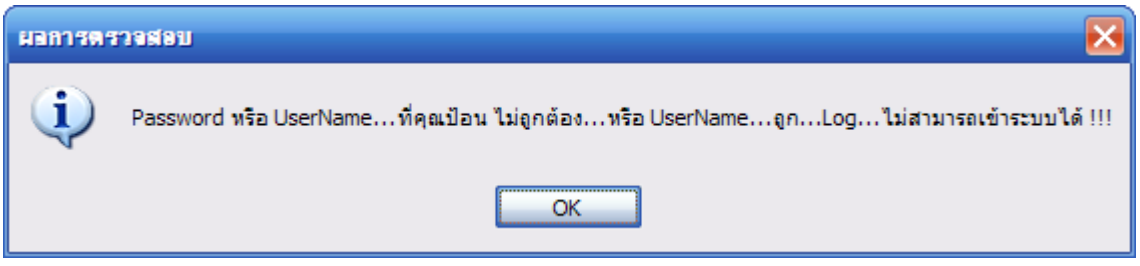


Figure 5.14 The warning text appeared on screen if wrong user name or password was entered.

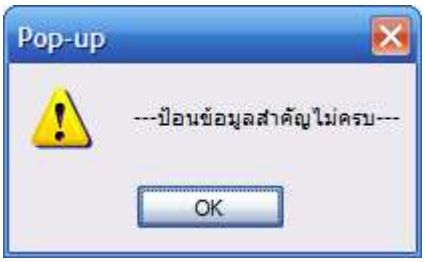


Figure 5.15 The screen alerted the warning if incomplete significant data was put in.

5.3 Comparison of the Software Operating Processes

5.3.1 Results of the Product Data Testing and Comparison

Figure 5.16 shows the old and new software product data entry stages whereas details of the product data used in the testing for comparative purpose are revealed in Table 5-1.

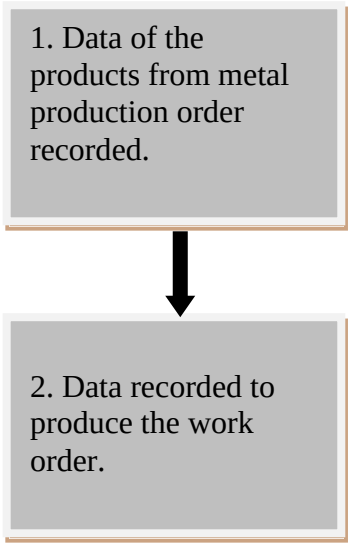


Figure 5.16 Product data entry stages of the old and new software.

Table 5-1 Details of the Product Data Used in the Product Data Entry Test.

No.	Customer ID.	Product ID.
1.	1-PDF	PDF-1-062
2.	1-SCI	SCI-5-246
3.	1-SCI	SCI-5-247
4.	1-SCI	SCI-5-248
5.	1-SCI	SCI-5-249
6.	1-BJM	BJM-1-811
7.	1-UFM	UFM-1-673
8.	1-SEN	SEN-3-280
9.	1-UNC	UNC-1-496
10.	1-NMI	NMI-7-047

The test result in the old software took 13.30 minutes on average to feed the product data per listed item against the corresponding 9.60 minutes on average in the newly developed software. The comparing results are displayed in Table 5-2.

Table 5-2 Comparison of the Data and Product Data Entry the Old and New Software.

No.	Customer ID.	Product ID.	Working time per listed item (minutes)	
			The old system	The newly system
1.	1-PDF	PDF-1-062	15	9
2.	1-SCI	SCI-5-246	12	10
3.	1-SCI	SCI-5-247	12	9
4.	1-SCI	SCI-5-248	15	8
5.	1-SCI	SCI-5-249	16	8
6.	1-BJM	BJM-1-811	12	7
7.	1-UFM	UFM-1-673	12	9
8.	1-SEN	SEN-3-280	10	10
9.	1-UNC	UNC-1-496	12	11
10.	1-NMI	NMI-7-047	17	15
Average time (minutes)			13.30	9.60

5.3.2 Results of the Test and Comparison of the Production Time Calculations

The product data entry processes of the old and new software are demonstrated in Figure 5-17 and details of the product data used in the test for comparative reasons in Table 5-3.

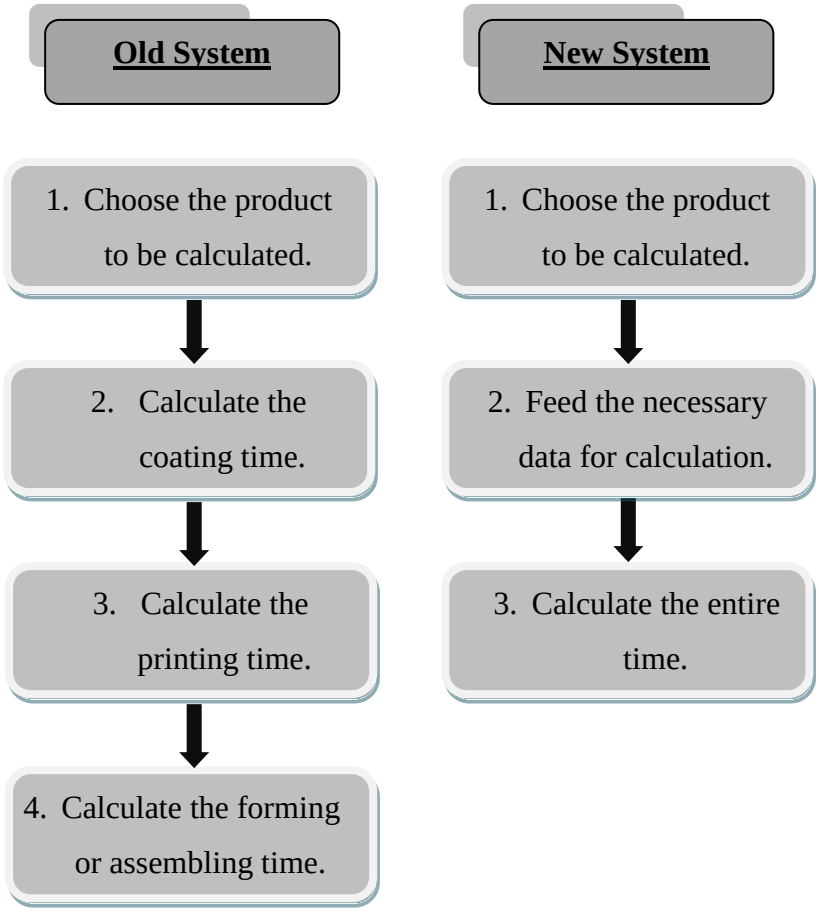


Figure 5.17 The production time calculation processes of the old and new system.

Table 5-3 Details of the product data used in the test and the production time calculation

No.	Job Order No.	Product ID.
1.	M15000510	PDF-1-062
2.	M15000543	SCI-5-246
3.	M15000544	SCI-5-247
4.	M15000545	SCI-5-248
5.	M15000546	SCI-5-249
6.	M15000504	BJM-1-811
7.	M15000488	UFM-1-673
8.	M15000492	SEN-3-280
9.	M15000571	UNC-1-496
10.	M15000501	NMI-7-047

In the old software, the production planner took 21.1 minutes on average per listed item compared to 2 minutes on average per listed item in the new software. Table 5-4 indicates the comparative results.

Table 5-4 Comparison of the data, the production time calculation of the old and new software.

No.	Job Order No.	Product ID.	Working time per listed item (minutes)	
			The old system	The newly software
1.	M15000510	PDF-1-062	17	2
2.	M15000543	SCI-5-246	21	2
3.	M15000544	SCI-5-247	25	2
4.	M15000545	SCI-5-248	22	2
5.	M15000546	SCI-5-249	28	2
6.	M15000504	BJM-1-811	27	2
7.	M15000488	UFM-1-673	22	2
8.	M15000492	SEN-3-280	23	2
9.	M15000571	UNC-1-496	19	2
10.	M15000501	NMI-7-047	17	2
Average time (minutes)			22.1	2

5.3.3 Comparing of the production schedule adjustment and production reporting

In the old software, the planner adjusted the production plan at his discretion, in some cases of which may cause the product delivery delay. The new software however permitted the change of the production plan in this software whereby the planner could prevent the product delivery delay by checking the delivery date in the software.

Regarding the production department's production reporting, in the old software it was made in paper, which barred the production planning department from learning of the real-time production data. The new software provided prompt data on the contrary.

5.4 Result of comparison of using information across departments before and after bringing new developed system to use

Information networking in production planning process presented according to Table 5-5

Table 5-5 Information-to-Actors Matrix AS-IS

Information / Actors	Customer	Sale department	Production planning department	Steel arranging department	Production department	Purchasing department	Warehouse
Sale department							
- Job order	O	X	O				O
Production planning department							
- Production order bill			X	O	O	O	O
- Production plans			X		O		
Steel arranging department							
- Steel arranging reports			O	X			
Production department							
- Production sum-up			O		X		O
Warehouse							
- Amount of product		O			O		X

X = Information owner O = Information required to send to other departments

According to Information-to-Actors Matrix AS-IS, information that required to share among departments or required to send to other departments includes Job order, Production order bill, Production plans, Steel arranging reports, Production sum-up and Amount of product. Based on this Information-to-Actors Matrix AS-IS there was several parts of information that lack of networking effectively:

1. Production planning department cannot issue production order bill conveniently and quickly due to there is no effective customer/product data collection.

2. Production planning department will weekly arrange production schedule and adjust production planning and cannot perform daily production schedule arrangement and production planning adjustment, so the production schedule is not up-to-date.

3. Production report done by production department will be reported weekly, and there is not daily report, so production planning department do not know the actual production information.

According to the above analysis of Information-to-Actors Matrix AS-IS, it can be designed new information networking used as presented in Table 5.6.

Table 5-6 Information-to-Actors Matrix TO-BE

Information / Actors	**Customer**	**Sale department**	**Production planning department**	**Steel arranging department**	**Production department**	**Purchasing department**	**Warehouse**
Sale department							
- Job order	O	X	O				O
Production planning department							
- Production order bill			X	I	I	I	I
- Production plans			X		I		
Steel arranging department							
- Steel arranging reports			I	X			
Production department							
- Production sum-up			I		X		I
Warehouse							
- Amount of product		O			O		X

X = Information owner, O = Information required to send to other departments

I = Information implemented by using new developed system

According to the analysis of Information-to-Actors Matrix TO-BE, it is found that using new developed system can lead to effective information networking across the departments includes:

1. Issuing of production bill order can be done faster because there is systematic data collection.

2. Production planning department can adjust production plan every day and can send production schedule to all belonged departments.

3. Steel arranging department can send Steel arranging report through the system.

4. Production report can be reported everyday so that all belonged departments know accurate production information.

CHAPTER VI
DISCUSSION

This research presented the modes that can bring about the fast yet convenient production planning by developing the computer software to handle the production table arrangement. The aim was to improve the operating processes that can shorten each of its queuing time, make automatic links to all offices and thereby cut down the workloads of the manpower to one extent. Below are significant issues of this research.

6.1 The System Analysis and Design

This research studied the existing system and analyzed the working processes by adopting the operating method of the SDLC (System Development Life Cycle), which is the clear division of the operations. That started from studying the system possibilities as to whether the newly developed system could help solve the problems. Then undertaken was the analysis about who were to use the system and what functions the system had to carry out. This research collected all sides of manpower demands for the production planning processes. In data collection the making of the Business Process Map is one instrument that can help manifest the entire working system and facilitates the business process designer to estimate, adjust and lay down the business process much better. The Business Process Mapping, in this way, is like building the business process model that is based upon the IT applying abilities. Various predicaments of plenty of factors that influence the business procedure can be put into the model for the designing or improving of a new process in response to the change of customer needs and business environment. Analyses were conducted to design the new system by using IDEF0 to present the working stages. The designing emphasized the use of solutions to solve problems acquired by the analyses over the IDEF0 chart. The Data flow diagram (DFD) was also utilized as the simulation of the new system’s processes thanks to its projection of the overall

schemes and clear details about the processors and data, which indicated the origins and destinations of the data flowing into all procedures. The software on screen used the Graphic User Interface to make high qualities of the data input where various templates were offered to users. After the working processes were completely designed, the software development hence started and tested to seek errors by using Alpha Testing. That was the system test by building a simulation of situations, environments, system users and data that were fed and processed in the system. A number of mistake-finding tests were carried out. Once successfully passing them, the new system was installed and run the use test whereas the Use Manual was prepared.

6.2 Database Design

Important to the development production planning system is the database design. Those databases comprise of machinery, product, customer, holidays, purchase orders, production planning, and reporting databases, etc. ERD (Entity Relationship Diagram) was used to design the databases on the ground of its presentation of the relationships between data. Microsoft SQL Server 2005 was used to build the databases thanks to its properness for the research and integrative operations with the developed software.

6.3 Production Planning and Production Table Arrangement

Production planning has the objectives of using the limited resources to make the maximum benefits in the way that can satisfy the customers' demands. The term resources herein refer to the production facilities like machines and equipment, labor and raw materials including the software to help the operations flow conveniently and fast. A good production planning also requires the forecast, planning, work designation, analyses, inventory control and the production control. Those processes of the case study firm(s) still lacked the intra-office data connection and the information system that could provide more convenient and fast working. That was the beginning point of the process analysis to make the production planning and production table arrangement that suited the operations. The production planning office needed the versatile production table for the employees that provided time to solve the contingent problems like the sale office's demands for a large number of

inventory reserve for maximum sale and least attempts to make delayed deliveries, which are against the finance office's avoidance of the cost arising from the production facilities and needs for inventories. The production office accordingly had to balance the contradictory needs of all agencies in the organization. Importantly, it had to reduce the operating time much as possible. The program developed could help cut down the time of the production planning and table arrangement because of its high flexibility. The production planner and table arranger could calculate the production time of each kind of products conveniently, designate the works easily, track down the results and feel confident that the operations should be correct.

The production schedule proposed was similar to that originally produced but differed slightly owing to the improvement of the production scheduling method to serve the change, regardless of increase, decrease, product volume, postponement of the due delivery or the work interference, etc. The software developed however certain restrictions about the production plan alteration had. The research conducted by Bangsaranthip (2005) mentioned few productions scheduling software at the time and their failure to show the results in Gantt Chart. The Technological Promotion Association (Thailand – Japan) provided the details about the time consuming and difficulty of the software development in presenting such results. That hence had caused working and improvement uneasiness thanks to the inability to see the overall production scheduling.

Another limitation of the developed software was the need for the planer's experience to designate the production capacity of the machine if wanting to calculate the product forming / assembling duration. This was because of the wide variety of the machines to be possibly used. It was hard to make clear distinction as to which machine could be utilized to form / assemble which kind of products.

To option for which production scheduling method still requires the discretion of the production planner to help decision making over the real situations. However using heuristic approach is another choice to generate efficient production schedules

CHAPTER VII
CONCLUSION AND RECOMMENDATION

This research emphasized on the business process analysis that aimed to find the operating problems and proper solutions. The case study firm was an industrial plant producing the metal containers that had the working process from the purchase order receiving stage to the raw materials purchasing stage, the production planning stage, the product manufacturing stage and the product storage and delivery stage. Such process met the production planning office's important problems, namely, the production scheduling. The production schedules could not be changed to cope with various arising situations owing to the production office's weekly production reports without the daily ones. Besides, the manual change of the production plan faced difficulty on the ground of the shortage in the good production plan management system. Those problems led to the development of the production planning and scheduling software, which as a result, contributed to increase in the efficiency of the production information linkage in the production planning system for all relevant offices. Those data were current to make in-time efficient yet fast adjustments to the manufacturing planning office's production plans.

7.1 Conclusion of Research Results

7.1.1 Conclusion of the Software Development

The development of the information system for production planning and scheduling found that the developed software could cut down the operating time and provide convenient yet quick local area network system by transmitting the data to make the daily paperless adjustable production scheduling. Earlier, the production office had been required to issue each weekly production report, thereby being unable to receive the correct production data. The new software made the daily production reports and the production schedule calculation faster.

7.1.2 Conclusion of the Results of the Data Accuracy Test

Alpha Testing was used repeatedly over a simulation of situations, environments, users, and data. This was to find errors. The simulated data were close to the then operations. It was found that warning was issued whenever a working error or wrong data input was made. Data could be keyed into the software without mistakes.

7.1.3 Conclusion of the Results of the Software Operation Process Comparison

After the software development and accuracy checking, use test was carried out at the case study plant. Tables 7-1 and 7-2 manifested the results of the test over the production scheduling software operations.

Table 7-1 Results of the Comparison of the Software Operation Process

Process	Working time per listed item (minutes)		Results of the Comparison	
	The old software	The newly developed software	Decrease time	Percent
Product data entry	13.30	9.60	3.7	27.82
production time calculation	22.1	2	20.1	90.95

Table 7-1 portrayed that the software could shorten every working stage. It was because of the complexity of the production planning and production plan adjustment. The IT system for production planning could prove to facilitate the planning.

Table 7-2 Comparison of the Working System of the Developed Software and the Earlier Working Mode

Topic	Manual Scheduling	Scheduling by Developed Software
Production planning	Manually made by using calculator	Automatic calculation by software
Report	Manually made by using Excel	Immediate issuance of reports to all relevant office
Production plan adjustment	Production plan adjusted weekly, for which reports had to be concluded	Prompt production plan

7.2 Recommendation

7.2.1 There should be the development of software that has higher capacities by enabling the production scheduling software interactive in case of the existence of the uncertainty variables or changes in the production process arising from the customers and the production / production scheduling process.

7.2.2 This research adopted the assessment mode that compared the results of the former operating method and those of the software developed by measuring the duration of each process. The test with the real users and data including the enquiries about the users' satisfaction to the developed software shall better the evaluation on the software efficiency.

7.2.3 There is various existing work dispatching rules particularly those dynamic ones. The developed software has only those/that of the simple approach only. Additional work dispensing rules shall create the solution seeking process more efficient.

7.2.4 The manufacturing planning system still has other relevant working issues. To perfect the software use, the development of those portions should be added as well.

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APPENDIX

DATA DICTIONARY

Table Structure of Iron

Attribute	Description	Type	Key	Reference
Id_Iron	Iron code	nvarchar(10)	PK	
Detail_Iron	Iron name	nvarchar(20)		

Table Structure of IronStrong

Attribute	Description	Type	Key	Reference
Id_Iron_Strong	Hardness code of Iron	nvarchar(10)	PK	
Iron_Strong_Detail	Hardness detail of Iron	nvarchar(20)		

Table Structure of Skin

Attribute	Description	Type	Key	Reference
Id_Skin	Skin code	nvarchar(10)	PK	
Detail_Skin	Skin name	nvarchar(20)		

Table Structure of Color

Attribute	Description	Type	Key	Reference
Id_Color	Color code	nvarchar(10)	PK	
Name_Color	Color name	nvarchar(20)		
Detail_Color	Color detail	nvarchar(20)		

Table Structure of Box

Attribute	Description	Type	Key	Reference
Id_Box	Box code	nvarchar(10)	PK	
Detail_Box	Detail of box	nvarchar(50)		

Table Structure of Package

Attribute	Description	Type	Key	Reference
Id_Package	Packaging code	nvarchar(10)	PK	
Detail_Package	Details of packaging	nvarchar(50)		

Table Structure of Delivery

Attribute	Description	Type	Key	Reference
Id_Delivery	Transportation code	nvarchar(10)	PK	
Detail_Delivery	Transportation detail	nvarchar(50)		

Table Structure of Department

Attribute	Description	Type	Key	Reference
Id_Department	Department code	nvarchar(10)	PK	
Name_Department	Department name	nvarchar(30)		

Table Structure of Weekend

Attribute	Description	Type	Key	Reference
Id_Year	Year code	int(4)	PK	
Year	Year name	int(4)		
Date_Stop	Date	smalldatetime		
Date_Detail	Date detail	nvarchar(50)		

Table Structure of UserLogin

Attribute	Description	Type	Key	Reference
Id_User	User ID	nvarchar(10)	PK	
Name_User	User name	nvarchar(20)		
Password_User	User password	nvarchar(10)		
Status_Pass	Password status	nvarchar(1)		
Id_Department	Department code	nvarchar(10)	FK	Department

Table Structure of Machine

Attribute	Description	Type	Key	Reference
Id_Machine	Machine code	nvarchar(10)	PK	
Name_Machine	Machine name	nvarchar(50)		
Power_Machine	Capacity of the machine	numeric(3,0)		
Clean_Machine	Time to clean the machine	numeric(3,0)		
Setup_Machine	Time to setup the machine	numeric(3,0)		
NewAdd_Machine	Time to change the machine parts	numeric(3,0)		
StartDate_Machine	Date of the machine starts	smalldatetime		
Status_Machine	Machine status	nvarchar(1)		

Table Structure of Cutomer

Attribute	Description	Type	Key	Reference
Id_Customer	Customer Id	nvarchar(10)	PK	
Name_Cus	Customer name	nvarchar(50)		
Address_Cus	Customer address	nvarchar(50)		
Fax_Cus	Phone numbers of customers	nvarchar(15)		
Tel_Cus	Fax numbers of customers	nvarchar(15)		
Name_Contact_Cus	Contacts name	nvarchar(50)		

Table Structure of TypeProduct

Attribute	Description	Type	Key	Reference
Id_Type	Product type code	nvarchar(10)	PK	
Type_Detail	Detail of Product type	nvarchar(50)		

Table Structure of Scheduling

Attribute	Description	Type	Key	Reference
Id_Scheduling	Scheduling code	nvarchar(10)	PK	
Day_Scheduling	Date of schedule	smalldatetime		
Coat_Scheduling	Date of coat	smalldatetime		
Time_Coat	Coating time	numeric(3,0)		
Print1_Scheduling	Date of print	smalldatetime		
Time_Print1	Printing time	numeric(3,0)		
Print2_Scheduling	Date of print	smalldatetime		
Time_Print2	Printing time	numeric(3,0)		
Assembly_Scheduling	Date of assembly	smalldatetime		
Time_Assembly	Assembling time	numeric(3,0)		

Table Structure of Cover

Attribute	Description	Type	Key	Reference
No_Cover	Cover code	nvarchar(10)	PK	
Id_Iron	Iron code	nvarchar(10)	FK	Iron
Id_Iron_Strong	Hardness code of iron	nvarchar(10)	FK	IronStrong
Id_Skin	Skin code	nvarchar(10)	FK	Skin
Id_Color	Color code	nvarchar(10)	FK	Color
Size_Wide_Cover	The width of the cover	decimal(3, 2)		
Size_Long_Cover	Length of the cover	decimal(3, 2)		
Size_Thick_Cover	The thickness of the cover	decimal(3, 2)		
Coat_In_Cover	Color coated the inside of the cover	nvarchar(20)		
Coat_Out_Cover	Color coated the outside of the cover	nvarchar(20)		
White_In_Cover	The white coating inside the cover	nvarchar(20)		
White_Out_Cover	The white coating outside the cover	nvarchar(20)		
Sizing_In_Cover	The sizing coating outside the cover	nvarchar(20)		
Sizing_Out_Cover	The white coating outside the cover	nvarchar(20)		
Put_man_Cover	Number of workers used to produce cover	int(2)		

Table Structure of Body

Attribute	Description	Type	Key	Reference
No_Body	Body code	nvarchar(10)	PK	
Id_Iron	Iron code	nvarchar(10)	FK	Iron
Id_Iron_Strong	Hardness code of Iron	nvarchar(10)	FK	IronStrong
Id_Skin	Skin code	nvarchar(10)	FK	Skin
Id_Color	Color code	nvarchar(10)	FK	Color
Size_Wide_Body	The width of the body	decimal(3, 2)		
Size_Long_Body	Length of the body	decimal(3, 2)		
Size_Thick_Body	The thickness of the body	decimal(3, 2)		
Coat_In_Body	Color coated the inside of the body	nvarchar(20)		
Coat_Out_Body	Color coated the outside of the body	nvarchar(20)		
White_In_Body	The white coating inside the body	nvarchar(20)		
White_Out_Body	The white coating outside the body	nvarchar(20)		
Sizing_In_Body	The sizing coating outside the body	nvarchar(20)		
Sizing_Out_Body	The white coating outside the body	nvarchar(20)		
Put_man_Body	Number of workers used to produce body	int(2)		

Table Structure of Base

Attribute	Description	Type	Key	Reference
No_Base	Base code	nvarchar(10)	PK	
Id_Iron	Iron code	nvarchar(10)	FK	Iron
Id_Iron_Strong	Hardness code of iron	nvarchar(10)	FK	IronStrong
Id_Skin	Skin code	nvarchar(10)	FK	Skin
Id_Color	Color code	nvarchar(10)	FK	Color
Size_Wide_Base	The width of the base	decimal(3, 2)		
Size_Long_Base	Length of the base	decimal(3, 2)		
Size_Thick_Base	The thickness of the base	decimal(3, 2)		
Coat_In_Base	Color coated the inside of the base	nvarchar(20)		
Coat_Out_Base	Color coated the outside of the base	nvarchar(20)		
White_In_Base	The white coating inside the base	nvarchar(20)		
White_Out_Base	The white coating outside the base	nvarchar(20)		
Sizing_In_Base	The sizing coating outside the base	nvarchar(20)		
Sizing_Out_Base	The white coating outside the base	nvarchar(20)		
Put_man_Base	Number of workers used to produce base	int(2)		

Table Structure of Other

Attribute	Description	Type	Key	Reference
No_Other	Other code	nvarchar(10)	PK	
Id_Iron	Iron code	nvarchar(10)	FK	Iron
Id_Iron_Strong	Hardness code of iron	nvarchar(10)	FK	IronStrong
Id_Skin	Skin code	nvarchar(10)	FK	Skin
Id_Color	Color code	nvarchar(10)	FK	Color
Size_Wide_Other	The width of the other	decimal(3, 2)		
Size_Long_Other	Length of the other	decimal(3, 2)		
Size_Thick_Other	The thickness of the other	decimal(3, 2)		
Coat_In_Other	Color coated the inside of the other	nvarchar(20)		
Coat_Out_Other	Color coated the outside of the other	nvarchar(20)		
White_In_Other	The white coating inside the other	nvarchar(20)		
White_Out_Other	The white coating outside the other	nvarchar(20)		
Sizing_In_Other	The sizing coating outside the other	nvarchar(20)		
Sizing_Out_Other	The white coating outside the other	nvarchar(20)		
Put_man_Other	Number of workers used to produce other	int(2)		

Table Structure of Product

Attribute	Description	Type	Key	Reference
Id_Product	Product Id	nvarchar(10)	PK	
Name_Pro	Product name	nvarchar(50)		
Size_Wide_Pro	The width of the product	decimal(3, 2)		
Size_Long_Pro	Length of product	decimal(3, 2)		
Size_Hight_Pro	Height of the product	decimal(3, 2)		
Size_Dai_pro	Dimensions of the product	decimal(3, 2)		
Size_DaiHieght_Pro	Height of the product	decimal(3, 2)		
Price_Unit_Pro	Unit price of product	money		
Price_Total_Pro	Total price of product	money		
Id_Type	Product type code	nvarchar(10)	FK	TypeProduct
No_Cover	Cover code	nvarchar(10)	FK	Cover
No_Body	Body code	nvarchar(10)	FK	Body
No_Base	Base code	nvarchar(10)	FK	Base
No_Other	Other code	nvarchar(10)	FK	Other

Table Structure of JobOrder

Attribute	Description	Type	Key	Reference
Id_JobOrder	Job order code	nvarchar(10)	PK	
No_PO_Order	PO number	nvarchar(10)		
Date_Order	Order date	smalldatetime		
Date_Delivery	Delivery date	smalldatetime		
Amount_Order	Number of products ordered	numeric(3,0)		
Remark_Order	Order remark	nvarchar(150)		
Id_Customer	Customer Id	nvarchar(10)	FK	Customer
Id_Package	Packaging code	nvarchar(10)	FK	Package
Id_Box	Box code	nvarchar(10)	FK	Box
Id_Product	Product Id	nvarchar(10)	FK	Product
Id_Delivery	Transportation code	nvarchar(10)	FK	Delivery

Table Structure of IronReport

Attribute	Description	Type	Key	Reference
Id_IronReport	Iron report code	nvarchar(10)	PK	
Set_no	Number of a series of steel	numeric(3,0)	PK	
Id_JobOrder	Job order code	nvarchar(10)	FK	JobOrder
Date_Iron	Date of set iron	smalldatetime		
Iron_amount	Amount of steel	numeric(3,0)		

Table Structure of Print1

Attribute	Description	Type	Key	Reference
Id_Print1	Color printing code of round 1	nvarchar(10)	PK	
Id_JobOrder	Job order code	nvarchar(10)	FK	JobOrder
CoverColor1	Color printing cover round 1	nvarchar(20)		
CoverColor1_Amount	The number of times the printed color cover round 1	int(2)		
BodyColor1	Color printing body round 1	nvarchar(20)		
BodyColor1_Amount	The number of times the printed color body round 1	int(2)		
BaseColor1	Color printing base round 1	nvarchar(20)		
BaseColor1_Amount	The number of times the printed color base round 1	int(2)		
OtherColor1	Color printing the other part round 1	nvarchar(20)		
OtherColor1_Amount	The number of times the printed the other part round 1	int(2)		

Table Structure of Print2

Attribute	Description	Type	Key	Reference
Id_Print2	Color printing code of round 2	nvarchar(10)	PK	
Id_JobOrder	Job order code	nvarchar(10)	FK	JobOrder
CoverColor2	Color printing cover round 2	nvarchar(20)		
CoverColor2_Amount	The number of times the printed color cover round 2	int(2)		
BodyColor2	Color printing body round 2	nvarchar(20)		
BodyColor2_Amount	The number of times the printed color body round 2	int(2)		
BaseColor2	Color printing base round 2	nvarchar(20)		
BaseColor2_Amount	The number of times the printed color base round 2	int(2)		
OtherColor2	Color printing the other part round 2	nvarchar(20)		
OtherColor2_Amount	The number of times the printed the other part round 2	int(2)		

Table Structure of Print3

Attribute	Description	Type	Key	Reference
Id_Print3	Color printing code of round 3	nvarchar(10)	PK	
Id_JobOrder	Job order code	nvarchar(10)	FK	JobOrder
CoverColor3	Color printing cover round 3	nvarchar(20)		
CoverColor3_Amount	The number of times the printed color cover round 3	int(2)		
BodyColor3	Color printing body round 3	nvarchar(20)		
BodyColor3_Amount	The number of times the printed color body round 3	int(2)		
BaseColor3	Color printing base round 3	nvarchar(20)		
BaseColor3_Amount	The number of times the printed color base round 3	int(2)		
OtherColor3	Color printing the other part round 3	nvarchar(20)		
OtherColor3_Amount	The number of times the printed the other part round 3	int(2)		

Table Structure of Print4

Attribute	Description	Type	Key	Reference
Id_Print4	Color printing code of round 4	nvarchar(10)	PK	
Id_JobOrder	Job order code	nvarchar(10)	FK	JobOrder
CoverColor4	Color printing cover round 4	nvarchar(20)		
CoverColor4_Amount	The number of times the printed color cover round 4	int(2)		
BodyColor4	Color printing body round 4	nvarchar(20)		
BodyColor4_Amount	The number of times the printed color body round 4	int(2)		
BaseColor4	Color printing base round 4	nvarchar(20)		
BaseColor4_Amount	The number of times the printed color base round 4	int(2)		
OtherColor4	Color printing the other part round 4	nvarchar(20)		
OtherColor4_Amount	The number of times the printed the other part round 4	int(2)		

Table Structure of Print5

Attribute	Description	Type	Key	Reference
Id_Print5	Color printing code of round 5	nvarchar(10)	PK	
Id_JobOrder	Job order code	nvarchar(10)	FK	JobOrder
CoverColor5	Color printing cover round 5	nvarchar(20)		
CoverColor5_Amount	The number of times the printed color cover round 5	int(2)		
BodyColor5	Color printing body round 5	nvarchar(20)		
BodyColor5_Amount	The number of times the printed color body round 5	int(2)		
BaseColor5	Color printing base round 5	nvarchar(20)		
BaseColor5_Amount	The number of times the printed color base round 5	int(2)		
OtherColor5	Color printing the other part round 5	nvarchar(20)		
OtherColor5_Amount	The number of times the printed the other part round 5	int(2)		

Table Structure of Print6

Attribute	Description	Type	Key	Reference
Id_Print6	Color printing code of round 6	nvarchar(10)	PK	
Id_JobOrder	Job order code	nvarchar(10)	FK	JobOrder
CoverColor6	Color printing cover round 6	nvarchar(20)		
CoverColor6_Amount	The number of times the printed color cover round 6	int(2)		
BodyColor6	Color printing body round 6	nvarchar(20)		
BodyColor6_Amount	The number of times the printed color body round 6	int(2)		
BaseColor6	Color printing base round 6	nvarchar(20)		
BaseColor6_Amount	The number of times the printed color base round 6	int(2)		
OtherColor6	Color printing the other part round 6	nvarchar(20)		
OtherColor6_Amount	The number of times the printed the other part round 6	int(2)		

Table Structure of Print7

Attribute	Description	Type	Key	Reference
Id_Print7	Color printing code of round 7	nvarchar(10)	PK	
Id_JobOrder	Job order code	nvarchar(10)	FK	JobOrder
CoverColor7	Color printing cover round 7	nvarchar(20)		
CoverColor7_Amount	The number of times the printed color cover round 7	int(2)		
BodyColor7	Color printing body round 7	nvarchar(20)		
BodyColor7_Amount	The number of times the printed color body round 7	int(2)		
BaseColor7	Color printing base round 7	nvarchar(20)		
BaseColor7_Amount	The number of times the printed color base round 7	int(2)		
OtherColor7	Color printing the other part round 7	nvarchar(20)		
OtherColor7_Amount	The number of times the printed the other part round 7	int(2)		

Table Structure of Print8

Attribute	Description	Type	Key	Reference
Id_Print8	Color printing code of round 8	nvarchar(10)	PK	
Id_JobOrder	Job order code	nvarchar(10)	FK	JobOrder
CoverColor8	Color printing cover round 8	nvarchar(20)		
CoverColor8_Amount	The number of times the printed color cover round 8	int(2)		
BodyColor8	Color printing body round 8	nvarchar(20)		
BodyColor8_Amount	The number of times the printed color body round 8	int(2)		
BaseColor8	Color printing base round 8	nvarchar(20)		
BaseColor8_Amount	The number of times the printed color base round 8	int(2)		
OtherColor8	Color printing the other part round 8	nvarchar(20)		
OtherColor8_Amount	The number of times the printed the other part round 8	int(2)		

Table Structure of JobPlan

Attribute	Description	Type	Key	Reference
Id_JobPlan	Code schedule	nvarchar(10)	PK	
Id_IronReport	Iron report code	nvarchar(10)	FK	IronReport
Id_JobOrder	Job order code	nvarchar(10)	FK	JobOrder
Id_Machine	Machine code	nvarchar(10)	FK	Machine
Id_Scheduling	Scheduling code	nvarchar(10)	FK	Scheduling
Id_Year	Year plan Id	int(4)	FK	Weekend
Time_Coat	Coating time	numeric(4,0)		
Time_SetUp_Coat	Set up coating time	numeric(4,0)		
Time_Print	Printing time	numeric(4,0)		
Time_SetUp_Print	Set up printing time	numeric(4,0)		
Cover_Amount	Amount of cover	numeric(4,0)		
Cover_Power	Capacity of machine	numeric(4,0)		
Cover_TotalTime	Time to produce a cover	numeric(4,0)		
Body_Amount	Amount of body	numeric(4,0)		
Body_Power	Capacity of machine	numeric(4,0)		
Body_TotalTime	Time to produce a body	numeric(4,0)		
Base_Amount	Amount of base	numeric(4,0)		
Base_Power	Capacity of machine	numeric(4,0)		
Base_TotalTime	Time to produce a base	numeric(4,0)		
Other_Amount	Amount of other part	numeric(4,0)		
Other_Power	Capacity of machine	numeric(4,0)		
Other_TotalTime	Time to produce other part	numeric(4,0)		
Total_Component	Amount of total component	numeric(4,0)		
Total_Time	Time to produce product	numeric(4,0)		

Table Structure of CutIronReport

Attribute	Description	Type	Key	Reference
Id_CutIronReport	Cutting reporting code	nvarchar(10)	PK	
Id_IronReport	IronReport code	nvarchar(10)	FK	IronReport
Amount_Do	Number of products produced	numeric(4,0)		
Amount_Lost	Number of waste products	numeric(4,0)		

Table Structure of CoatReport

Attribute	Description	Type	Key	Reference
Id_CoatReport	Coating reporting code	nvarchar(10)	PK	
Id_IronReport	IronReport code	nvarchar(10)	FK	IronReport
Amount_Do	Number of products produced	numeric(4,0)		
Amount_Lost	Number of waste products	numeric(4,0)		

Table Structure of Print1Report

Attribute	Description	Type	Key	Reference
Id_Print1Report	Printing reporting code	nvarchar(10)	PK	
Id_IronReport	IronReport code	nvarchar(10)	FK	IronReport
Amount_Do	Number of products produced	numeric(4,0)		
Amount_Lost	Number of waste products	numeric(4,0)		

Table Structure of Print2Report

Attribute	Description	Type	Key	Reference
Id_Print2Report	Printing reporting code	nvarchar(10)	PK	
Id_IronReport	IronReport code	nvarchar(10)	FK	IronReport
Amount_Do	Number of products produced	numeric(4,0)		
Amount_Lost	Number of waste products	numeric(4,0)		

Table Structure of AssamblyReport

Attribute	Description	Type	Key	Reference
Id_AssemblyReport	Assembling reporting code	nvarchar(10)	PK	
Id_IronReport	IronReport code	nvarchar(10)	FK	IronReport
Amount_Do	Number of products produced	numeric(4,0)		
Amount_Lost	Number of waste products	numeric(4,0)		

BIOGRAPHY

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