An Online Web-based System for Product Design and Analysis

by

Mr. Nattapol Thanathammanan

A Final Report of the Three-Credit Course
CE 6998 Project

Submitted in Partial Fulfillment
of the Requirements for the Degree of
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Project Title	An Online Web-based System for Product Design and Analysis
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The Graduate School of Assumption University has approved this final report of the three-credit course, CE 6998 PROJECT, submitted in partial fulfillment of the requirements for the degree of Master of Science in Computer and Engineering Management.

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ABSTRACT

The heat pipe industry is one of the electronic business that is interested in the future due to the highly people using in the computer. It is used for cooling system in computers. In order that companies improve delivery time and reduce their cost, they plan to improve the computerized based system to be more fully automated and well integrated with all interdependent parts of information. This project studies the promises of the web-based online system for heat pipe industries and prepares a prototype for it.

Like any task in handling routine, companies have the problems of data updating and storing, because the computers used in each department are individual. The formats of data keeping and report are varied. The proposed system will be used to keep a standard data so that these files can link computers under distributed client/sever network. The system will reduce risk of losing information and error in data. Also data entering is a redundancy of data storing in several files.

There are 3 main objectives in this project. Firstly, the new system can develop a business system prototype based on the Information Technology to reduce the operation cost. Secondly, the new system can estimate lead-time, materials, manpower, and machines in product design. Finally, the system can optimize inventory levels by synchronize supply and demand.

An online web-based system includes order module, payment, inventory and purchase module. First of all, the system converts customer orders to accurate information. After checking the valid order, the system projects schedule and material plan into production processes. Finally, finished goods are produced and/or shipment is accepted. The system reports lists of the shipping items and generate invoice to customers.

The comparative economic evaluation of alternatives between the existing system and the new online web-based system is in design and development of cash flows in financial project. The system development costs will be recovered from the cost of saving benefits within 2.4 years after implementation.

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to Dr. Chamnong Jungthirapanich for his helpful guidance, valuable advice, precious comments and encouragement throughout the project. Without his support this project would never have been completed on time. I would like to extend my deepest and most sincere thanks to my family as well for their support during the project implementation.

I would also like to give special thanks to all my friends and some of my classmates from ABAC for their help and boundless inspiration. I would like to express deep gratitude to Fujikura (Thailand) company for helping me and giving the processes of product design in heat pipe industries. This project would not be accomplished without their help and cooperation.

TABLE OF CONTENTS

Chapter		Page
ABSTRACT		
ACKNOWLEDGEMENTS		iii
LIST OF FIGURES		vi
LIST OF TABLES		vii
I.	INTRODUCTION	1
1.1	Background of the Project	1
1.2	Overview of the Problems	2
1.3	Objectives of the Project	3
1.4	Scope of the Project	3
II.	THE EXISTING SYSTEM	4
2.1	Introduction	4
2.2	Background of the Organization	4
2.3	Product Characteristic	5
2.4	Overview of the Product Design and Analysis	6
2.5	The Existing Business Function	8
2.6	Current Problems and Functional Areas for Improvement	13
2.7	Goals of Implementing	16
2.8	Expected Improvement	16
III.	THE PROPOSED SYSTEM	19
3.1	Requirements Specification and Scope	19
3.2	System Architecture Overview	20
3.3	System Design	22

Chapter Page

3.4 Features 28

3.5 System Cost Evaluation and Comparison 30

IV. PROJECT IMPLEMENTATION 36

4.1 Overview of System Implementation 36

4.2 Test Plan 36

4.3 Conversion 36

4.4 Training, Documentation and Support 37

4.5 Maintenance 38

V. CONCLUSIONS AND RECOMMENDATIONS 39

5.1 Conclusions 39

5.2 Recommendations for Future Project 41

APPENDIX A CONTEXT DIAGRAM AND DATA FLOW DIAGRAMS OF AN ONLINE WEB-BASED SYSTEM 43

APPENDIX B DATABASE DESIGN 49

APPENDIX C WEB INTERFACE AND REPORT DESIGN 50

APPENDIX D PROCESS SPECIFICATION 58

APPENDIX E DATA DICTIONARY 61

BIBLIOGRAPHY 63

LIST OF FIGURES

Figure		Page
2.1.	Organization Chart of Fujikura Co., Ltd.	5
2.2	Picture of Heat Pipe Product	5
2.3	Example of Using CAD (Computer-Aided Design)	7
2.4	The Flow Chart of Design Control in the Current System	11
3.1	Bill of Materials of Heat Pipe Product	29
3.2	Break-even Analysis of an Online Web-based System	35
A.1	Context Diagram for Web-based Online System	43
A.2	Data Flow Diagram Level 0 for Web-based Online System	44
A.3	Data Flow Diagram Level 1 of Order Module for Web-based Online System	45
A.4	Data Flow Diagram Level 1 of Apply Payment for Web-based Online System	46
A.5	Data Flow Diagram Level 1 of Inventory Module for Web-based Online System	47
A.6	Data Flow Diagram Level 1 of Purchasing Module for Web-based Online System	48
B.1	Entity Relationship Diagram	49
C.1	Main Menu Form	50
C.2	Customer Order Form	52
C.3	Production BOM Form	53
C.4	Routings Form	54
C.5	Inventory Form	55
C.6	Purchase Order Form	56
C.7	Invoice Report	57

LIST OF TABLES

Table		Page
2.1	Specification of Heat Pipe Product in Length and Diameter	6
3.1	Database Design - Customer	26
3.2	Database Design - Order	26
3.3	Database Design - Order Detail	26
3.4	Database Design - Product	27
3.5	Database Design - Work Center	27
3.6	Database Design - Vendor	27
3.7	Database Design - Component	28
3.8	Example of Heat Pipe Process Charts	30
3.9	Transaction-Time Comparison	33
3.10	Economic Feasibility Analysis of an Online Web-based System	34
E.1	Data Dictionary for the Online Web-based System	61

I. INTRODUCTION

1.1 Background of the Project

In Today's highly competitive global business environment, their major policies are "Delivery on spec, on time". Each business must improve their company with "Information Technology" to reduce their cost. They work through suppliers, producers, distributors and customers in called "Supply Chain Management". First, demand with a product or service is forecast. Plans and schedules are made to meet demand within a time frame by suppliers. Second, parts and materials are transformed through a complex process into final products or services. These products may be stored at a distribution center or warehouse. Finally, these products are transported by external or internal customers.

During processing, they can design and operate their products through "Operation Management". The four primary functional areas of a company are marketing, finance/accounting, operations, and human resources. For most companies, operations are the technical core of the organization, interacting with the other functional areas to produce goods and provide services for customers.

For example, marketing provides operations with sales forecasts, customer orders, customer feedback, and information on promotions and product development. Operations, in turn, provide marketing with information on product or service availability, lead-time estimates, order status, and delivery schedules. To obtain monetary resources for production, operations provide finance and accounting with production inventory data, capital budgeting requests, and capacity expansion and technology plans. Finance pays workers and suppliers, performs cost analyses, and approves capital investments. Human resources need operations to recruit, train, and compensate workers with job design. Outside the organization operations interact with

suppliers to order materials or services, communicate production and delivery requirements, certify quality, negotiate contracts, and finalize design specifications.

1.2 Overview of the Problems

In work experiences, Fujikura Company works in an electronics business. Before they produce the mass-production, they must provide the sample product or pilot run. So they need to reduce lead-time of products and operation cost. They must cooperate with all functional areas such as Sale/Marketing, Purchase/Warehouse, Planning, Design/ Engineering, Production, Maintenance, QA, and Shipping.

In this project, we focus in one of the products that is provided by Fujikura Company called " Heat pipe". The main structures include "copper tube", "copper wire", "copper spring", and "water". The type of heat pipe production layout is "Product Layouts". Using BOM (Bill of Materials) and routing processes in a Web-based On-line system, we can estimate lead-time, materials, manpower, and machines when customers order our products. While we make pilot-run products, we also can use CAD (Computer-Aided Design) for product designs and SPC (Statistical Process Control) for product analysis.

In the Future Business Strategies, we start using the Wireless Technology such as Mobility, WiFi Technology, and **RFID** (Radio Frequency Identification). Each business can provide them to link their company ordering, delivering, accounting and stock available. While salespeople or potential customers can allow checking in the product information, they also can place orders on the web site. Moreover, companies also can use them in remote maintenance mails, transaction database and documentation on the real time on-line.

1.3 Objectives of the Project

According to problems overviewed above, the purpose of this project is to design and implement a business system prototype based on the Information Technology to reduce costs.

1.4 Scope of the Project

The project focuses on "Operations management" through using the "Information Technology". The main tools are "Online Web-based system" and "Wireless Technology" to help in Product design and analysis. Based on the literature review, it develops a business plan and technology plan for implementation. In the plan, it assumes to establish an imaginary company. Next, using experience in jobs as case studies, discuss the system and the technology used. Meanwhile, it describes how "the products online in a Web-based Systems" can be integrated into "Operations management". Finally, it implements a working prototype with the "Wireless Technology" to improve their Future Business Intelligence.

II. THE EXISTING SYSTEM

2.1 Introduction

This chapter reviews the concepts of literature that used an Online Web-based system that helps in Product Design and Analysis. The flow of information will be linked between each department that we will record in the databases.

2.2 Background of the Organization

FUJIKURA Thermal Solutions are tailored to meet customer specifications and comprises of micro-heat pipe, vapor chambers, heat sinks, fans, and thermal interface material and attachment accessories. The engineers are dedicated to apply sound engineering and manufacturing expertise in working with customer, for the entire product life cycle, in providing personalized engineering design services and support to develop and deliver innovative and cost effective thermal solutions.

To achieve the needs of customers, company is always open to adopt and implement the use of new technologies to assist and support the work in office operations and production lines. In terms of computer technology, company sets up IT (Information Technology) department to support the computer system and database management.

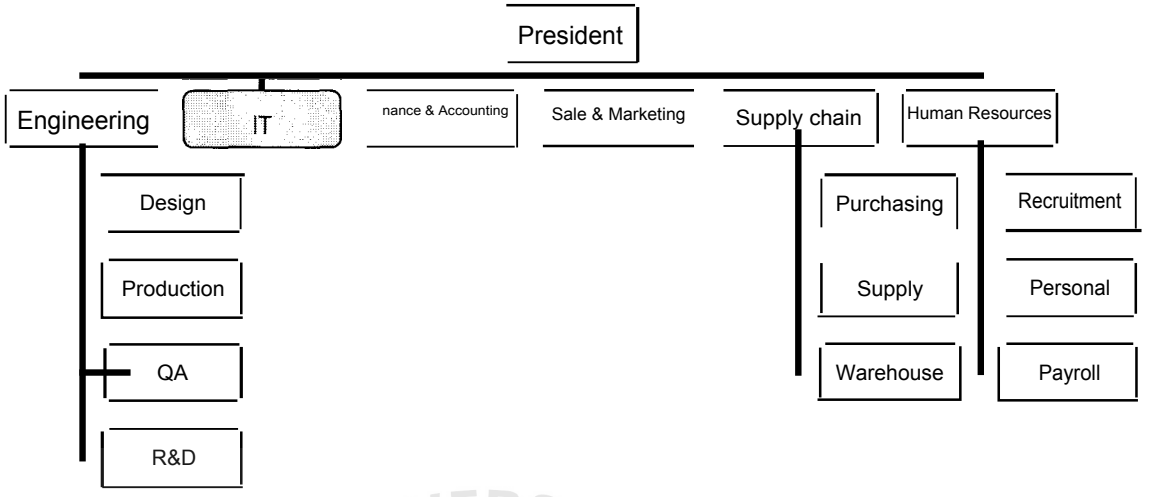


Figure 2.1. Organization Chart of Fujikura Co., Ltd.

2.3 Product Characteristic

Heat pipe product is an efficient heat transfer device commonly used for cooling an electronic component. Demand is growing ever more unpredictable. So, the Life cycle of heat pipe product normally is about 3 months forecast.

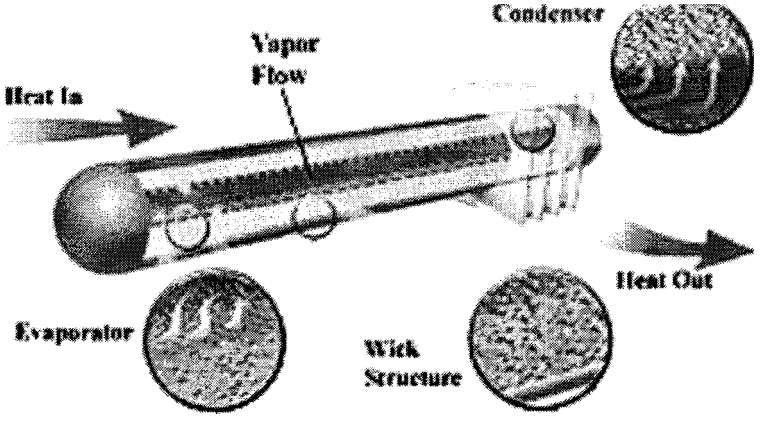


Figure 2.2. Picture of Heat Pipe Product.

The types of heat pipe products are different in "Length" and "Diameter". "Heat pipe" product has 3 main structures including "copper tube", "copper wire", and "copper spring". So the units of product structure use "meter", "kg", and "PCs". But when customers order heat pipe product, the unit is "PCs".

The current manufacturing of heat pipe is to produce 80-350 mm in length and 3-8 mm in diameter. So when we order the copper tube, we use 3-8 mm in diameter. The copper wire and the copper spring also vary in different sizes of heat pipe product.

Table 2.1. Specification of Heat Pipe Product in Length and Diameter.

Length / Dia	Min (mm)	Max (mm)
3mm	80	350
4mm	80	350
5mm	80	350
6mm	80	350
8mm	80	350

The type of heat pipe production is "Product Layouts" better known as assembly lines. The routing of process flow passes through each machine or work center. The processes of each work center are pipe cut, assembly, input water, welding (Closed end), plating, and inspection.

2.4 Overview of the Product Design and Analysis

"Heat pipe" is one of assembly industries. Before customers order our products, they normally request for sample making products first. The processes of sample making product are more important to meet customer requirement. Sales coordinators

must check the essential information with Customers and/or Design engineers. Sales coordinators contact Design engineers in charge to get new product code (name of products). When Sales coordinators input data into the Sales system, Planner will issue original "RQ (Request for Quotation)" pass to Design engineering department. During processes, the Design engineer issues "Deviation drawing" form by using CAD to inform customer any specification changes from customer drawing relating to price Quotation.

Figure 2.3. Example of Using CAD (Computer-Aided Design).

The Design engineering department estimates and/or purchases the material requisition through Purchasing and Planning department. The design engineers issue the necessary documents such as Drawing, BOM (Bill of Material), SOPs (Standard Operating Procedures). Then they create sample production schedules by cooperating with Planners. After the Production department produces the samples following SOPs,

planners will issue "Shipping Order Report". Finally, Quality assurance department will inspect finished products.

During product manufacturing, the Design engineering department also develops samples by comparing the result of design output with design input. We use SPC (Statistical Process Control) to monitor the processes.

Finally, we send out the heat pipe products to plating vendors. The design-engineering department must specify type of test report in the system to control vendor's quality. After we get the products back, the purchase or warehouse department will check by following up the type of test report as shown on purchase order.

2.5 The Existing Business Function

2.5.1 the database in different departments

Each department uses the stand-alone PC. The staff uses Microsoft office such as Word, Excel to produce the official documents. All function areas need to share the customer information between departments from one place to others through using e-mail and/or calling. Each function needs different databases as details below:

(1) Sales Coordinators department

When customers order our products, they will refer to their customer drawing number. Next, they transfer the customer information and orders to the planning. After that they wait for the e-mail reply in product name that refer to the products. Moreover, most customers have many branches in many countries. So sales coordinators also informs the places to shipment. The sale department gathers the databases as below:

(a) Customer Name/ Bill to/ Ship to

(b) Customer drawing number

(c) Product Name

(d) Quantity

(e) Unit price

(f) Shipment date

(2) Planning department

After the planners get the orders, they check the raw materials in stock that can support production department by calling to warehouse. They also plan materials on order following up customer forecasting. After the planners check material status, they will plan production schedule to keep delivery and print it to production area. The planning department gathers the databases as below:

(a) Product Name

(b) Quantity

(c) Component of product

(d) Shipment date

(e) Work order

(3) Production department

When production department produces the products, they will produce them by following up the schedule plan and refer document number that is issued by design engineer. The documents are issued for procedure guideline. The documents also specify product name, quantity, and component of product.

(a) Product name

(b) Quantity

(c) Component of product

(d) Document number

(e) Work order

(4) Design engineer department/QA department

When design engineer department gets the customer specification, they will check our capability so that we can produce the products. Also they must consider the raw materials and evaluate the supplier.

The purpose of QA department is to check customers' needs. So they must check what the difference is between customer drawing and produced product. They also must check shipment's quantity and place of shipment. After they inspect produced products, they will approve standard of product to keep in next shipment called "first lot".

(a) Customer Name/Bill to/ Ship to

(b) Customer drawing number

(c) Product name

(d) Quantity

(e) Component of product

(f) Work order

(5) Shipping department

The shipping department must check product name, quantity, and shipment destination. They also record work order of shipment because if customers find any problems, we can feed back product checking.

(a) Customer Name/ Bill to/ Ship to

(b) Product name

(c) Quantity

(d) Work order

(e) Shipment date

2.5.2 The Current System

The design process follows the "Design flow" as shown below:

30 /9

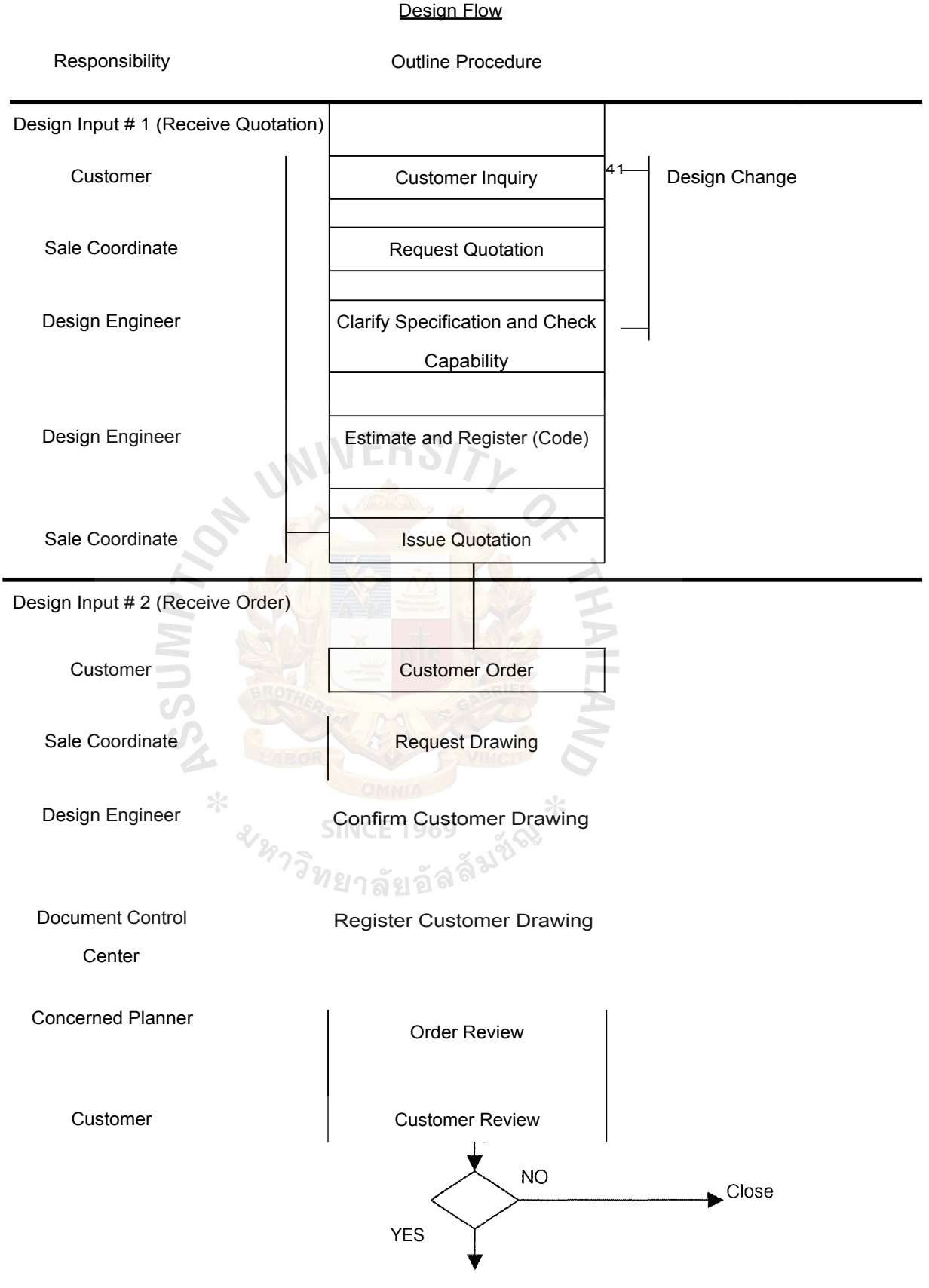


Figure 2.4. The Flow Chart of Design Control in the Current System.

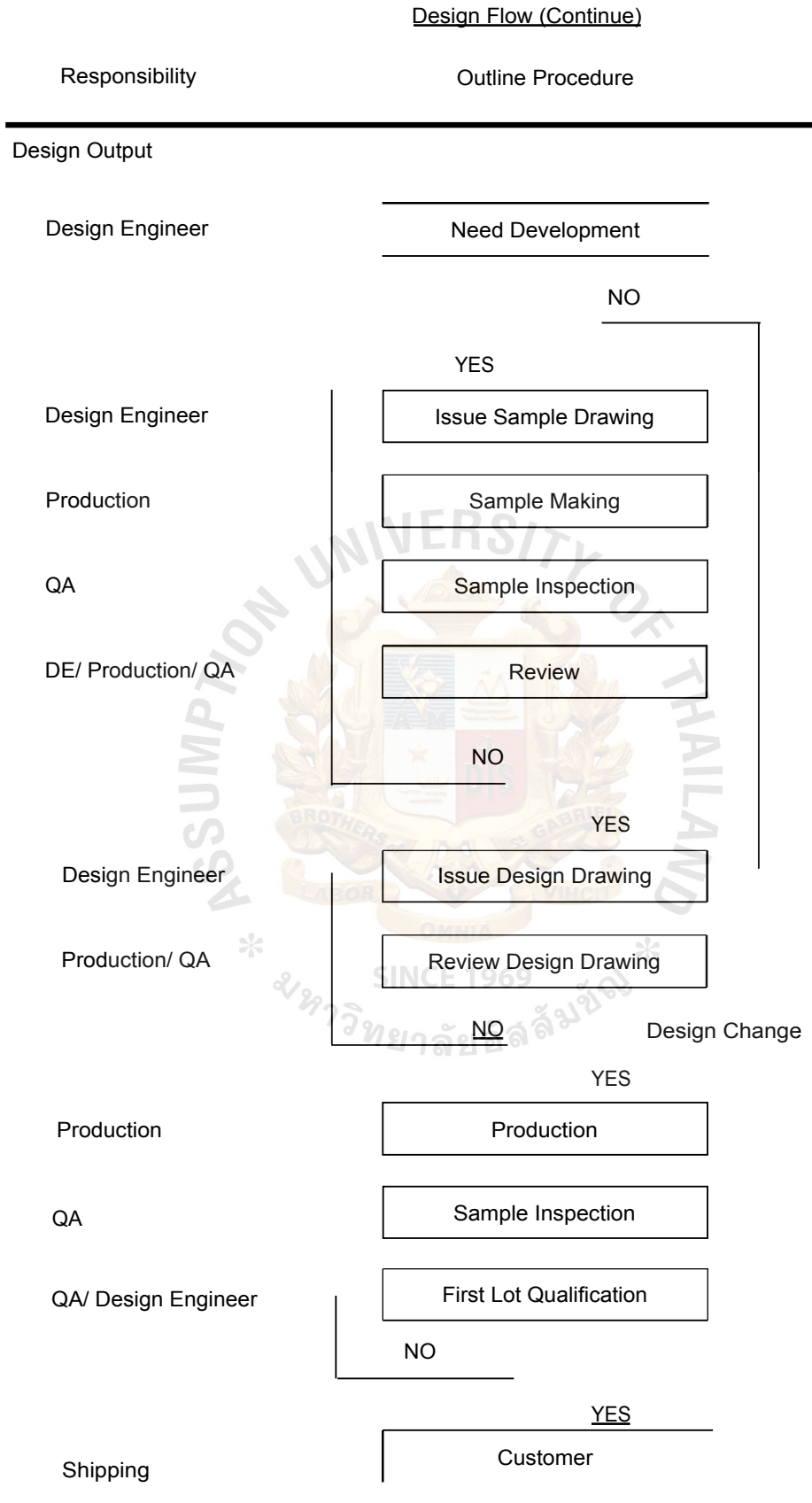


Figure 2.4. The Flow Chart of Design Control in the Current System (Continued).

2.6 Current Problems and Functional Areas for Improvement

2.6.1 Current Problems

Like any task in handling routine, company has problems of data updating and storing, as several departments i.e. Sale & Marketing department, Planning department, Finance & Accounting department, Engineering department, use data. Therefore the problems are usually encountered in consistency, validity, and redundancy of data.

The computers used in these departments are individual and separate. The formats of data keeping and reporting are varied while all departments require cost-related data. The update data needs to be printed out and distributed among departments. Each department needs to update or key-in the data in own computers. This situation is risky of losing information and potential error in data. Also data entering is redundant in data storing in several files.

2.6.2 Functional Areas Subject to Improvement

To break down barriers between functional areas, all functional areas work with concurrent design through an Online Web-based system. Moreover, they can do transactions and share information that are linked to the system.

(1) Operations Function

The processes begin with customer demand or demand planning, which in turn drive sales and operations and enterprise planning. Demand and operations planning drive advanced planning or directly drive the master schedule, which then feeds rough-cut capacity, MRP, and CRP. Master schedules use detailed forecasts to determine what to produce, when to produce it, and in what quantities. Using an Online Web-base system, we can analyze sales shipment history, calculate forecasts, and update demand for material requirements planning (MRP). Capacity Requirements Planning (CRP) utilizes MRP planned orders, other work orders, and repetitive schedules to determine

work center load and generate a capacity-requirements plan for a department, work center, or machine. CRP calculates load from planned and/or released work orders, as well as exploded repetitive schedules. Work centers/machine requirements are expressed in hours and can be reported within time periods based on days, week, or months. CRP also recalculates time-phased capacity plans and produces capacity planning reports.

An Online Web-based system functionality has supported production, using work orders and repetitive schedules, either separately or together, in a mixed-mode manufacturing environment. The work order is used to authorize and control the manufacturing of products, record material issues and receipts, and control rework and scrap. The work orders can be created manually or generated from MRP planned orders. The work order authorizes the production of specific items or products and includes a list of the required components and manufacturing steps. Prior to releasing a work order, component availability can be checked, and specific items or substitute items can be allocated. Labor and machine availability can be checked and alternate routings or work centers can be selected.

A product structure defines the relationship between component items and maintains the bill of material (BOM) for each product and assembly. Product structures in Online Web-based system can add and maintain the list of components for each product and subassembly. The Routings/Work Centers defines the areas where manufacturing activities are performed in the production process such as work centers, machines, manufacturing process standard operation times, and routings.

Quality Management defines and records the quality of products. This includes inspection and testing during the incoming inspection of purchased items, the manufacturing process and inventory sampling.

With an Integrated Quality Management application, test instructions can be quickly and easily included in work order documentation. Test results, along with production progress information, can also be rapidly reported to the system. The Quality Management module contains definitions of standard testing procedures, applies tests to work orders and repetitive schedules, and holds quality work orders. Throughout the production process, testing procedures may be devised and routed along with the products.

(2) Non-operations Function

In order to increase market share, companies must maintain an excellent record of accurate on time deliveries at competitive price while meeting higher customer expectations. Business process provides a fully integrated order fulfillment life cycle, enabling an enterprise to maximize demand and product availability while reducing fulfillment costs and delivery lead times.

When a customer demand is identified, this demand must be confirmed and converted to an order to either start production or ship product from inventory. This order is then tracked through production, warehousing, and shipment. Once items are shipped, an invoice is created and finally, payment is recorded.

Sales can provide easy-to-use functionality for order entry, shipping, invoicing, sales analysis, and supply chain planning. The Sales Quotation allows the sales coordinates to create responses to customer request for quotes (RFQs), and maintain historical information on sales quotations to customers. Quotations can be released to Sales Orders/Invoices to create sales orders.

Sales Orders/Invoices allow users to input customer orders, release packing lists to shipping, print invoices, and maintain sales histories. Posted invoices are

automatically recorded in an Online Web-based system to Accounts Receivable for payment maintenance.

Accounts Payable automates and streamlines the processing of payments to suppliers. The Accounts Payable manages supplier accounts, monitors outstanding payable, and processes payments to suppliers. Supplier invoices are matched with pending vouchers generated from purchase order (PO) receipts. Accounts Receivable provides a comprehensive credit management system to track customer balances and payments.

2.7 Goals of Implementation

The goals of Online Web-based system are to link the existing information system of company to each functional area, once there is a connection to the Online Web-based system. Next we need to consider what to know and what to do in the product design. Here are some questions to help us to decide:

(1) Who does use the Online Web-based system?

(2) What information does transfer on the Online Web-base system?

(3) Where does area do transactions?

(4) How do they interface with the Online Web-based system?

When the answers to the above questions are identified, we can start to design an Online Web-base system.

2.8 Expected Improvement

An Online Web-based system will have the following expectations:

(1) Maximize demand and availability of Heat pipe product, thereby gaining a competitive edge and increasing market share

(2) Streamline business processes to achieve superior productivity and profitability

(3) Synchronize supply and demand to maintain optimal inventory levels and improve cash flow

(4) Speed time to market and drive innovation across all levels of the companies

The benefits of an Online Web-based system are as follow:

(a) Provide superior customer service by establishing an efficient order entry system with sophisticated order tracking capabilities (Sales & Receivables - Orders)

(b) Improve cash flow through an integrated system of order processing, invoicing, and payment processing (Sales & Receivables - Orders, Invoices)

(c) Profitability depends on synchronizing supply and demand to optimize inventory levels and improve cash flow. Excess inventory ties up valuable resources, while an out-of-stock situation can result in manufacturing downtime, lost sales, and dissatisfied customers (Inventory/Warehouse)

(d) Communicate demand automatically among warehouses, manufacturing plants, suppliers, and transportation providers (Inventory/Warehouse)

(e) The fulfillment/replenish process can start with a demand in the plant or warehouse, a customer order, or demand on the production line within the enterprise. (Inventory/Warehouse)

(f) Improve predictability of demand that integrates marketing plans, historical demand patterns, and causal factor such as events and promotions (Sales & Receivables - Orders)

(g) Improve customer satisfaction with better resource allocation and a high degree of predictability through the coordination of demand, production scheduling, and materials planning (Manufacturing/Planning)

(h) Optimize the flow of materials through internal and external supply chains (Manufacturing/Planning - Production BOM)

(i) Establish replenishment strategies and reduce production bottlenecks by comparing planned requirements to manufacturing capacity (Manufacturing/Planning - Routings)

(j) Create realistic production plans that span production locations (Manufacturing/Planning - Routings)

(k) Optimize logistics resources - for both inbound and outbound transportation - to increase efficiency and lower costs (Manufacturing/Planning - Routings)

III. THE PROPOSED SYSTEM

3.1 Requirements Specification and Scope

The scope of the business processes will be described in the following steps:

(1) Input Order

When the customer places an order, the sales coordinates will enter an Online Web-based system. It then places an order online. After that sales coordinator will confirm with the design engineer for product approval.

(2) Estimated Delivery Date

When an order has been approved, we need to estimate the delivery date. The most likely case is that the delivery date will be kept in customer's expectation or promised date.

(3) Planning/Purchasing

In the inventory system, it shows the material status. If there is no raw material available - copper tube, copper wire, and copper spring - in the warehouse or the amount is not sufficient, the planning can check lead-time in each component and then order the purchasing department to buy raw material.

(4) Raw Material Warehouse/Distribution

After raw material has been purchased, it will be stored in the warehouse. If the design engineers specify test report of each component in the inventory system, the purchasing will require test report from vendors and then warehouse must check following the measurement notified.

Next is the production plan to produce products, the production manager will decide what kind of raw material will be withdrawn from the warehouse and put into the production line according to the order.

(5) Production

The production process will be carried on according to the production manager. Using the routing system, production manager can check lead-time to produce the products by following up sequence of routings. They also can check load profile. They can plan number of workers and/or machines if they need more capacity in production to optimize the production cost. Moreover if they know the material loss (%Yield) in each process, they can estimate material available.

(6) Shipment

When the finished goods are produced and/or the shipment has been accepted, the shipping will print invoice that list the shipping items. The shipping will check the orders, shipping bills, and shipping items before they send out the products to customers.

(7) Accounting

An Online Web-based system will be linked to the accounting department. After receiving the payment, the accounting clerk will be able to update the information to the customer databases.

(8) Reports and Analysis

An Online Web-based system will generate daily/weekly/monthly/quarterly/annual reports on the details on the daily transactions, raw material information, customer orders and delivery

3.2 System Architecture Overview

3.2.1 Hardware and Software Requirements

The proposed Online Web-based system require computer network to link several PCs within department and it also connects to other departments i.e. Sale & Marketing

department, Planning department, Finance & Accounting department, Supply Chain, and Engineering department.

(a) Clients - To access an Online Web-based system, a client needs a web browser. A web browser is simply a program that presents the user with a graphical user interface and includes the protocols necessary to connect to the web. It should be running on operating systems such as MS Windows NT or MS Windows 2000 or above.

(b) Web server - The web server is more often the software that provides the service to the machine running the implementation and maintaining the web pages. A web server is used to receive requests from web browser and manipulate the requests. The implementation will be running IIS 5.0 or above.

(c) Database - The database could be part of the server that communicates with client's web browser or could be part of another server that can be referenced to each other. Database is used to keep data associated with servers. In web application systems, database is simply manipulated by web applications in the form to create table, insert data, and update data.

The proposed Online Web-based system is linked and/or share databases in each department. Even all-functional areas have client computers in each department and we still have LAN system within the building but we still need more requirements in computer system. Also we need a new one for server computer to serve and link the centralize database. The requirements are as follows:

(1) Hardware Requirements

(a) Server Computer (1 no.): CPU Pentium 4, 3.2GHz., 40 GB hard disk, 256 MB RAM, Ethernet Networking Connection

(b) Client Computer: CPU Pentium III 833 MHz

(c) Input Devices: keyboard and mouse

(d) Output Devices: laser printer and screen 17" monitor

(e) Storage Devices: Up to 10 GB hard disk and tape back up

(f) Data Communications: Fiber optic, Network card 10/100 Mbps

(2) Software Requirements

(a) OS - MS WindowsNT/2000 Advanced Server

(b) Database Server - MS SQL sever 2000, MS Access 2000

(c) Web Server - MS IIS 5.0 for WindowsNT/2000

3.2.2 Security Control and Backup

To provide the protection scheme for information security in the computer system:

(1) Operation system checks the permissibility of each access by specific users to ensure authorized access.

(2) Enforce users to log on by entering user identifier and password, it provides log on service to determine who is allowed to use an Online Web-based system.

(3) Anti-virus software installs all computers and use full-featured protecting of scanning. Also it can be updated from time to time via the Internet.

(4) The Backup file is kept in tape back up once a week.

3.3 System Design

3.3.1 Data Flow Diagrams (DFDs)

When customer places the orders, the sale representative will check the customer inquiry. The sale representative uses the web-based online system to customer information and product details. If the orders are approved and finished goods are already prepared in shipment, the web-based online system will list products to the warehouse/shipping and create invoice to customer. If not, the web-based online system will prepare reject notice of the orders to customer. After customers apply their payment

of cash, the system automatically entry cash receipts and generate daily payments to accounting manager.

In manufacturing process: when planning receives the orders, planning will set production schedules and production capacities through the web-based online system. The system provides the material availability to production by checking in stock information. If raw material is not enough, the system will create purchase orders to approved suppliers, whereas approved suppliers must follow up in the material specifications that are created by design-engineering department.

In business process, the computer program consists of the following modules:

Module 0: Web-based Online System

Module 1.0: Order Module

- Module 1.1: Verify Order
- Module 1.2: Prepare Reject Notice
- Module 1.3: Assemble order

Module 2.0: Create Invoice

Module 3.0: Apply Payment

- Module 3.1: Post Payment
- Module 3.2: Prepare Accounting Entry

Module 4.0: Inventory Module

- Module 4.1: Check Material Availability
- Module 4.2: Requisition

Module 5.0: Purchasing Module

- Module 5.1: Check Supplier Information
- Module 5.2: Create Purchase Order
- Module 5.3: Check Validate Material

3.3.2 Entity Relationship Diagram

An entity-relationship diagram is a data modeling technique that creates a graphical representation of the entities, and the relationships between entities, within an information system. The relationship cardinalities of an Online Web-based system are as follows:

Places: A customer places zero to many orders, and an order is for exactly one customer.

Generate: An order is generated from one to many order details, and an order detail is for exactly one order.

Lists: A product is listed by zero to many orders, and an order detail is for exactly one product.

Comprised of: A product is comprised of one to many components, and a component goes into making one to many products.

Supplied by: A component is supplied by one to many vendors, and a vendor supplies one to many components.

Produce: A product is produced by one to many work centers, and a work center produces one to many products.

3.3.3 Database Design

Customer Table - List of registered customers in the system, which contains data regarding Customer ID, Customer Name, contact person, telephone number, customer address, and where to ship product.

Order Table - Orders are placed from customer to producer after receiving price quotation, which contains regarding Order No, Work order, Product No, and amount of money paid in this time.

Product Table - Users can check components of product, which list in the Production BOM. The data consists of Product number, Product name, Product price, List of component and quantity of each component in the product.

Component Table - Components are produced by suppliers, which contains data regarding Component name, Component description and Price.

Inventory Table - Users can check each component in inventory details, which contain data regarding Quantity on hand, Quantity on order and Lead-time.

Routing Table - List of procedure in product routing and work center, which contain data regarding Product name, Operation, Work center description, Machine per worker, Overlap units, Setup time, Production rate, Cost of subcontract and yield of each operation.

Table 3.1. Database Design - Customer.

Key	Name	Data Type	Size	Null
PK	Customer ID	AutoNumber	Long Integer	No
	Customer Name	Text	50	No
	Contact	Text	50	No
	Tel	Text	50	No
	Address	Text	50	No
	Bill to	Text	50	No

Table 3.2. Database Design - Order.

Key	Name	Data Type	Field size/Format	Null
PK	Order_No	AutoNumber	Long Integer	No
	Work_order	Text	7	No
	Order date	Date/Time	Medium Date	No
	Shipping_date	Date/Time	Medium Date	No

Table 3.3. Database Design - Order Detail.

Key	Name	Data Type	Field size/Format	Null
PK	Order_detail_ID	AutoNumber	Long Integer	No
FK (Orders)	Order_No	Number	Long Integer	No
FK (Products)	Product No	Number	Long Integer	No
	Quantity	Number	Long Integer	No

Table 3.4. Database Design - Product.

Key	Name	Data Type	Field size/Format	Null
PK	Product No	Number	Long Integer	No
	Product Name	Text	13	No
	Product_descriptionl	Memo	-	Yes
	Product_description2	Memo	-	Yes
	Customer drawing	Text	9	No
	Unit of measure	Text	10	No
	Price	Currency	Currency	No

Table 3.5. Database Design - Work Center.

Key	Name	Data Type	Field size/Format	Null
PK	Operation	AutoNumber	Long Integer	No
FK (Products)	Product No	Number	Long Integer	No
	Description	Text	50	No
	Machine_per_Worker	Number	Long Integer	Yes
	Setup_Time	Number	Long Integer	Yes
	Production rate	Number	Long Integer	Yes
	Subcontract cost	Currency	Currency	Yes
	Yield%	Number	Long Integer	Yes

Table 3.6. Database Design - Vendor.

Key	Name	Data Type	Field size/Format	Null
PK	Vendor ID	AutoNumber	Long Integer	No
	Vendor Name	Text	50	No
	Address	Text	50	No

Table 3.7. Database Design - Component.

Key	Name	Data Type	Field size/Format	Null
PK	Component No	AutoNumber	Long Integer	No
	Component_Name	Text	50	No
	Component_description	Memo	-	Yes
	Unit of measure	Text	10	No
	Price	Currency	Currency	No
	Quantity_Per_Unit	Number	Long Integer	No
	Scrap%	Number	Long Integer	Yes
	Quantity_On hand	Number	Long Integer	No
	Quantity_On order	Number	Long Integer	No
	Lead time	Number	Long Integer	No
	Price	Currency	Currency	No

3.4 Features

This project implementation is focused on an Online Web-based system in Operation management with simplified features. An Online Web-based system provides the following functionality:

3.4.1 Material Requirement Planning (MRP)

In the web-based online system, Production BOM and Inventory provide the computerized inventory control system for calculating the material demand, and developing work orders or purchase orders that consider the lead time required to produce the materials in-house or acquire them from the outside suppliers. The input requirement is provided as follows:

(1) Production structure file - heat pipe product is still a know-how business, so we assume the proportion of components to specify when and in what quantity each component is required in the production process, as below

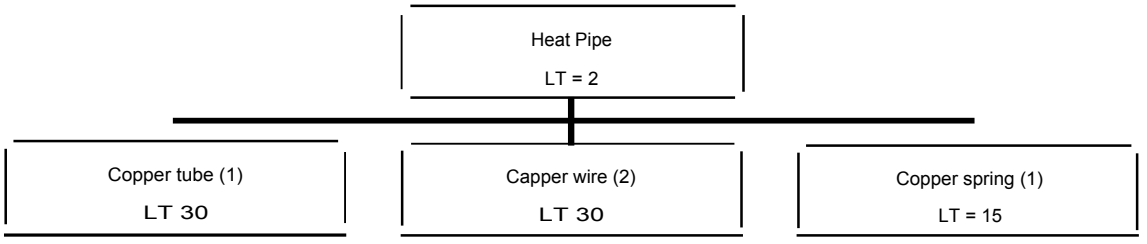


Figure 3.1. Bill of Materials of Heat Pipe Product.

(2) Inventory master file- we can know product on-hand in Inventory database that considers the lead-time required to produce the components.

(3) Master production schedule (MPS) - when we work together with customers, customers will provide the forecast to lowest possible level of inventory.

From those inputs, production management can summarize in the planned order report. The report shows the items, quantity and period to make sure the material availability.

In the bill of materials, the heat pipe products consist of copper tube, copper wire, and copper spring. If they produce 1 unit of heat pipe, they must plan to order lunit of copper tube, 2 units of copper wire and 1 unit of copper spring. Before the production manufactures the heat pipe products, the planners also order in their lead-time if they are not in stock. For example: the planners must plan to order 30 days in lead-time of copper tube, 30 days in lead-time of copper wire and 15 days in lead-time of copper spring.

3.4.2 Capacity Requirements Planning (CRP)

In the web-based online system, Routing provides the load profile for each machine center. The production management can allocate workers and/or machines to increase the load percent. The input requirement is provided as follows:

(1) Routing - the process sequence of each operation as following:

Table 3.8. Example of Heat Pipe Process Charts.

Operation	Details of process	Operation	Transportation	Inspections	Delays	Storage	Time (sec)
10	Pipe cut						5.0
20	Assembly						3.6
30	Input water						7.2
40	Welding (Closed end)						4.5
50	Plating						-
60	Inspection						36.0

(2) Load profile - Setup time, utilization and efficiency of each work center are provided in the web-based online system to plan the orders.

From heat pipe process chart, the productions can estimate total time in manufacturing. The Routing is shown in machine per worker, setup time and production rate. The projected load can be computed from the process sequence, the duration of each operation and setup time. Also the capacity is computed from the machine per worker.

3.5 System Cost Evaluation and Comparison

3.5.1 Cost Analysis

As all-functional areas have own client computers in each department and they currently use LANs system within the building, the new system still needs some

installation costs, an Online Web-based system can have IS-related development cost both one-time and recurring.

One-time costs include the new hardware requirements, new software requirements and implementation. Though, the current system has client computers and LANs system in each department such as Engineering, Finance & Accounting, Sale & Marketing, Warehouse & Shipping, and Purchasing, we still need to estimate the load of client computers that are shared in the new system. In the implementation, IT department plans to test run system in parallel. They make documents in the web-based system and set the training classroom. IT developers will estimate all costs as follows:

(1) One-time costs (Year 0)

(a) New hardware

Server Computer with storage (1 no.)	200,000
Client Computer (5 no.) (1 no. x 40,000 @ load 30%)	60,000
Laser printer (2 no.) (1 no. x 7,500)	15,000
Network accessories and connection	100,000

(b) New software

- Operation system (1 no.)	30,000
- DBMS application software (5 no.) (1 no./ 1 user x 25,000)	125,000

(c) Implementation

- User training (5 users) (1 person/12,000 of Salary)	60,000
- User Manual	10,000
- System development (1 person of IT support)	80,000
Total one-time cost	680.000

Recurring costs include application software maintenance and incremental data storage required. To effectively run the new system, IT developers prepare budget to upgrade and maintain the system. The other expense is increased data storage. It should also be expected.

(2) Recurring costs (Year 1 through 5)

(a)	Application software maintenance	35,000
(b)	Incremental data storage required (1 GB = 50 Bahts)	20,000
	Total recurring costs	55,000

3.5.2 Benefit Analysis

An Online Web-based system can provide many benefits to company. For example: reduce errors, improve organizational efficiency, speed and flexibility. In general, the benefits can be viewed as being both tangible and intangible.

In tangible benefits: Firstly IT developers survey the person responsible for collecting, entering, recording and analyzing the current system. These persons estimate that they spend 10 percent of their time correcting data entry error. Given that a person's salary is 12,000 Bahts/month so we estimate reduced personnel expense in 6 departments i.e. Sale, Planning, Design Engineer, Production, Purchasing, and Warehouse, benefit of 80,000 Bahts/year.

Using the interface, they can reduce the time by comparison between existing and proposed system. The existing system used only MS office and is kept in their databases. Also it doesn't have interface to link or share the data between departments. They always waste time in the data input, output, update, and storage.

Table 3.9. shows the transaction-time per day, each department increases speed of activity and reduces waste time. An online web-based system can save total time 95 min/day. Given that these person's salary is 12,000 Bahts/month (1 day = 8 working

hours in office). So, benefit of 475 Bahts/day or 170,000 Bahts/year from 6 departments.

Table3.9. Transaction-Time Comparison.

Transaction Time	Existing System	Proposed System
Data Input	60 min	20 min
Data Output	45 min	10 min
Data Update	20 min	5 min
Data Storage	10 min	5 min

Further, improvements are in management planning or control result from analysis in the new system. The operation management and supply chain analyst helps to estimate the saving inventory costs that consist of transport costs, storage costs, and lost sales. They can run more machine utilization, labor productivity, improve bottleneck process and reduce cycle stock. Assume the operation cost is 100 Bahts/hr (1 day = 18 working hours in production) and the new system can save about 20% of their operation cost. So overall, this analysis benefit forecast is approximately 130,000 Bahts/year.

Tangible Benefits

(a) Reduced personnel expense	80,000
(b) Increased speed of activities and Cost reduction (less waste)	170,000
(c) Improvement in management planning or control	130,000
Total tangible benefits	380,000

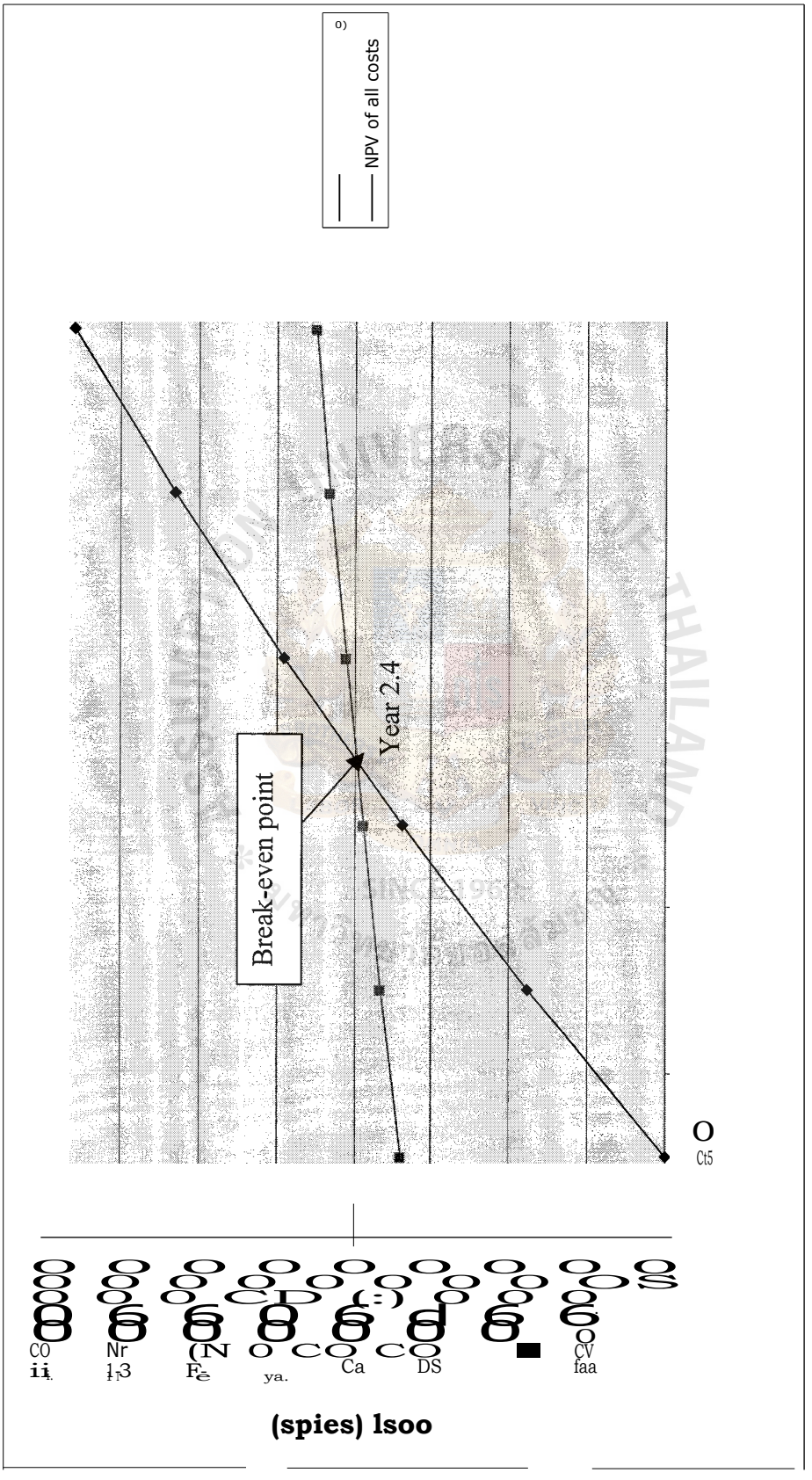
3.5.3 Break-even Analysis

The objective of the break-even analysis is to discover at what point benefits equal costs. In this system, we assume discount rate 8% according to debt of SMEs industry. The two curves intersect at 2.4 years, which is the break-even point. The system development costs will be recovered by the cost saving benefits within 2.4 years after implementation.

Table 3.10. Economic Feasibility Analysis of an Online Web-based System.

Cost/Benefit Analysis Worksheet

Web-based online system:							
	Year-0	Year-1	Year-2	Year-3	Year-4	Year-5	Totals
Net benefits (net cost saving)	0	380000	380000	380000	380000	380000	
Discount rate (8%)	1	0.9259	0.8573	0.7938	0.735	0.6806	
Present value of benefits	0	351842	325774	301644	279300	258628	
NPV of all benefits	0	351842	677616	979260	1258560	1517188	1517188
One-time costs	680000						
Net recurring costs	0	55000	55000	55000	55000	55000	
Discount rate (8%)	1	0.9259	0.8573	0.7938	0.735	0.6806	
Present value of costs	0	50924.5	47151.5	43659	40425	37433	
NPV of all costs	680000	730924.5	778076	821735	862160	899593	899593
Overall NPV							61/595
Overall 001							0 686527129
Yearly NPV cash flow	-680000	300917.5	278622.5	257985	238875	221195	
Overall NPV cash flow	-680000	-379082.5	-100460	157525	396400	617595	
Actual break even point	r 2.4 Years7)						


NPV of all costs
Break-even point
Year 2.4
(spies) lsoo

IV. PROJECT IMPLEMENTATION

4.1 Overview of System Implementation

This project discusses what is an Online Web-based system, and the needs of adapting it to the existing heat pipe business. Next the project discusses the design issues for the online system. Finally the project discusses the technology that is used in the actual implementation of an Online Web-based system.

4.2 Test Plan

The purpose of the testing is confirming that the system satisfies requirements. The type of test being conducted:

(1) Response time in the online system

(2) Test boundary data, illegal and out-of-range data

(3) Fix errors and debug

4.3 Conversion

The process of moving from the current information system to the new online web-based system that uses parallel installation. Under parallel installation, the current system still run alongside the new online system until users and management are satisfied that the new system is effectively performing its duties and then the old system can be turned off. The activities in system conversion include:

(1) Creating new databases

(2) Installing new system

(3) All working done in the new system

(4) Training and Supporting the users

4.4 Training, Documentation and Support

4.4.1 Training

The necessary knowledge to use the basic functions of the web-based online system will provide the end-user community through a combination of formal (in classroom) and independent (study-yourself) training modules. An additional optional self-study module will be available for those users wishing to learn the more advanced features of the online system.

It is anticipated that the training organization will be engaged to prepare the training modules and conduct the training sessions. This organization has a broad range of expertise in the training arena.

4.4.2 Documentation

The planned documents in the web-based online system include:

(1) User's Guide

(2) Programmer's Reference Manual

(3) System Administration Manual

(4) Database Administration Manual

(5) Operations Manual

The User's Guide should be a very visual, graphical orientation; it helps users a more quick understanding of the subject matter.

4.4.3 Support

The online system helps in main menu. Users can send e-mail to IT department about the problems. Moreover, they can call directly to IT department in urgently cases.

4.5 Maintenance

After the web-based online system is installed, the system is essentially in the maintenance phase of the systems development process life cycle (SDLC). To keep the current software with the changing processing requirements or business needs and fix the errors of the software, system maintenance plan have been developed. The types of maintenance that are performed are as follows:

(1) Corrective maintenance - repair design and programming errors i.e., program logic errors, system errors, and operation errors.

(2) Adaptive maintenance - make the changes to an Online Web-based system to evolve its functionality to changing business needs.

(3) Perfective maintenance - evolve system to solve new problems or take advantage of new opportunities.

(4) Preventive maintenance - reduce the chance of future system failure.

V. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

This project provides the online workflow applied to the heat pipe business. Due to the scope and time constraints, the implementation in this project is based on an idealized simplified business processes. However, the challengers of heat pipe business innovation among customers and suppliers could be considered for further development.

In the problem, product life cycle (PLC) of heat pipe is very short and the growth is unpredictable. When customer requests the sample products, the company must check product ability in quick response. Further, the heat pipe product consists of 3 components. There are copper tube, copper wire, and copper spring in the bill of materials. When company produces the heat pipe products, they also plan the raw materials different in amount and lead-time to provide the product available.

Each department uses separate and individual PC. The staff uses MS office to produce the documents. So, the databases are possibly used in different codes. The problems are usually encountered in consistency, validity, and redundancy of data. The update data need to be printed out and distributed among departments.

From those problems, an Online Web-based system is one of the management information and control functions in product design and analysis. With the using of an Online Web-based system, the centralize database can manage the integrated information from several departments. It can easily provide more synchronized environment in order tracking and optimize the inventory system in the flow of material through internal and external supply chains. Also it can improve cash flow in payment processing.

In operations function, company can use detailed forecasts to determine what to produce, when to produce it, and in what quantities. Using an Online Web-base system,

they can analyze sales shipment history, calculate forecasts, and update demand for material requirements planning (MRP). Capacity Requirements Planning (CRP) utilizes MRP planned orders, other work orders, and repetitive schedules to determine work center load and generate a capacity-requirements plan for a department, work center, or machine. CRP calculates load from planned and/or released work orders, as well as exploded repetitive schedules. Work centers/machine requirements are expressed in hours and can be reported within time periods based on days, week, or months. CRP also recalculates time-phased capacity plans and produces capacity planning reports

A product structure defines the relationship between component items and maintains the bill of material (BOM) for each product and assembly. Product structures in Online Web-based system can add and maintain the list of components for each product and subassembly. The Routings/Work Centers define the areas where manufacturing activities are performed in the production process such as work centers, machines, manufacturing process standard operation times, and routings.

In non-operations function, company also needs to increase market share. They must maintain an excellent record of accurate on time deliveries at competitive prices while meeting higher customer expectations. Business process provides a fully integrated order fulfillment life cycle, enabling an enterprise to maximize demand and product availability while reducing fulfillment costs and delivery lead times.

Using the new system, we prospect in the cost reduction. Firstly, it can reduce the data error and risk of losing information. Secondly, it can reduce time consuming by using the interface. For example, data input, output, update, and storage. The interfaces are linked or shared the data between departments. Finally, it can improve management planning. It can reduce the inventory costs that consist of transport costs, storage costs, and lost sales. Also it can utilize man & machine to operate more capacity.

In conclusion, the principles of engineering economy is useful in making comparative economic evaluation of alternatives between the existing system and the new online system in design and developing cash flows in financial project. This project's break-even occurs at 2.4 years. The system development costs will be recovered by the cost saving benefits within 2.4 years after implementation.

5.2 Recommendations for Future Project

In the future, highly competitive global business is increasing. The company must integrate all functional areas and work with the partners so they start using more new technology i.e. Mobility, Wi-Fi Technology, RFID (Radio Frequency Identification) and e-business. In the wireless society such as mobile phone and Pocket PC technology, they can load/save all document files via Bluetooth, Infrared and USB link to eliminate paperwork.

In RFID Technology, they can use RFID tags in the warehouse department to track the products in stock and/or spare parts of machines. It can be linked in their data warehouse and adjust product available all time. If they combine with PDA, they can check product information in RFID tags that are attached in those products.

In Wi-Fi Technology (Wireless Fidelity), Wi-Fi enabled computers send/receive data indoors and out; anywhere within the range of a base station. Wi-Fi networks can connect multiple computers to each other, to peripherals, and to the Internet. A Wi-Fi network can connect computers together to share such hardware and software resources as printers and the Internet. That means everyone in the company can share stored files, documents and print them out on a single printer attached to one desktop computer - all without moving cables or installing complicated hubs and routers.

From this project, company is planning a framework that links the information system with the physical flow of materials required to fulfill demand. Next, company

can continue improvement programs to link in the Internet-Enable because they already prepare the web-based online system within the business functions. Then customers can work in e-Business to web fulfillment via the Internet. The real-time orders are validation and confirm with customers & suppliers. They also can return online approval in specification of products/materials and alert in tracking event. The order cycle time can be dramatically reduced. They allow suppliers to manage replenish inventory to space requirement in warehouse.

APPENDIX A

CONTEXT DIAGRAM AND DATA FLOW DIAGRAMS OF AN ONLINE WEB-BASED SYSTEM

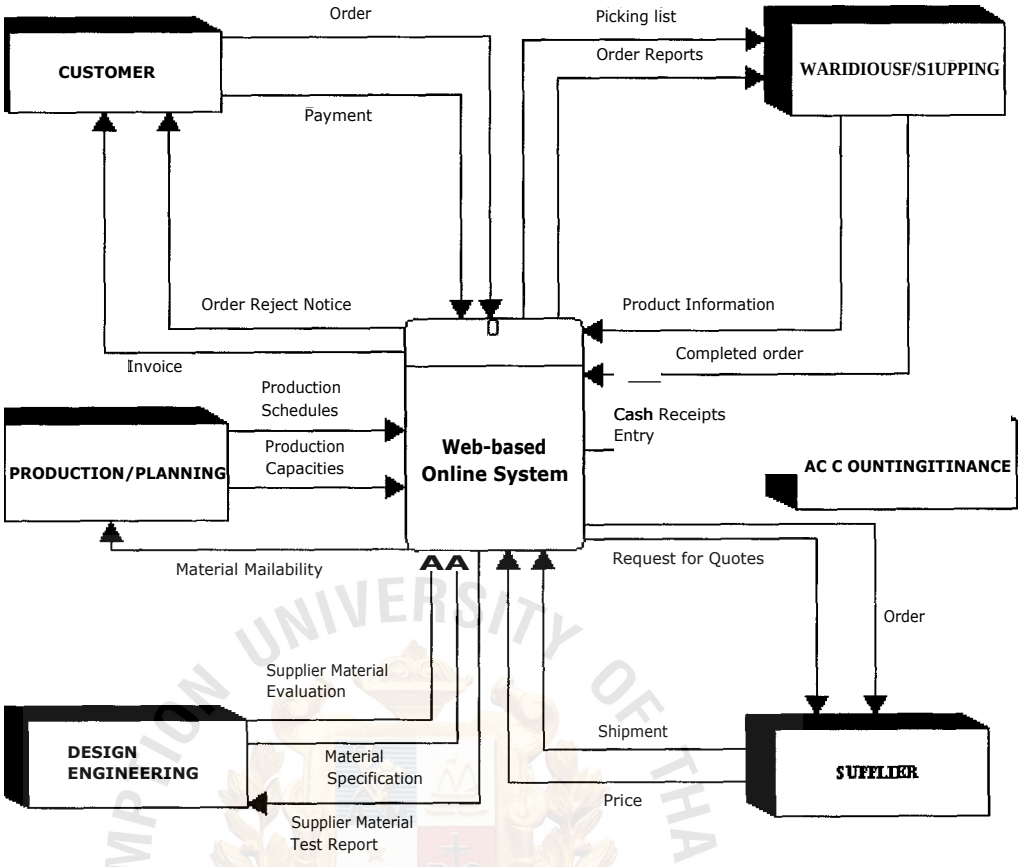


Figure A.1. Context Diagram for Web-based Online System.

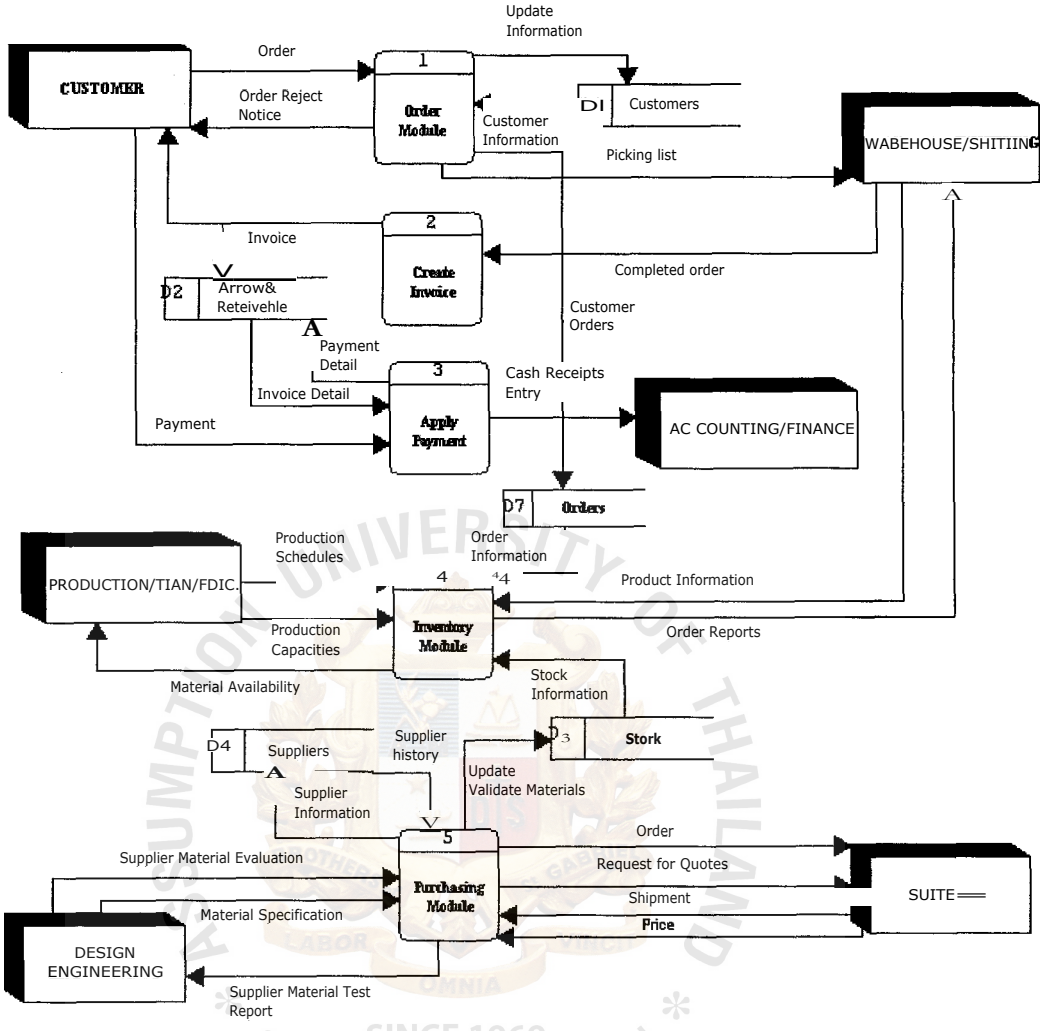


Figure A.2. Data Flow Diagram Level 0 for Web-based Online System.

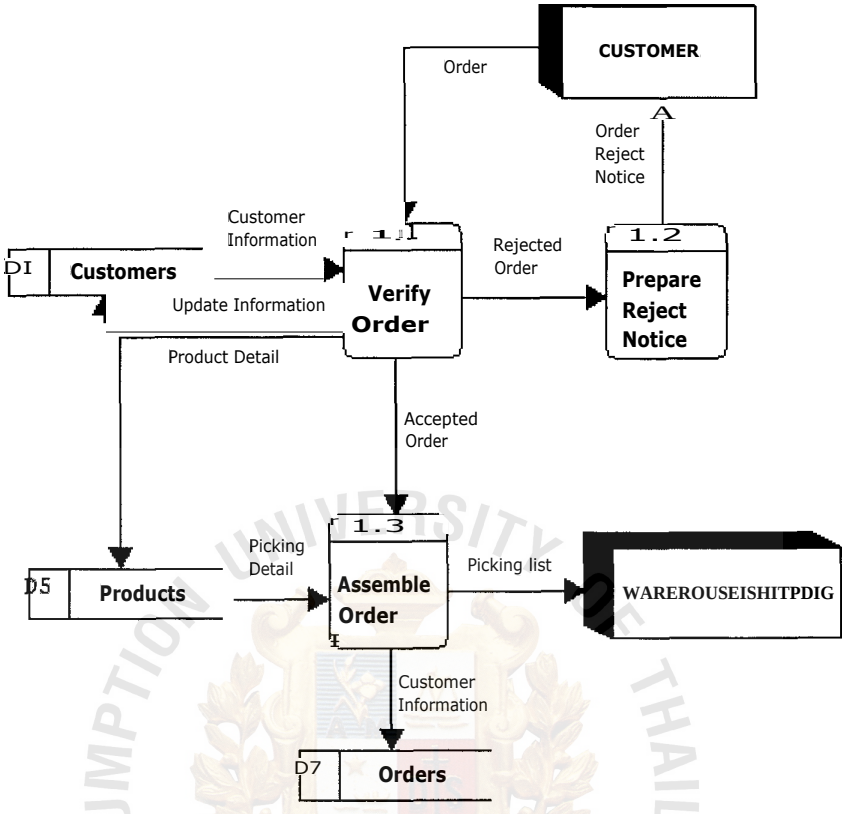


Figure A.3. Data Flow Diagram Level 1 of Order Module for Web-based Online System.

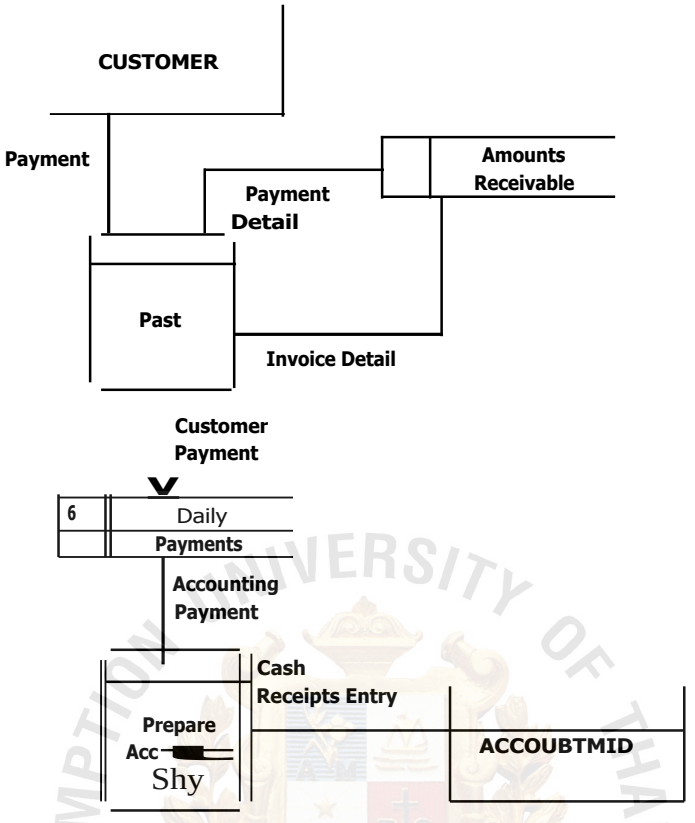


Figure A.4. Data Flow Diagram Level 1 of Apply Payment for Web-based Online System.

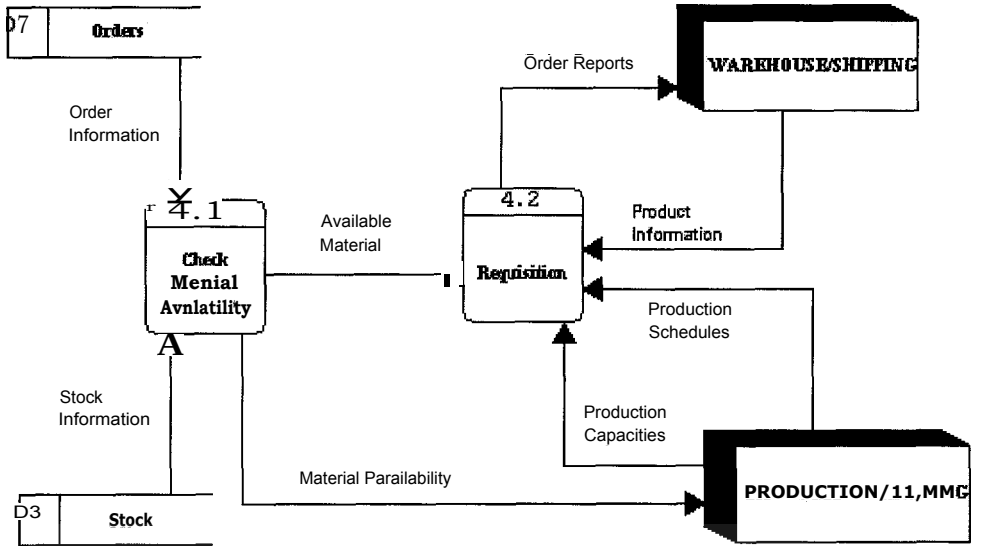


Figure A.5. Data Flow Diagram Level 1 of Inventory Module for Web-based Online System.

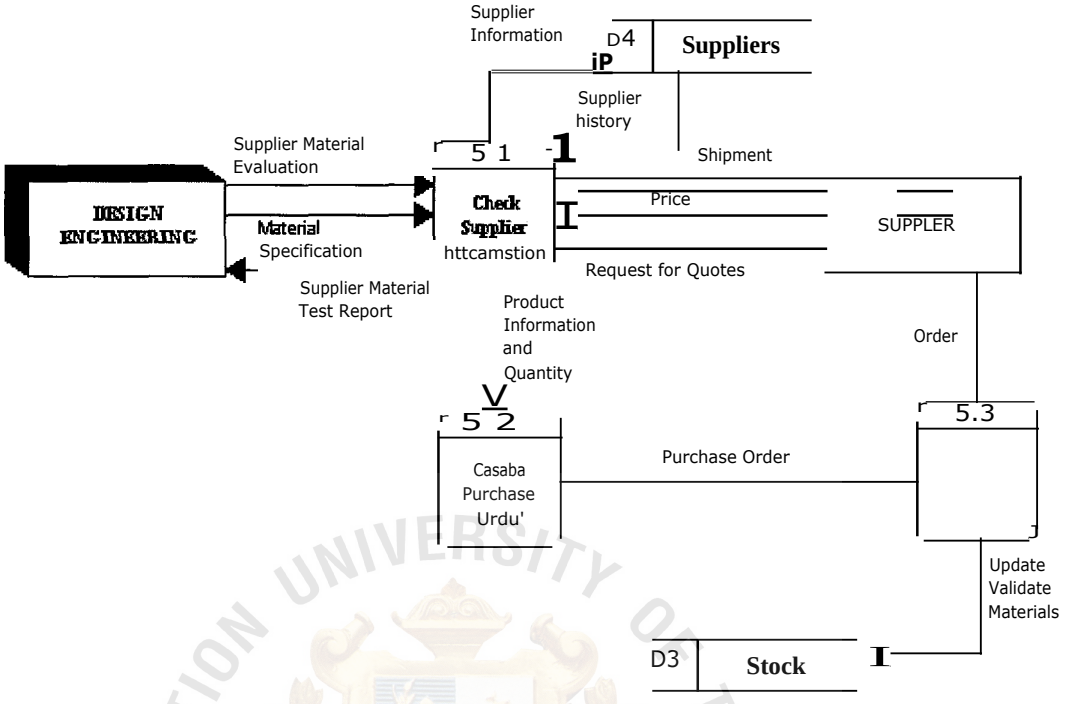


Figure A.6. Data Flow Diagram Level 1 of Purchasing Module for Web-based Online System.

APPENDIX B

DATABASE DESIGN

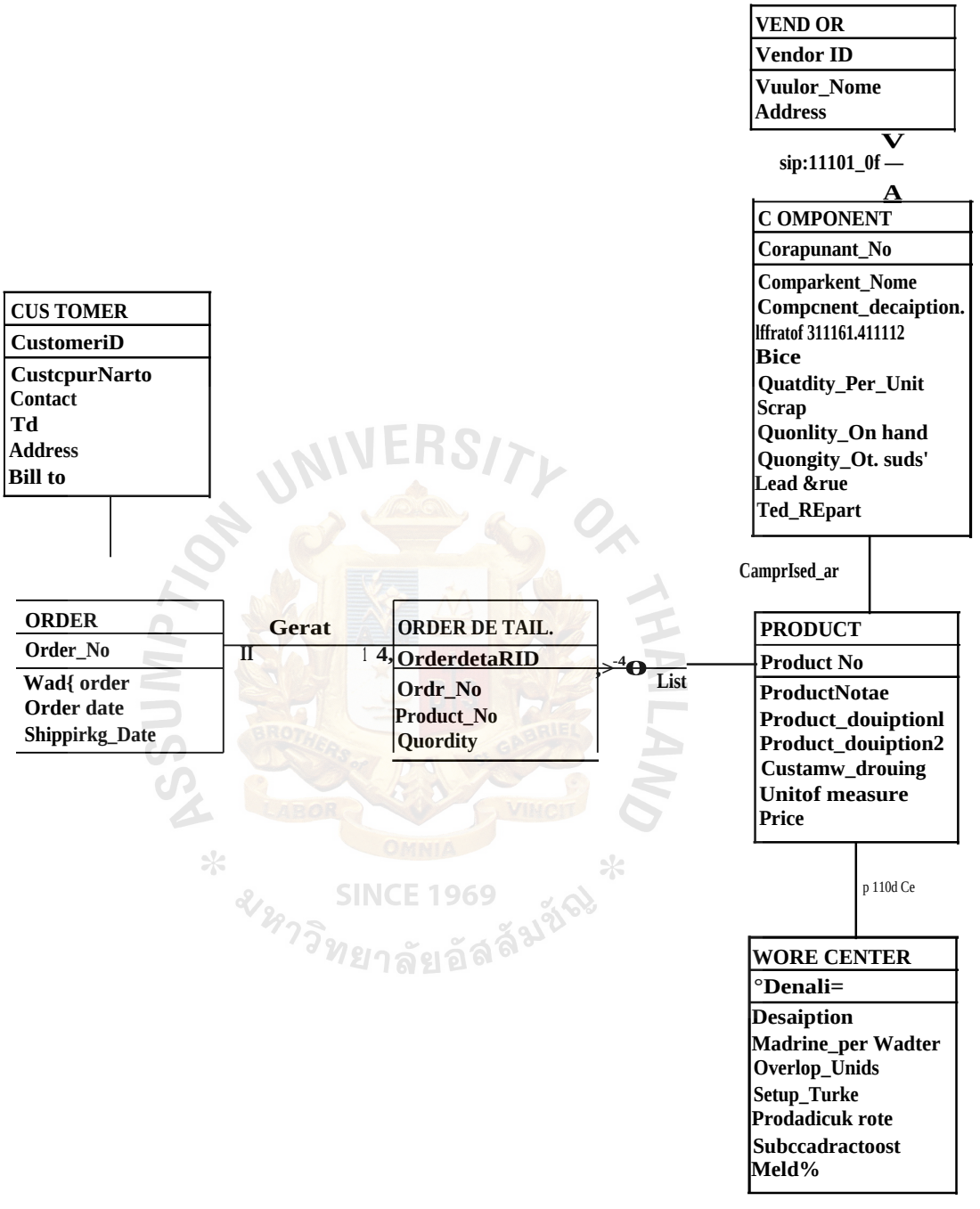


Figure B.1. Entity Relationship Diagram.

APPENDIX C

WEB INTERFACE AND REPORT DESIGN

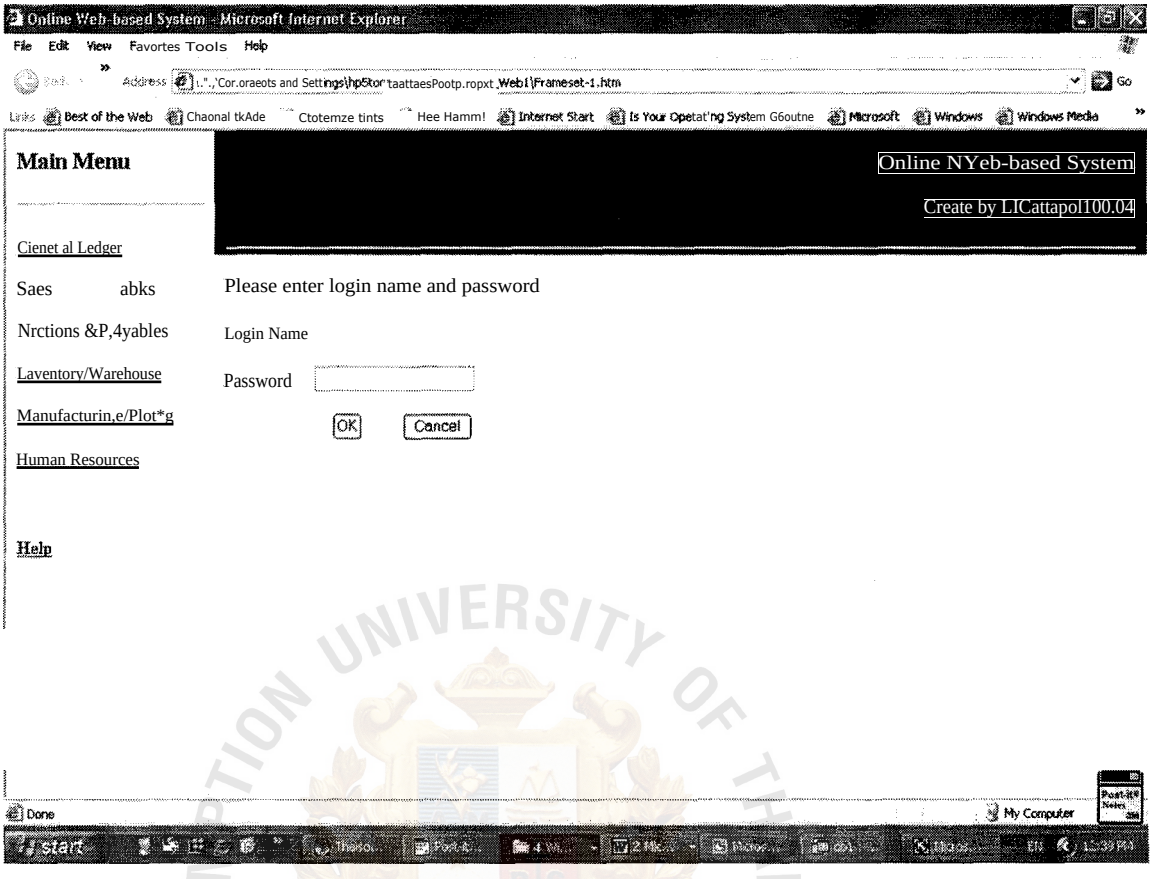


Figure C.1. Main Menu Form.

This is the Main Menu; users can select which section by clicking on the navigation bar located on the left and at the bottom of page. Before using an Online Web-based system, users must login your name and password that each user can do transactions related to the different levels.

Sections:

(1) General Ledger - The accounts can check the balance sheet in the online system.

(2) Sales & Receivables Sales department can check the orders related to customers.

(3) Purchases & Payables - Purchases department can check the quote related to vendors.

(4) Inventory/Warehouse - Supply chain department can check the materials on hand.

(5) Manufacturing/Planning - Both manufacturing and planning can check and/or plan the bill of material related to production capacity.

(6) Human Resources - Human Resource department can check status of employees and easy to calculate wage.

(7) Help - Writes email to the IT support department.

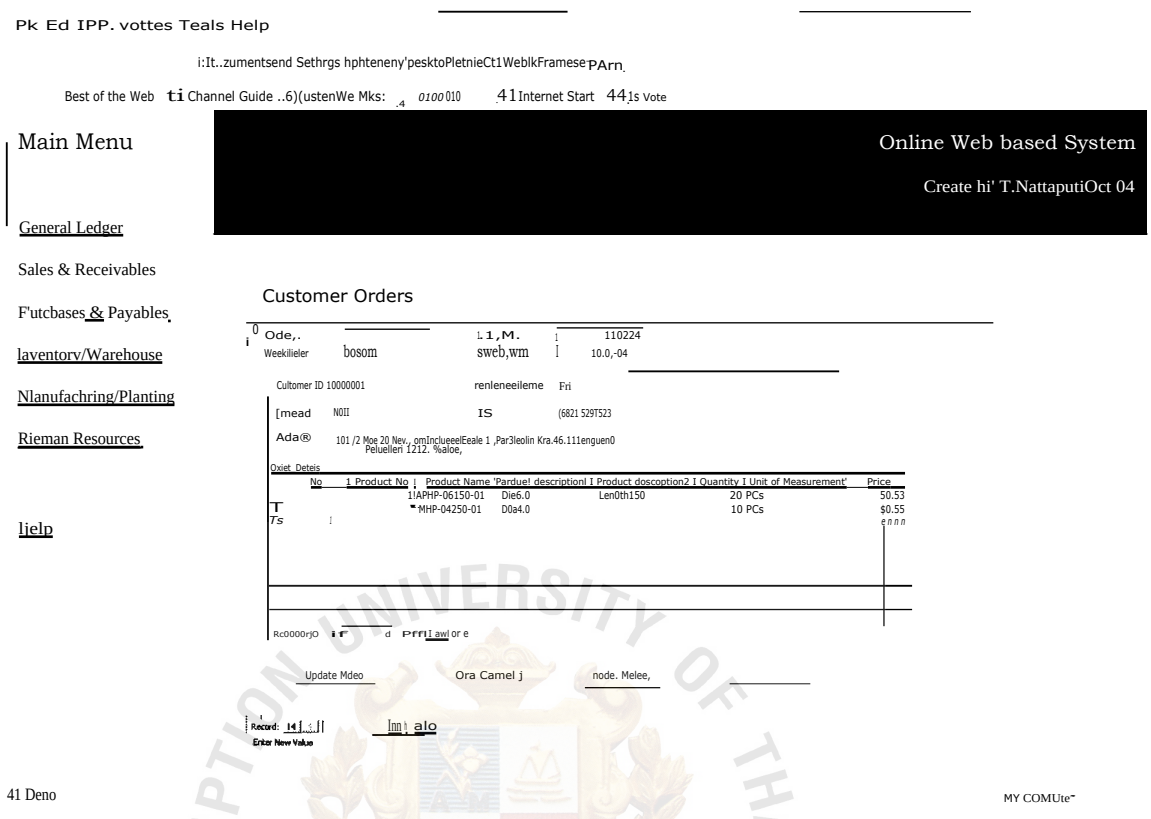


Figure C.2. Customer Order Form.

Firstly customers place the orders, sales department can create purchase order. They can serve in customer databases and list a price of each product in the web-based online system. Also they can check the previous customer orders to get more benefits in the future plan. After clicking on the Update Order button, the orders will be saved to the customer databases.

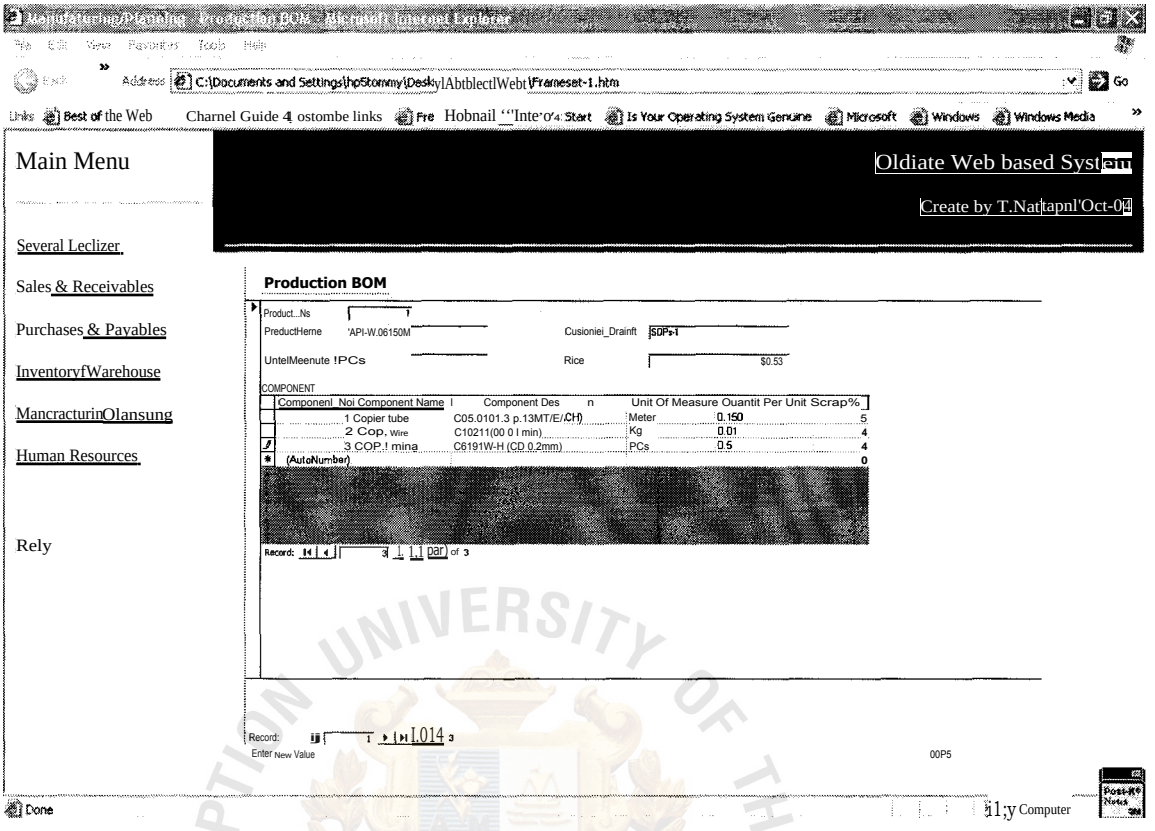


Figure C.3. Production BOM Form.

In during processes, the planning must check quantity in each component by using BOM (Bill of Material) in the online system. They also can calculate reject of each component enough to serve in the production line.

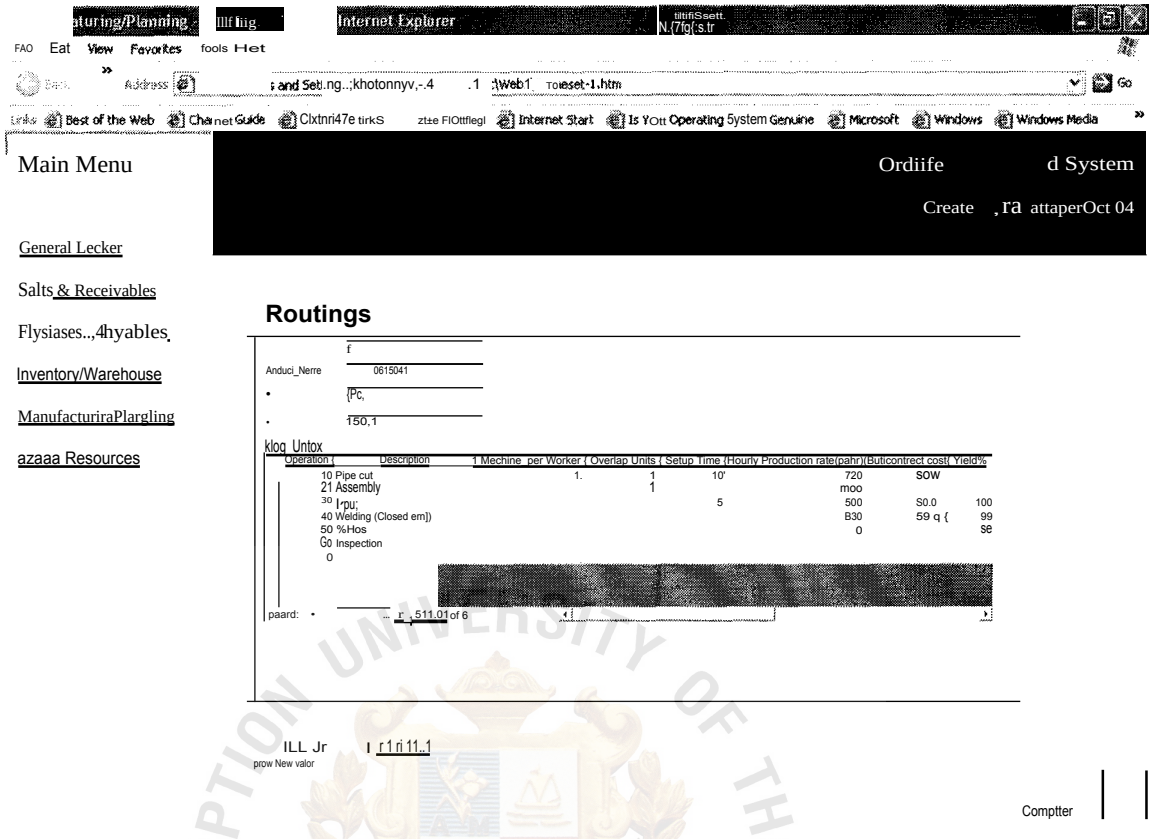


Figure C.4. Routings Form.

After checking the components of product, planning department create the production schedules by using routings of each work center. They can check the product capacities and lifetime of product to confirm the delivery. Moreover, they can add price of subcontractor to keep data in the processing cost.

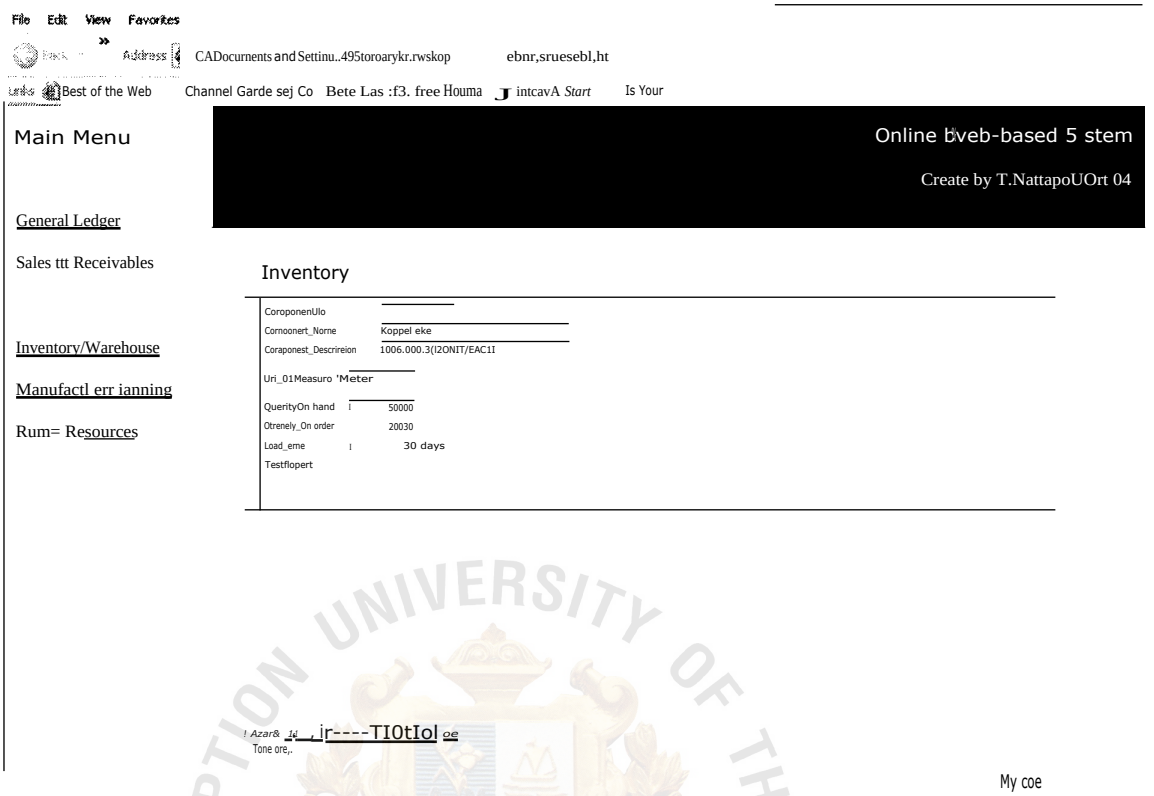


Figure C.S. Inventory Form.

In the web-based online system, the planner can check material status - Quantity on hand, Quantity on order, and Lead-time. Also the system can notify about attach test report before warehouse department receive the raw material to checking follow up the measurement method.

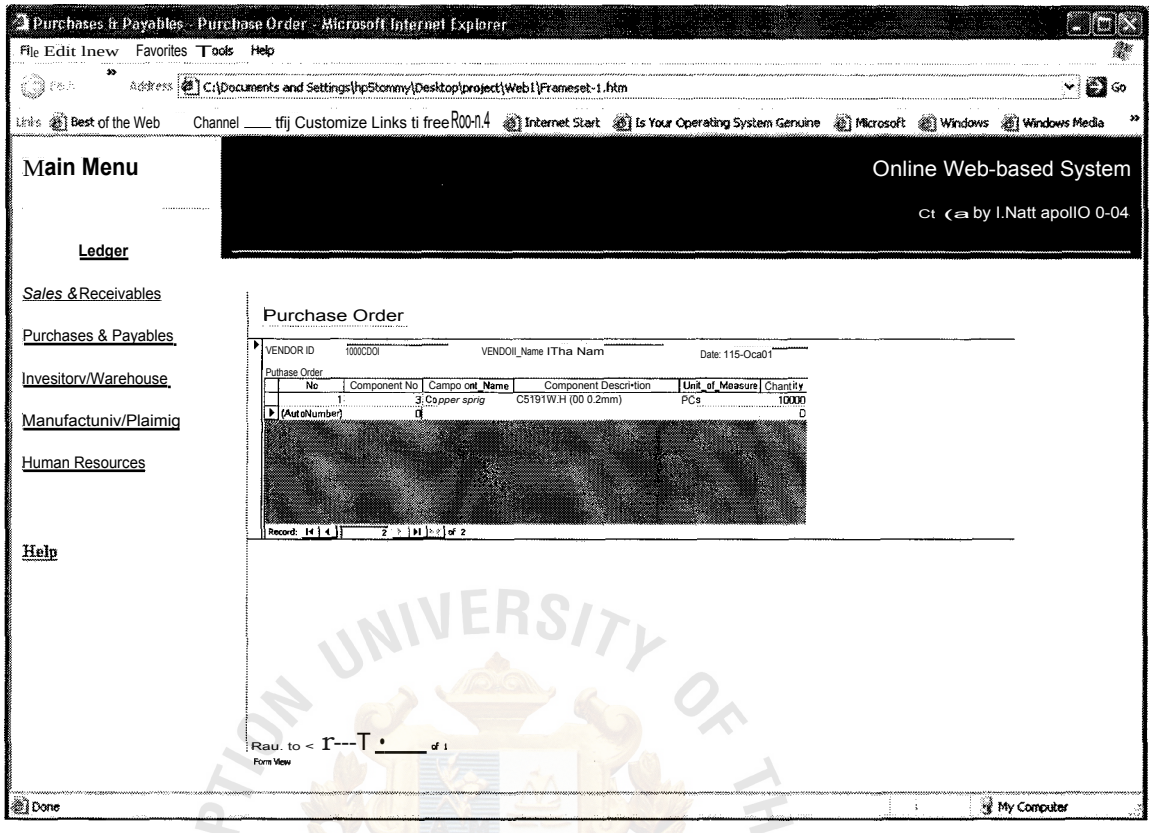


Figure C.6. Purchase Order Form.

After the customers place the orders and the production plans production schedule, the planning department check the materials on hand. If there is no material in stock, an online system will generate purchase order to each vendor that supplies the raw materials (component of product).

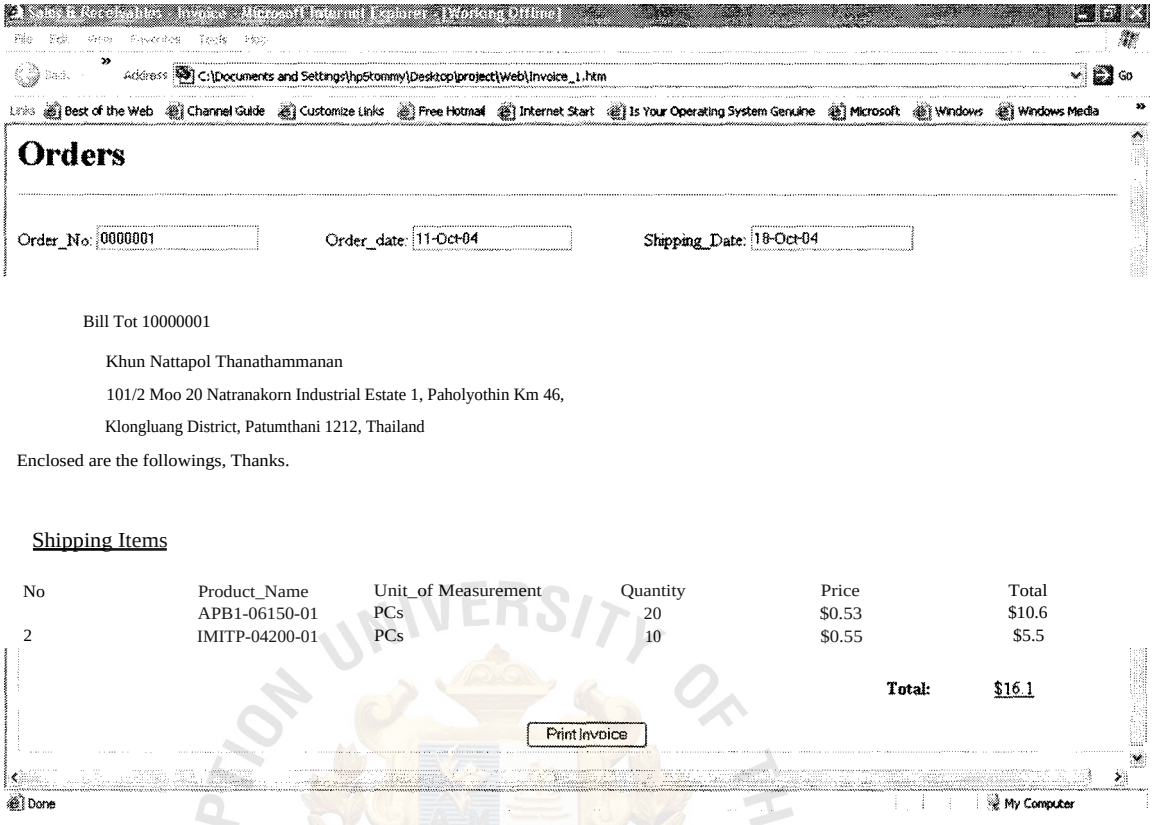


Figure C.7. Invoice Report.

Finally, finished goods are produced and QA department already inspected them. The shipping department will create invoice to customers. They can check the shipping items and where to shipment.

APPENDIX D

PROCESS SPECIFICATION

Process Specification

Processes 1 to 3 are fundamental elements in ordering system. Theses processes develop work for customer information, product details and apply payment. The new online system can record and update in real time when customers place the orders. The orders will send to planning and design department. Design engineers check the product ability. If they cannot make follow customer specification, the online system will notice the reject order to those customers. If the orders are accepted or the customer specifications are approval, the gathering orders are sent to next processes.

Processes 4 to 5 involve the development of inventory system. Theses processes develop work for production plan and material control. The new system can check product capacities and material availability by using stock database. If there is no raw material in stock, the system will request for quotation to order it. The chosen suppliers will provide price and shipment that is ordered the material. Before the purchasing orders are sent to the material suppliers, the design engineers make material specification to evaluate them. If those suppliers are approved and the design engineers request test report to attach every shipment, the warehouse must check in the material follow the measurement methods.

Process 1.0: Order Module

Order Module is order processing when customer places on the online system.

Process 1.1: Verify Order

The online system checks to see if the products are ability to produce, issues status messages to the customers and update their information.

Process 1.2: Prepare Reject Notice

After checking the orders if the product cannot be produced, the ordering system will prepare reject notice to the customer.

Process 1.3: Assemble order

If the products are approved, the online system will gather the ordering and picks the list of raw material to inventory system.

Process 2.0: Create Invoice

If finished goods are produced, the online system generates the shipping order to the warehouse/shipping, which fills the orders.

Process 3.0: Apply Payment

Apply payment is payment processing that reports to accounting department.

Process 3.1: Post Payment

After customers place the orders, the online system checks payment details of customers to generate the invoice.

Process 3.2: Prepare Accounting Entry

When the order is shipped, the customer is billed. The online system also produces various reports.

Process 4.0: Inventory Module

Inventory module is inventory system that tracks the material control.

Process 4.1: Check Material Availability

When the orders are placed by customer, the online system check material availability by using stock information.

Process 4.2: Requisition

After check material availability, the online system creates the requisition through the warehouse/shipping to prepare product information for production/planning.

Process 5.0: Purchasing Module

Purchasing module is automatic generate purchasing order through the chosen supplier.

Process 5.1: Check Supplier Information

Before the suppliers are chosen, the design engineers issue material specifications to evaluate them. If those suppliers are accepted, the online system will record in the supplier information. Then the online system requests for the quotes to check price and shipment.

Process 5.2: Create Purchase Order

If the suppliers can provide the product information and quantity follow requirement, the online system will create the purchase order to them.

Process 5.3: Check Validate Material

After the materials keep in stock, the online system update the validate materials.

APPENDIX E

DATA DICTIONARY

DATA DICTIONARY

Table E.1. Data Dictionary for the Online Web-based System.

Name	Type	Meaning
Cash Receipts Entry	Data Flow	The system generates cash receipts into accounting/finance.
Completed order	Data Flow	After finished products are manufactured, the system gathers the completed order.
Invoice	Data Flow	The system create invoice to customer.
Material Availability	Data Flow	The system checks the material availability to enough for production.
Material Specification	Data Flow	The design engineer creates the material specification into the system.
Order	Data Flow	The order is placed by customer.
Order Reject Notice	Data Flow	If the order is invalid, the system notices the reject order.
Order Reports	Data Flow	The system generates the order report to warehouse.
Payment	Data Flow	The system checks the payment methods.
Picking list	Data Flow	The system lists the products into the order.
Price	Data Flow	Supplier sends the product pricing.
Product Information	Data Flow	The system checks the product availability in warehouse.
Production Schedules	Data Flow	The system checks the life cycle of products and plans them into production schedules.
Request for Quotes	Data Flow	If there is no material in the system, the system will automatically requests for quotes.
Shipment	Data Flow	Supplier sends shipment details.

Table E.1. Data Dictionary for the Online Web-based System (Continued).

Name	Type	Meaning
Supplier Material Evaluation	Data Flow	The design engineer sets the supplier evaluation into the system.
Supplier Material Test Report	Data Flow	If supplier material test report is required in the system, this supplier must attach it for approval.
Accounting/Finance	External Entity	Accounting/Finance department
Customer	External Entity	Who order the products.
Design Engineering	External Entity	Design engineering department
Production/Planning	External Entity	Production/Planning department
Supplier	External Entity	Who supply the materials.
Warehouse/Shipping	External Entity	Warehouse/Shipping department
Apply Payment	Data Process	The process checks the payment methods.
Create Invoice	Data Process	The process creates the invoice to customers.
Inventory Module	Data Process	The process controls the inventory in the materials.
Order Module	Data Process	The ordering processes include verify, assembly, and reject the orders.
Purchasing Module	Data Process	The process automatically creates purchase order to supplier.
Customers	Data Store	The database file records the customer information.
Orders	Data Store	The database file records the customer orders.
Stock	Data Store	The database file records the materials that keep in the stock.
Suppliers	Data Store	The database file records the evaluated suppliers.

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