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Framework to Build Component Based E-Manufacturing

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Framework to Build Component-Based E-Manufacturing (Production Module)

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By

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Abstract

E-Manufacturing system is a large system that comprises of various modules such as sales, production, material management, financial, scheduling and so on. Most of the system are usually customise based on the manufacturer needs. In nature, e-Manufacturing system is divided into stand-alone application and web application.

This project is to build a framework to develop a component-based e-Manufacturing system. A group of four members are assigned to run this project. This proposed system consists of four main modules such as Sales, MRP, Production, and Material Management. The framework should be embedded with important components.

The essence of the framework is able to support reusable approach where it is a hot trend in software development. Apart from that, framework should be extensible and scalability due to rapid business requirement changes.

In order to enhance the system efficiency, robustness and able to meet the user requirements, existing e-Manufacturing systems have been reviewed and analysis in depth. Besides that, some of researches have been done the latest technologies such as development environment or tools, DBMS, assemblies and so on.

A combination of incremental and iterative model development approach has been chosen to develop the framework. There are some substantial reasons that advocate this approach that will be ideal for this project development. Unified Modelling Language (UML) is being used to illustrate or visualise the functional and non-functional requirements for the system. Class diagram is used to illustrate the design of the database.

Acknowledgement

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Chapter 1

Introduction

1.1 Project Introduction

E-manufacturing is concerned with the use of the Internet and e-business technologies in manufacturing industries [1.1]. It covers all aspects of manufacturing such as sales, marketing, customer service, inventory management, procurement, supplier relationships, logistics, production management, decision making and scheduling for upper level management and so on.

Nowadays, businesses are getting intensely, and the Net has empowered customers with finger-tips of information. Therefore, manufacturers not only have to minimise the delivery time but also have to produce good quality end-product with the minimum cost. Therefore, E-manufacturing system is getting essential and promising in manufacturing industries.

E-manufacturing system enables manufacturer to receive real-time information for on-going improvement and decision making. Furthermore, integrated manufacturing execution system able to streamline operation which could lead to reduce time and improving the output.

The main aim of this project is to develop a framework for manufacturer to build a component-based E-manufacturing system. Several components will be built and embedded in the framework to assist developer to build an e-Manufacturing system.

The framework comprises of four main modules: Sales module, Scheduling module, Production module and Inventory module. Each module is able to share information with each others. So this will meet the objective of E-manufacturing is to bridge the gap between the shop-floor and the management level.

1.2 Project Definition

As we proceed to next page or chapter, certain terms will be used such as framework, component and so on. Below is the brief explanation to its corresponding terms:

- **Framework**

  A framework is a reusable or semi-complete application that can be specialised to produce custom applications (Johnson, R. *et al*, 1988). Frameworks are focused on a particular business units and application domains. Framework divides into three: System Infrastructure Framework, Middleware Integration framework, and Enterprise Application Framework.

- **Component**

  Component is an independent container that encapsulates functions and provides services through interfaces. It can be plugged into system when services that it provides are needed. For example, .NET data component provides functions such SqlCommand, SqlConnection and much more. There are four essential characteristic of a software component model: the component itself, component socket, the ability to cooperate or communicate with other components, and the user of the components.

- **Statistical Process Control**

  SPC is the abbreviation for Statistical Process Control. It refers as a useful means or tool to gather and analysing data to answer the practical quality problems. The main objective of introducing SPC is to improve quality of a production and at the meantime reducing the non-conforming products.

1.3 Project Objective

Project objective refers as the main goal of the system that needs to be achieved. The following are the objectives of this project:

- Develop a framework to build a component – based e-Manufacturing system.
- Develop a framework supported by various components.
- Building components that are easily maintain or upgraded.
- Develop a stand-alone framework that able to supports reuse approach.
- In terms of speed, it is capable to edge over paged based system.
- Framework that able to implement in different kind of manufacturers. In other word, the framework is applicable to different field of manufacturers such as moulding, food & beverage, and much more.

1.4 Project Scope

- **Database Builder**

  System provides a wizard that guides system user through the database creation process. Through the wizard, user able to add new, change, or drop certain fields. Besides that, system user is able to set field type such as int, char, nvarchar, datatime, and much more.

- **User Interface Builder**

  Various templates are provided to system user to choose. Each of the field or controls properties such as textbox is saved into XML file. Control properties refer as control size, name, location, text and so on. InterfaceBuilder component is the component or tool that converts the control properties into XML file.

- **Report Generator**

  A component is designated that generate different kind of reports for each module. Report will be generated based on the user specification. For example, in production module system user is able to generate graphical production report.

- **Authentication**

  System able to provide some security feature where the accessibility among the modules is monitored. Therefore, system administrator is able to assign authorities for each of the system end-user.

➢ **Production Module**

Sales module in consists of two sub modules, which are:

- **Statistical Process Control**

  In this sub-module, system developer able to setup a statistical process control chart for a particular product. The chart able to analyse any outliers or abnormities variations occurred.

- **Data Collection**

  System developer able to create a data collection form to collect productivity information from shop-floor. This sub-module is important to evaluate a particular job status. Thus, top level management able to monitor the productivity at the shop -floor.

1.5 Project Motivation

The following are the motivations that set off the project:

- Framework is reusable where it can be deployed again.
- Trend is moving from is automation towards integration automation.
- Faster delivery because the system is developed based on modular.
- In terms of speed, stand-alone application or component-based much faster than page-base systems such as web application.
- Extensibility for framework is much easier by adding new component.
- System user does not need the framework was build but they need to know how to use instead. Thus, system user does not need to know the cumbersome programming coding behind.

1.6 Target User

Small-scale manufacturer is the main target user of the system. System user will separate into two types of user such as system administrator or system developer and system end-user. This is to ensure authority segregation is implemented in the system. Thus, contradiction between roles played by different users can be avoided.

System Developer / Administrator

In this level, system developer able to use the framework to create or setup the modules such as Sales Module, MRP Module, Production Module and Material Management Module. During the setup, system developer is prompted with wizard that guides the user throughout the process. On the other hand, system administrator able to set the data center for the system. This includes switching data server and switching database. In authentication module, system administrator is entitled to create new user, update system user information, delete system user, assigning authority, and switching user type from administrator to end-user or vice-versa.

System End-User

System end-user is considered as system front-end user. In this level, user does not deal with any setup processes but data entry processes indeed. It divides into high-level users and lower-level users. High-level users have the authority to modifying, update, or even delete relevant information or data. As for lower-level users such as shop floor labours are entitled to view certain information. Modifying and deleting information are not inclusive in their tasks.

1.7 Strength

Below are the strengths of the system:

- Reusable stand-alone application that not only can implement once.
- Framework that complements with various component such as SpcGraph.dll, SpcArray.dll, InterfaceGenerator.dll and much more.
- System properties are less database dependency. In means that certain system properties such as system connection elements are store in xml file rather in database.
- Developer able to build a component-based e-Manufacturing system with dealing with cumbersome of coding.
- System is editable or able to evolve in order to meet the changing needs of user.
- Components that support the framework can be easily upgraded.

1.8 Constraints

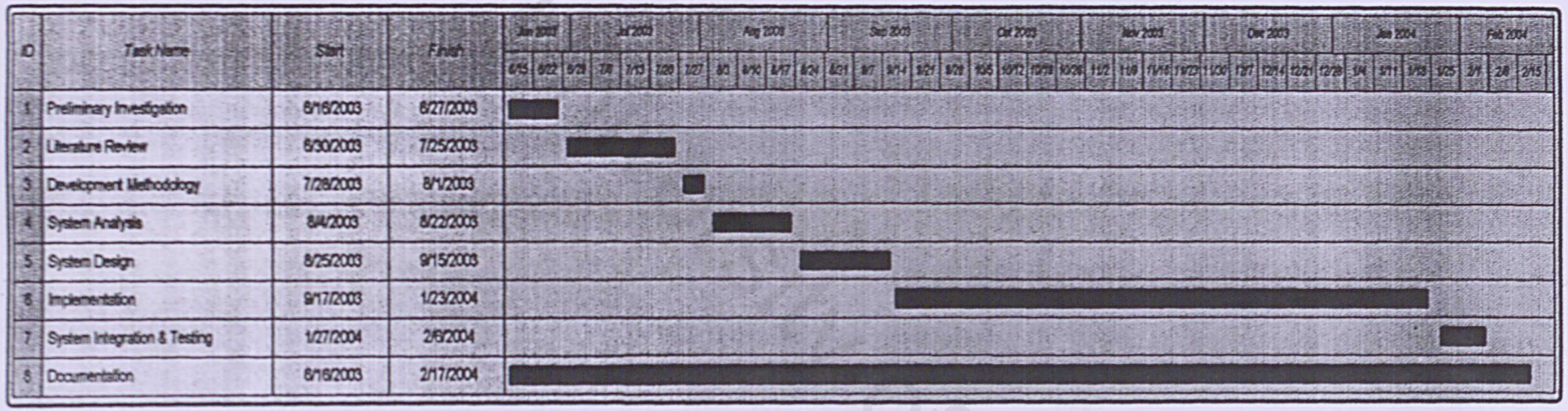
- The framework unable to cover the entire elements or modules of an e-Manufacturing system. Financial module is one of the modules that are not included in the framework.
- Framework does not provide any debugging function.
- The system is applicable to small-scale manufacturer.

1.9 Expected Outcome

Below are the expected outcomes of the project:

- A framework that comprises of four main modules such as Sales, MRP, Production and Material Management.
- Framework that embedded with important components.
- System user able to build a small e-Manufacturing system by using the framework.
- System able to generate table fields which specify by user.
- System able to provide authentication module so that it will enhances the system security.
- System able to generate graphical and professional look report.
- System able to generate Statistical Process Control mean chart and range chart.
- System enables system user to perform basic functions such as save, edit, and delete files or data.
- Framework is built in such a way that it is easy for future enhancements.
- System able to fulfil some important criteria such as user friendly, reliability, stability, and consistency.
- Framework is built in such a way that it is easy to perform testing.

1.10 Project Schedule



ID	Task Name	Start	Finish
1	Preliminary Investigation	6/16/2003	6/27/2003
2	Literature Review	6/30/2003	7/25/2003
3	Development Methodology	7/28/2003	8/1/2003
4	System Analysis	8/4/2003	8/22/2003
5	System Design	8/25/2003	9/15/2003
6	Implementation	9/17/2003	1/23/2004
7	System Integration & Testing	1/27/2004	2/6/2004
8	Documentation	6/16/2003	2/17/2004

Figure 1.1 Project Schedule

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

Review of literature is a background study about the knowledge and information gained to develop this project. The main purpose is to acquire a better understanding on the development tools that can be deployed during development. Besides that, it also can gain a better knowledge on the development methodologies applying to the project. On the other hand, review of literature enables the developers to study, analyse, and compare the relevant existing systems that have been commercialised in the market.

2.1 What is Framework?

A framework is a reusable or semi-complete application that can be specialized to produce custom applications (Johnson, R. *et al*, 1988). This is contrast with the Object Oriented reuse techniques that based on class libraries. Frameworks are focused on a particular business units and application domains.

This project is to build a framework to develop an e-Manufacturing system. In that case, the framework should have a collection of dynamic and static components to facilitate system building. The main purpose to embed the components into framework is to provide functions that can be reused by user.

Although there are a number of frameworks using object-oriented approach, however component-based approach is getting the important. Framework can be classified into three: System Infrastructure Framework, Middleware Integration framework, and Enterprise Application Framework. Brief description for each type of frameworks is stated as following:

- **System Infrastructure Frameworks**

  It concerns about frameworks that facilities system developer to develop a system infrastructure such as communications, user interfaces and compilers.

- **Middleware Integration Frameworks**

  These frameworks are commonly used to integrate distributed applications and components. Middleware integration frameworks are designed to enhance the ability of software developers to modularize, reuse, and extend their software infrastructure to work seamlessly in a distributed environment (Fayad, M. & Schmidt, D. C.)

- **Enterprise Application Framework**

  This type of framework usually addresses broad application domains such as manufacturing, telecommunications, financial system, avionics, and etc. Among these three types of framework, enterprise framework will provide a substantial return on investment.

Benefit of using framework

- **Flexibility**

  User able to change or modify the specifications that set to system beforehand by using the framework.

- **Reusability**

  Generic components in the framework are able to be reused to create new application.

- **Reduce development time**

  Since framework provides a lot of powerful and predefined functions or features, system developer does not need to build a system start from sketch.

- **Extensibility**

  Framework is easily to be evolved by coupling new components into framework. Apart from that, unstable components are easily to decouple from the framework.

2.2 Introduction of Component-Based Development

Component-Based Development is gaining ground for developing a high-quality, evolvable, and large software system. This reuse-based development emerged in the late 1990s. This technique is not a new chapter in software industry by now. Originally it was presented as early as 1968 on the NATO Conference on Software Engineering in a paper called "Mass-Produced Software Components" by Douglas McIlroy. (Vaughn T., 1990) It will be much easier to combine the components to construct a software application rather than develop it from the beginning. Constructing an application under this new approach involves the composition of reusable and independent components.

2.2.1 What is a component

Actually what is Component? Up until now the term "Component" is hardly to define and there is not clear definition of component. However, the definition of component that have made by Christiansson is widely supported.

"A software component...

- *is independent and reusable,*
- *offers explicitly specified services through an explicitly specified interface,*
- *can affect/be affected by other software components,*
- *should have one documented specification*

can have several independent implementation, i.e. one component can be implemented in several different programming languages and can have several executable (binary) shapes." (Christiansson B., 1999)

Component is a physical and replaceable part of a system that conforms to and provides the realisation of a set of interfaces. (Jacobson, I. *et al*, 1999) It is much more abstract than object classes and can be classified as a stand-alone service provider. Component is much more abstract because it has encapsulated the functionality and provides services through interfaces. It can be independently developed and delivered as a unit. A collection of components are able to develop an application. Reusable that has made component much more significant. Generally, components are much easier to use than class libraries. The reason is that software developers do not require to know its structure ('black box') before the component is use. All they need to know are the functionality that the component provides.

2.2.2 Why Component-Based

The reasons that made component-based approach widely accepted in software development are listed below.

- Portability – It means that, a component can be plugged into system when it is required and unplugged when it is not required.
- Support across applications – Component is developed not only meant for an application. It is able supports different applications.
- Applications are immovable – Complex application consists of vast features which are hardly to remove or upgrade independently.
- Simple to use – Component is much more easy to use than object class. Detail of knowledge of the object class is needed and this is opposed to component approach.

2.2.3 Benefits of Component-Based Software Development

The benefits of Component-Based are listed below:

- Component functionality can be reused across applications.
- Produce higher quality result and more reliable.
- Component can be created with any languages or tools whereas object class can be developed only with programming languages that support object oriented.
- Applications development is much faster.

2.2.4 Drawbacks of Component-Based Software Development

The main difficulty with component-based development is the problem of maintenance and evolution. As we know that, the source code of components is not available, it may be impossible to change the components to reflect any requirement changes. Therefore additional work is required to reuse components, this leads to increase the maintenance costs.

2.2.5 Component-Based Software Development Model

Figure 2.1 illustrates the model of Component-Based Software Development. Clients do not need any knowledge of how the component implements its interfaces. There will not cause any affects to clients, if the interface implementation is changed. Clients will only be affected if the interfaces are changed.

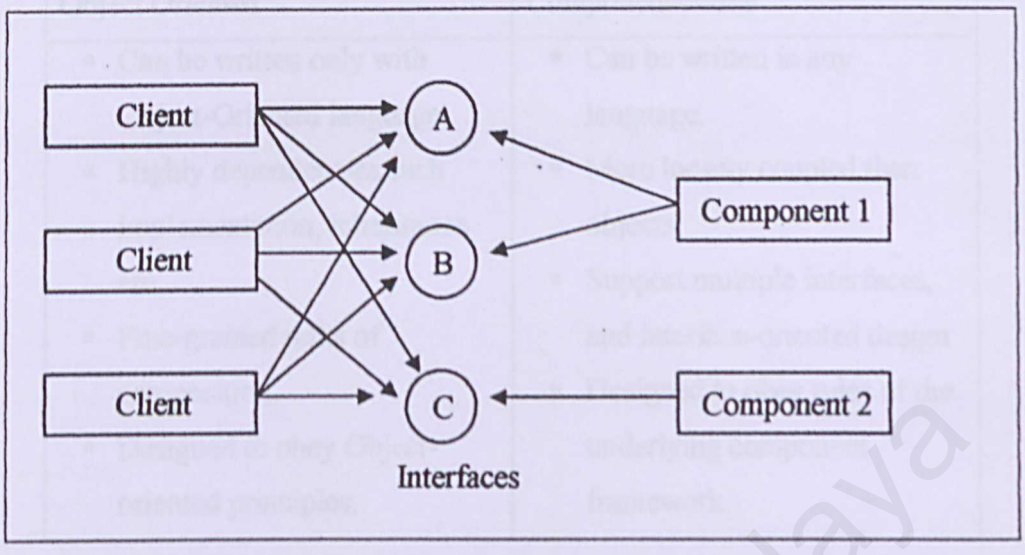


Figure 2.1 Component-Based Software Approach

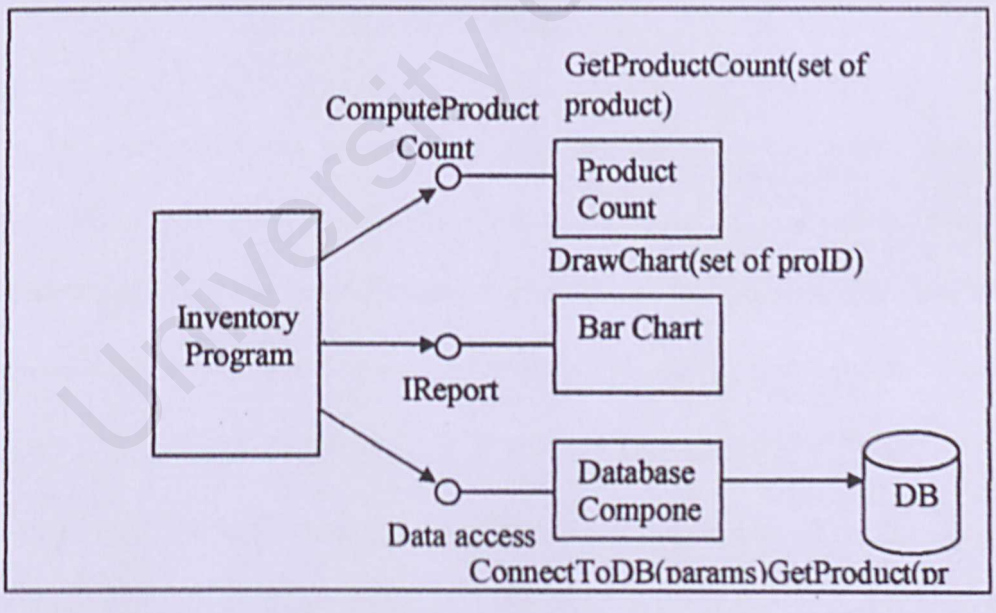


Figure 2.2 Services are provided by the component

2.2.6 Object-Oriented Vs Component-Based

Table 2.1 Component-Based Vs Object Oriented (ncst, 2001)

Object Oriented	Component-Based
▪ Can be written only with Object-Oriented language. ▪ Highly dependencies such implementation, inheritance etc. ▪ Fine-grained units of composition. ▪ Designed to obey Object-oriented principles.	▪ Can be written in any language. ▪ More loosely coupled than objects. ▪ Support multiple interfaces, and interface-oriented design. ▪ Designed to obey rules of the underlying component framework.

Microsoft's COM, COM+, DCOM, .NET framework, Sun's JavaBeans, EJB (Enterprise Java Beans), J2EE specifications, and OMG's COBRA specifications are the three popular software component technologies.

2.3 E-Manufacturing

"E-Manufacturing integrates customers, e-commerce systems and suppliers into manufacturing to provide an Internet-based strategic framework for factory." [2.1]

"E-manufacturing is concerned with the use of the Internet and e-business technologies in manufacturing industries." [2.2]

"A responsive manufacturing model that optimises the use of production assets based on information exchange from shop floor operations, across the enterprise and the extended supply chain." [2.3]

Based on the definitions stated above, E-Manufacturing can be summarised as using the e-business technologies to gain competitive advantages by optimise the efficiency, productivity, and minimise the costs of production. It covers all the aspects such as sales, financial, inventory, production, suppliers, scheduling, decision making in top floor and so on.

Make-to-order is the foundation of E-Manufacturing, which means products are made when an order is placed. This much more similar to the objective of agile manufacturing, lean manufacturing and constraint based manufacturing models. The difference is these models are based on the future forecasts. As compared to older manufacturing model, promotes idea of mass production and loaded inventory.

Agile and lean manufacturing models stress on the concept of producing only what's needed and maintaining minimal or zero end-products which avoid blooming the inventory. On the other hand, constraint-based manufacturing focuses on eliminating production delaying by optimising the material flow through bottleneck.

Unpredictable and unforeseen event or swings which occurred in the manufacturing process might cause manufacturer unable to meet the demand of the customer. Thus, manufacturing forecasts and real-time information from shop-floor are important to minimise the consequences of unpredictable event occurs in manufacturing process. For example, well scheduling might reduce the possibilities of delay in delivery time, process control minimise the variation in the process.

Below are the benefits of implementing E-manufacturing system.

- **Increased Agility:** Quick response to customer demand which is one of the key factors to gain competitive advantages. E-manufacturing is not only focuses on manufacturing processes but it also serves the customer needs
- **Increased Profitability:** It will produce a fine quality product with control process. This will reduce the numbers of scrap and non-conformant products. Thus, it will increase the productivity with minimal cost.
- **Reduced Lead Times:** Well scheduling and planning will smooth the production and delivery flows. Thus, it will minimise lead time.
- **Improved communications channel and knowledge sharing:** E-Manufacturing system enable the top level management to share critical data or information with lower lever such as shop-floor, inventory management and so on.

Over the past years retrieving critical data from shop-floor is still posing a challenge. This critical data is required in order to portray an accurate account of the day-to-day or hourly product manufacturing operations for continuous improvement and decision support.

2.4 Reviewing Operating Systems

2.4.1 Windows XP Profesional

Microsoft Windows XP is much more reliable, mobility, security, and provides vast of features than the previous version Microsoft Windows 2000. Windows XP was sailed off to the market on the end of the year 2001. It is the convergence of business / corporate and consumer operating system. Furthermore, it inherited some of the strength from previous version such as the dependability of Windows 2000 and ease to use of Windows Millennium.

The following are the four versions of Windows XP that have been launched in the market:

- Windows XP Professional
- Windows XP Home Edition
- Windows XP Tablet PC Edition
- Windows XP Media Center Edition

Windows XP Professional and Home Edition are the version that suitable for individual or personal user and small home network. The difference between Windows XP Professional and Home Edition version is that Windows XP Professional is added with additional business features.

Features provided by Windows XP Professional are stated below:

- Capable to support Peer-to-Peer networking for 10 simultaneously users.
- Access Control – monitoring file and folder accessibility.
- Remote Desktop(RD) – Remote Desktop allows you to work from virtually anywhere and access files, applications and network services from almost any computer

- Encrypted File System (EFS) to protect personal and sensitive data or information from unauthorised users.
- Able to support dual processors.
- Enhanced software restriction policy where only administrators are entitled to identify software and control its ability to execute.
- Group Policies allow administrators to organize users into logical groups and assign settings (security, appearance, management options)

2.4.2 Windows 2000 (Professional, Server and Advanced Server)

Windows 2000 is the outcome from the third attempt made by Microsoft Corporation to develop a reliable desktop operating system. Windows 2000 is a server and workstation that only can be deployed on Intel, Pentium, Cyrix, and AMD machine.

Windows 2000 was known as Windows NT 5.0 because it is built on NT technology. This operating system is claimed to be more stable than the previous Windows 98.

The following are the advantages provided by Windows 2000: (Cheng, L., W.,2003)

- **Reliability** – System will restart when web application crash occur.
- **Security** – uses the latest technology security such as Kerberos V5 Authentication, Fortezza, and Digest Authentication.
- **Scalability**
- **Software and Data integration**

2.4.3 UNIX

(www.unix-system.org)

UNIX was developed at AT&T Bell Laboratories 1669. It was the first entire operating system that developed or written in the C programming language. Today, UNIX gains the ground and widely accepted in the enterprise-networking environments. UNIX is capable to support multiple users that simultaneously access into the system, executing programs, establishing interactive communication with the system by using remote terminal.

The following are the advantages and disadvantages of UNIX

Advantages

- It supports multitasking, therefore multiple software, program or application can be executed at one time.
- Supports multi-user, where it allows more than a single user to work at any given time. In order to support multi-user, UNIX is capable to share processing time between each user.
- Safeguard memory or storage space from being used by another program.
- Offering user with flexibility to combine standard UNIX commands in endless ways to achieve different tasks. Other word, it is a programmable operating system.
- UNIX systems from different vendors are capable to integrate into same computer environment. Sharing computer peripherals or other resources such as share disk drives, terminals, printers, CPU's is not a matter.

2.4.4 LINUX

(www.linux.org)

Linux is an operating system that was created by a young student Linus Torvals at the University of Helsinki in Finland. Initially, Linus had an interest in Minix which is a small UNIX system. Subsequently, a system was developed which is exceeded the Minix standards.

Linux Kernel version 1.0 was released on 1994. The kernel where is the main part of Linux is developed and released under GNU Genereal Public License where its source code is freely distributed to public. Nowadays, the hundreds of companies and individuals that have reengineered and create their own versions of operating systems that based on the Linux kernel.

Besides Linux gaining the fame of its open source code, Linux's functionality, robustness, adaptability and maintainability have made the Linux as an alternative operating system. On the other hand Linux able to incorporate into microchips in a process called "embedding".

Linux's developments gain support from giant computer companies such as IBM, Hewlett-Packard and more. Below are some of the advantages and disadvantages provide by Linux

Advantages

- Open source code architecture where it can be modify, versatile, and flexible.
- Re-used and distributed by a global community of developers.
- Linux is much more stable operating system.
- Applications can be deployed or executed on a wide range of Linux platforms.
- Embedded with various development environment and compiler such as C, C++, and Fortran. It also consists of scripting languages such as Perl and Awk.

- Provide ideal environment to run web server such as Apache, tomcat or FTP server.

Disadvantages

- There is no single Linux standard.

2.5 Reviewing Database Management System

2.5.1 SQL Server 2000

Microsoft SQL Server 2000 is a full-featured relational database management system (RDBMS) that offers a variety of administrative tools to ease the burdens of database development, maintenance and administration. Microsoft SQL Server 2000 provides six powerful tools such as Enterprise Manager, SQL Profiler, Query Analyzer, Service Manager, Data Transformation Services and Books Online. Below is the brief description about the tools:

- **Enterprise Manager** is the main administrative console for SQL Server installations. It provides us with a graphical view of all of the SQL Server installations on our network. Users able to create, delete, modify and maintaining database. Apart from that, users able to perform high-level administrative functions that affect one or more servers.
- **Query Analyzer** offers a quick check on the SQL statement that insert by the user. It also allow users to test run the SQL command that they have specified
- **SQL Profiler** provides a window into the inner workings of our database. It can monitor many different event types and observe database performance in real time.
- **Data Transformation Services (DTS)** provide an extremely flexible method for importing and exporting data between a Microsoft SQL Server. Import and export data are the most commonly used DTS application to transferring and receiving data.

- **Service Manager** is used to control the MSDTC (Microsoft Distributed Transaction Coordinator), MSSQLServer (the main SQL Server process), and SQLServerAgent processes.
- **Books Online** is a help file to user that facing problem during using SQL Server. It contains answers to a variety of administrative, development and installation issues.

2.5.2 Microsoft Access

Microsoft Access 2000 is a relational database management system (RDBMS). Microsoft Access was first introduced into the market 1992. As the popularity gaining high, Access 95 was released on 1995 and follow by Access 97 on January 1997. Microsoft Access offers user an ease-to-use, maintainability and sharing data DBMS. Access 2000 not only provides the traditional vast range of easy data management tools but it also offers users the ability to integrate database with the Web for easier sharing of data across a variety of platforms and user levels.

Access 2000 is capable to share information via the corporate intranet and the ability to easily host a database within the browser. This combines the power of a desktop database with the power of the web. Below are some of the Access strengths and limitations.

Limitation

- Access is file-based database system where any query on Access database will not be done on the server. Thus, it increases the network's traffic.
- It will be an ideal DBMS for individuals or small workgroups only.
- Not capable to supports multiple users.

2.6 Reviewing Programming Language

2.6.1 Visual Basic .Net

(http://www.microsoft.com/net/basics/framework.asp)

Visual Basic 4 was one of the remarkable software programming application which released by Microsoft. It had brought the Object Oriented (OO) programming to reality. However, only few OO features were available at Visual Basic 4. Obviously, it was lacking of inheritance which was one of the key defining for any Object Oriented languages. Furthermore, secondary features such as overriding, overloading, and constructor were not included in VB.

Since Visual Basic was not a fully Object Oriented language, subsequently Microsoft released Visual Basic .NET. It is a full object oriented language. A programming language only can be considered as Object Oriented language when it supports four main features: Abstraction, Polymorphism, Encapsulation and Inheritance.

With Visual Basic 4, user is provided with the capability of object and COM component creation. This is contrast to Visual Basic .NET which has the capability of creating object and the defining how objects worked. In .NET, component-oriented features such as component-level scooping via Friend keyword and implements interface with Implements keyword are retained. Component level scooping means that users are capable to develop classes or methods which can be shared among others code within a component. On the other hand, the latter allows classes to have several identities.

In addition to these existing features, Visual Basic .NET provides user with inheritance features which made Visual Basic.NET much more remarkable.

Below are some of Visual Basic .NET significant advantages:

- It helps software developers to build robust Windows-based applications. It is easier and faster to build an interface for applications with the rich user interface features.
- It resolves versioning problems which hunted the previous VB version. Issues regarding component overwrites and Component Object Model registration are eliminated.
- Faster deployment with X-COPY features

2.6.2 Java

Java was initially designed by Sun Microsystems in 1991 as a language to embedding programs into electronic appliances such as microware, oven, home security and so forth. At that moment, the popularity of the internet and World Wide Web that led Sun to recast Java as a language for building web-based applications.

Java was developed based on C++ language. Nowadays Java has become the choice of programming language to develop intranet and internet application (Deitel, & D.,2001). Apart from that, Java comprises a special protocol that capable to made wireless communication between cell phones and Personal Digital Assistance (PDA) a reality.

Strengths

- Java Virtual Machine (JVM) that enables Java applications applicable to any type of machine platform.
- Java is a true Object-Oriented language (OO). It supports object-oriented features such as class, inheritance, and polymorphism.
- Java compiler is free and can be downloaded from web.
- Java is platform independent. A platform in this context is just a particular kind of computer system such as Macintosh or a Windows system.
- Java is a distributed language where its programs can be designed to run on the networks

Weakness

- In terms of speed of execution, Java applications are much slower than compiled applications. This is because Java application is never compiled but it is interpreted by the JVM indeed during the execution.

- Java is not similar to .NET IDE because Java does not provide any tool feature to create any interface objects. Coding will be the way to create user interface objects in Java. However there are some third parties Java IDE that provide drag-on-drop features.
- Not much of the third party software that can be integrated into Java application.
- Java is not capable to access into Windows API functions when Java application runs on Windows platform.

2.7 Reviewing Data Access Technologies

2.7.1 ADO.NET

ADO.Net is a data access technology, this includes components for retrieving data, storing data in memory, and binding data to controls *(Reynolds et al, 2002)*. ADO.Net is an evolutionary step in data access technologies that has unveiled by Microsoft. It brings four main advantages:

- **Interoperability**

  All data in ADO.Net are transported in XML format, which is a simply structured text document that provides higher readability for any platform.

- **Scalability**

  It promotes the use of disconnected datasets with automatic connection pooling bundled as part of the package.

- **Productivity**

  ADO.Net is able to improve the overall development time. For example, "Dataset" enables user to work faster and produce more bug-free code.

- **Performance**

  It reduces the occurrence of bottleneck in database server because ADO.Net supports disconnected architecture. It means that, an application connects to database when it needs to retrieve information and will be disconnected when the task is finished.

ADO.Net functionality is classified into two groups - Content components and managed-provider components. Content components essentially hold actual or real data and consist of DataSet, DataTable, DataView, DataRow, DataColumn and DataRelation classes. On the other hand, managed-provider components will communicate with database to assist data retrievals and updates. Managed-provide

components are divided into two key groups. The first one is designed specifically for regular data access and the other one is for SQL Server. Connection, Command, Data Reader and Data Adapter are the key managed-provider components *[2.4]*

ODBC is the abbreviation for Open Database Connectivity. ODBC was created by the SQL Access Group and was set off into market in September, 1992. At the moment, Microsoft Windows was the first operating system that provides an ODBC product. Subsequently, the latest versions are applicable to UNIX, OS/2 and Macintosh platforms.

2.7.2 ODBC

ODBC is an open standard application programming interface (API) for accessing a database. ODBC statements are capable to establish connection to heterogeneous databases. It is able to access into Access, dBase, DB2, and Excel databases. In order to access different databases, a separate module or driver is needed for each type of database. Microsoft Corporation is the main proponent and supplier of ODBC programming support.

In nature, ODBC is based on and closely similar with The Open Group standard Structured Query Language (SQL) Call-Level Interface. SQL requests are allow in programs to access to the database without knowing the proprietary interfaces to the database. ODBC will convert the SQL request into a request that understood by the database system to be connected.

2.7.3 OLE DB

OLE DB is an evolution from ODBC. OLE DB stands for Object Link Database. Before OLE DB was breed into the world, ODBC was a mature and fully express technology. However, Microsoft has ceased the plan to further develop ODBC. OLEDB and ODBC both provide a universal layer of code that uses the same core API to access into heterogeneous data sources.

OLE DB includes not only the SQL capabilities of the data interface Open Database Connectivity (ODBC) but also includes access to data other than SQL data.

2.8 Reviewing Component Technologies

2.8.1 COM

(www.msdn.microsoft.com)

COM is a component software architecture that allows applications and system to be built from components that have been developed by various software vendors. *[2.5]* COM defines an Application Programming Interface (API) that allows diverse of components to interact with each other.

Components need to have similar binary standard in order to interact. COM defines a binary structure for the interface between client application and component object. This binary standard provides interoperability between components written in any programming languages that support call function via pointers.

In COM, application interacts with components through interfaces. Interfaces define as a collection of functions provide a small and useful operation. Interface is differs from a class but a class can be instantiated to form a component object. An interface does not carry any implementations and inability to instantiated by itself.

Component objects can implement multiple interfaces, if the class has more than a set of services to provide. For example, a class might provide client to access data and performing calculations on the data. Each of these services requires different interfaces to be implemented.

Every interface has its own interface identifier. Thus, it will eliminate any chance of collision or versioning issue would occur. A new identifier is needed to define when a new component is defined.

The advantages of using interface in COM are listed below:

- Fast and simple object interaction.
- Interfaces are reusable.

- The ability for functionality in applications (clients or servers of objects) to evolve over time.
- Supports local and remote transparency.
- Programming language independence.

Figure below illustrates a component object support three different interfaces

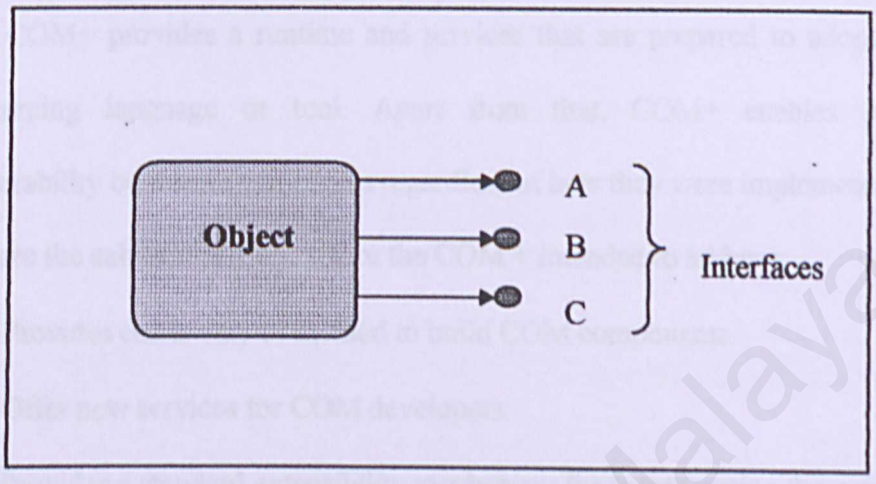


Figure 2.3 Component object with three interfaces (Williams, S. *et al*,1994)

2.8.2 COM+

COM+ is language-neutral. It doesn't care what syntax is used to implement components—that's up to the tool you use. All COM+ cares about are that the tool recognises some syntax as representing a request to do some COM+ thing. The programming model concepts are the same.(Kirtland, M.,1997)

COM+ provides a runtime and services that are prepared to adopt by any programming language or tool. Apart from that, COM+ enables extensive interoperability between components regardless of how they were implemented. Below are the substantial areas where the COM + intended to address:

- Provides easier way or method to build COM components.
- Offer new services for COM developers.
- Provides a standard extensibility mechanism for incorporating the new innovations.
- To address key issues about developing and deploying COM-based applications.

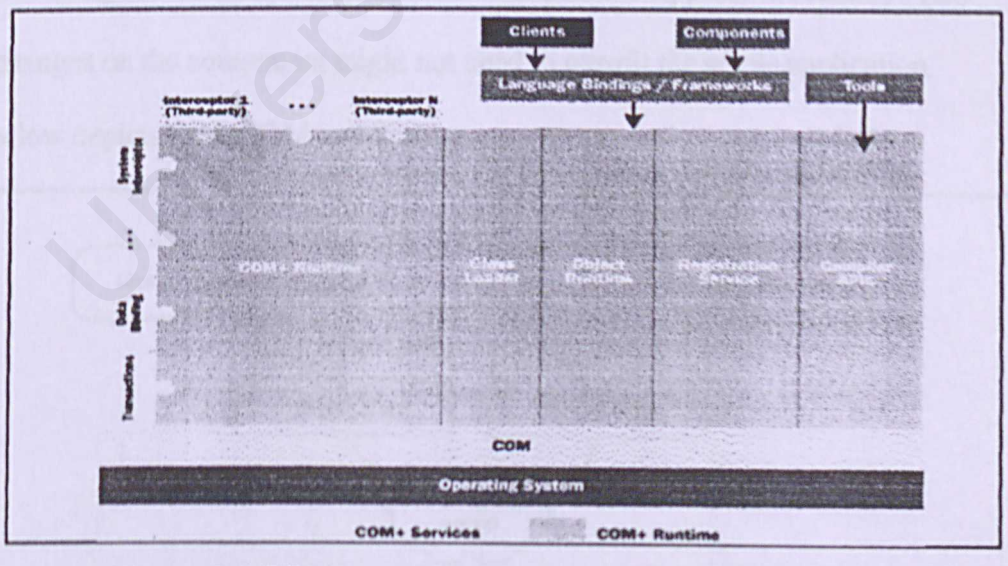


Figure 2.4 COM + Architecture (Kirtland, M.,1997)

2.8.3 DCOM

DCOM is the abbreviation for Distributed Component Object Model. DCOM is an extension from COM. The main purpose of DCOM is to support the communication among distributed components that reside on different computer.

DCOM is an evolution of COM and to address some of major issues about. COM. The major issue of the COM is when client and components are resided on different machines, client is unable to get services from the components. DCOM was bred to solve this communication problem.

Basically, DCOM ships with Microsoft Windows NT® version 4.0 operating system and available for Microsoft Windows 95 before end of 1996. The benefits of using DCOM are

- Allow components to interact independent of platform across networks.
- Modify and redeploy components without changing the entire application.
- Provides fast development processes by using the existing pre-built components.
- Lowering maintenance costs because component supports modularity. Any changes on the component might not need to retrofit the whole application.

Figure below depicts the DCOM architecture.

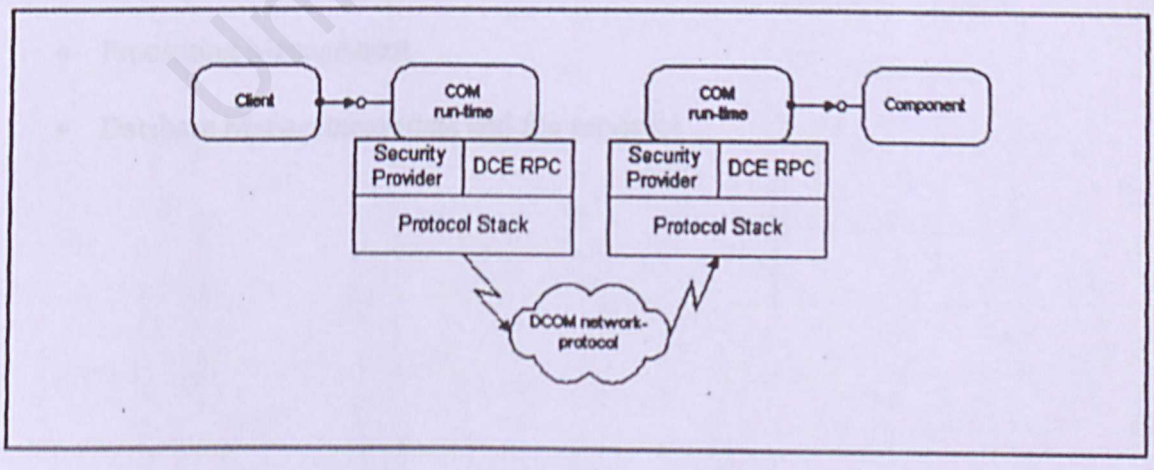


Figure 2.5 DCOM Architecture (Microsoft Corp, 1997)

2.9 Reviewing Client / Server Architecture

2.9.1 Client / Server Architecture

The basic concept of this architecture is client using query to propose a request to a server. The server will queues and processes the query and sending back the result to client. The clien application then display the result to user via graphical user interface. The purpose of the architecture is to reduce the network traffic by sending request through queries.

2.9.2 Two-Tier Architecture

The main objective of two-tier architecture is to improve the usability by supporting a form-based and user-friendly interface. It also improves the scalability by accommodating up to 100 users at a time. Apart from that, two-tier architecture also improves the flexibility by allowing data sharing in a single environment. What is more appealing for two-tier architecture is that it requires minimal operator intervention (Schussel and Edelstein).

In technically, two-tier architecture comprises of three important components in two layers (client and server layers). The three components are:

- User System Interface (display management services, session and etc.)
- Processing Management
- Database Management (data and file services)

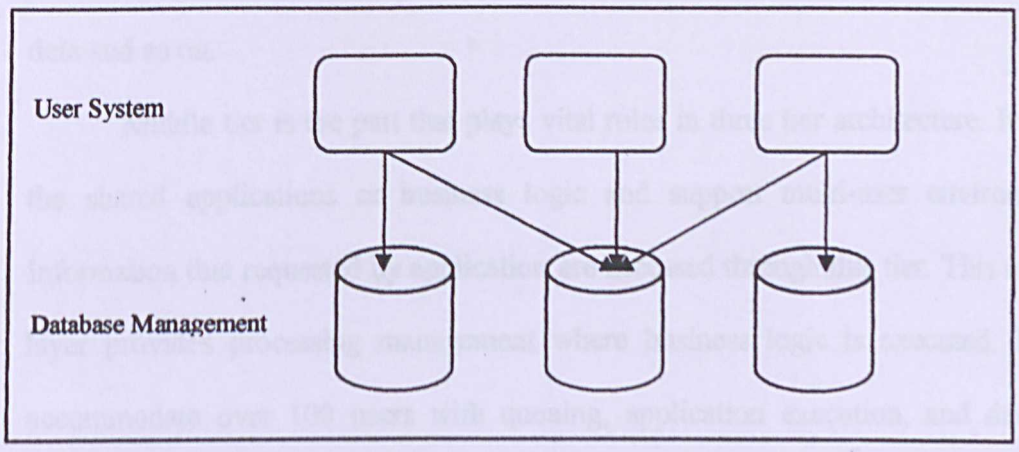


Figure 2.6 Two-Tier Architecture

Advantages

- **Scalability** – Where it can supports up to 100 users at a time.

Disadvantages

- Two-tier architecture unable to support batch job. Typically the client will be tied up until batch job finish.

2.9.3 Three-Tier Architecture

Separation and segmentation are the fundamental principle in the three tier architecture. Three tier or known as multi tier architecture emerged in 1990s. It is implemented to overcome the weakness of two-tier architecture. In multi tier environment, it consists of three separate layers. The general terms for these three layers are front-end, back-end and middle tier. Front-end is where it contains presentation logic, this is includes simple control, user input validation and so on. Usually the middle tier is known as Domain Server or Application Server. It is where the business logic resides on and share among the multiple users. Finally, the back-

end provides access to dedicated services such as data storage, retrieving business data and so on.

Middle tier is the part that plays vital roles in three tier architecture. It holds the shared applications or business logic and support multi-user environment. Information that requested by application are accessed through this tier. This middle layer provides processing management where business logic is executed. It can accommodate over 100 users with queuing, application execution, and database staging functions. Perhaps, middle tier is able to improve feasibility, reusability, scalability and maintainability by centralising process logic. Figure below illustrates the three tier architecture.

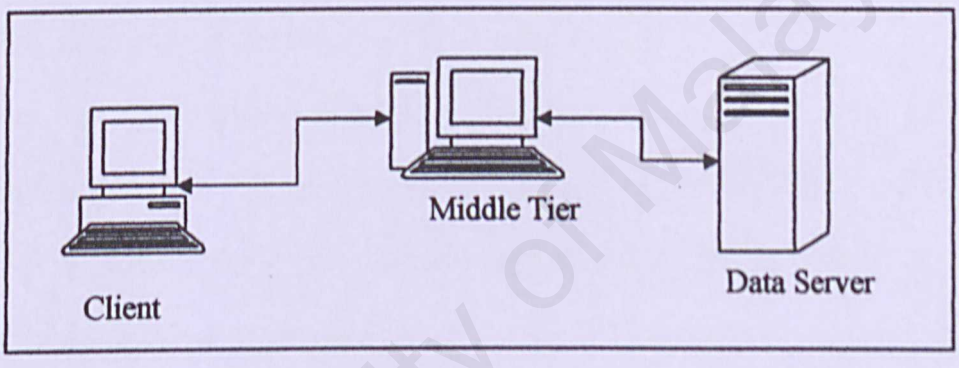


Figure 2.7 Three Tier Architecture

The advantages of three tier architecture are listed below:

- Allowing application to evolve easily. This is because any changes on presentation logic or business logic are highly independent.
- Increasing maintainability - altering business logic might not need to recode the GUI. Updating server is required.
- Business logic can be shared among applications with different User Interface.
- It will minimise the network bottleneck because application layer only transmit the required data or information.

- Client can access data easily and faster because client is insulated from database. Client does not need to know where the data resides in the database server.
- Besides business logic, database connection can be pooled and shared among clients.
- Application layer can be created with third or fourth generation languages such as Java, COBOL, C, and so on.

2.10 What is XML?

XML stands for Extensible Markup Language, concerning about the description and structuring of data. Before going into depth, two kinds of data files need to be known. Text files and binary files are the files that are understood by computers. Binary file and text file are just a stream of bits. However, in text file bits are grouped together in standardise ways to form numbers. These numbers are then further mapped to characters.

XML is a subset of SGML, with the same objectives where to markup any type of data. XML was designed fully compatible with SGML where any XML documents can be read by existing SGML tools. However, it does not go both ways, SGML document is not necessarily an XML document.

In nature, SGML is a complicated language that is not well suited for data interchange over the web. This is contrast with XML, where XML is a highly readable language. Imagine two different systems which use or support different platforms and different frameworks that exchange data with each other. The question is how would two different type of system interchange information with each other. Different system supports different format of data. XML will act as the intermediate medium when both systems exchanging data. Different type of systems able to understand or read data in XML format.

2.11 What is Quality?

'Quality' means degree of excellence as we refer to Oxford dictionary. When we talk about quality in manufacturing, it refers to the totality of features and characteristics of a product or service that bears on its ability to satisfy given needs (Evan. J. R., 1991). It means that we are able to identify the features and characteristics of products that customer needs.

What is believed is that high-quality goods and services can give an organisation a competitive edge in the marketplace. Furthermore, it leads to minimise the costs due to rework or scrap, warranty claims and returns. Most importantly, good quality products or services are able turn a new customer to be a loyal customer for the organisation.

Quality is perhaps the most important issue facing by manufacturers in today's intensely business market. According to Dr. A. V. Feigenbaum an international leader in quality management, quality can be most powerful tools to achieve both customer satisfaction and lower cost of production. The question is "How to ensure the end products is conforms to its quality?". This question can be addressed by introducing Statistical Process Control (SPC) which will be elaborated at below.

2.11.1 What is SPC (Statistical Process Control)

Statistical process control is a very useful means or tool to be used in promoting and maintaining the health of a commercial or industrial enterprise (Wetherwill, G. B. & Brown, D. W., 1991). Besides that, SPC is also a method of gathering and analysing data to solve practical quality problems. The statistical

means drawing a conclusion on the data or numbers that we have collected (Evan, J. R., 1991).

Before we proceed on, the terms of SPC will be used to represent 'Statistical Process Control' for the following discussion. As we trail back to the development of SPC, in the 1920s there are a numbers of SPC allied techniques of sampling inspection and quality control were developed. The first sketch of a modern control chart was produced by Walter A. Shewhart of Bell Telephone Laboratories. In 1931, these new techniques were presented to the Royal Statistical Society which had attracted interest in United Kingdom.

Although many statistical ideas originated in USA and UK but they have been under-used for many years. However, W. E. Deming brought SPC idea to Japan in 1950s. As a result, SPC had given a big impact on Japanese industry. SPC was widely applied then and it was proven saves money and attracts customers.

SPC is used to improve quality of a production and to increase yields (Wetherwill, G. B. & Brown, D. W., 1991). When the information about the production and control leads to reduce of non-conforming product this can be lead to reduce costs of production. The decline of production costs is due to less scrap, added value to defective product or rework. Besides that, this will indirectly increases the organisation reputation.

As we focus to manufacturing or production, it is undeniable that no two outputs from any production process are exactly the same. We will find a variation from the two outputs if we take a measure any quality characteristic such as weight, length and so on. For example, the level of sweetness in each bottle of coca-cola, diameters of a bolt nut, amount of soft drink filled in a bottle. It is impossible to control or predict these minors of variations in a production environment. They are

usually known as common variations. These common variations are unable to be eliminated but they can be minimised through change of process or measurement. As a result, SPC plays a vital role in measurement of the product quality.

SPC methods can be divided into on-line and off-line. On-line method again descried into two types, screening or preventative. Screening refers to screening out the all the non-conforming end-products. This method is not cost-practical. Preventative method refers to inspecting the process and trying to use process control to avoid producing defective items. Figure below illustrates the on-line SPC methods.

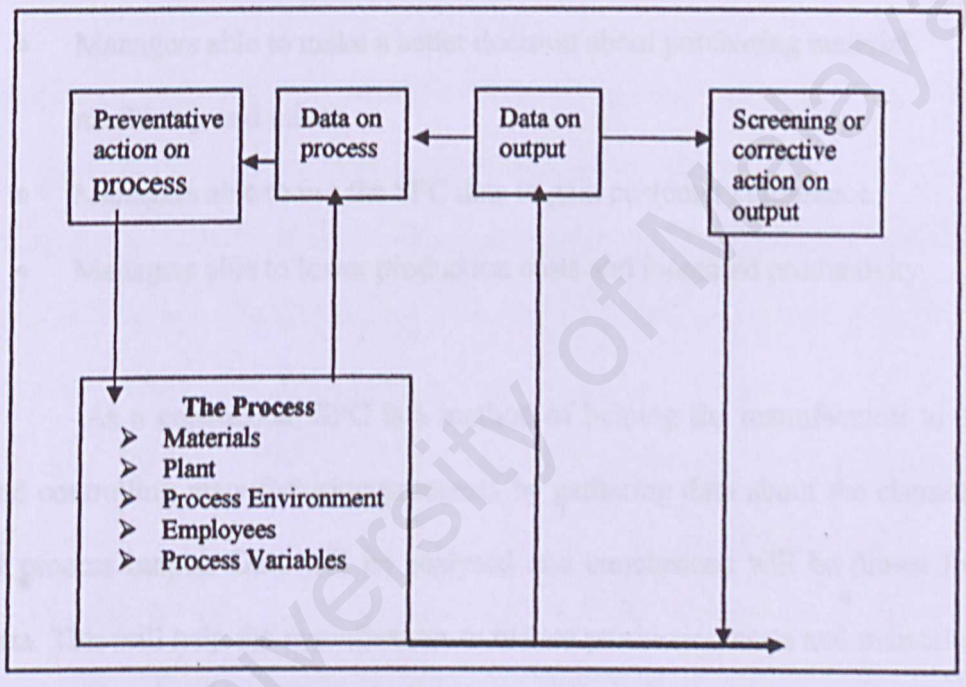


Figure 2.8 On-line Statistical Process Control Methods
(Wetherill, G. B. *et al* (1991))

Off-line process control refers to the next stage from on-line SPC. The main aim is to reduce or remove the effect of potential causes of variability by modifying the process or the product. In this phase it requires skill from different expertise such as statistician (Wetherwill, G. B. & Brown, D. W., 1991).

SPC gives several advantages for operators. The advantages are listed below:

- Operators can identify problems arising from unsuitable tools, materials and so on.
- Control chart provides the progress of a task which an operator is working on.
- Able to inform the operator whether the variation of process is in the acceptable range.

SPC also has several advantages for managers which are listed as following:

- Managers are able to determine the capability of a process to produce product which meet the customer needs.
- Managers able to make a better decision about purchasing material, machinery and others.
- Managers able to use the SPC data to gain customer confidence.
- Managers able to lower production costs and increased productivity.

As a conclusion, SPC is a method of helping the manufacturer to monitor and controlling manufacturing processes by gathering data about the characteristics of process output. Data will be analysed and conclusions will be drawn from the data. This will help the manufacturer to reduce production costs and maintaining the quality of the end-products.

Case Study on Existing System

2.12 EstiTrack™

(URL: http://www.henningsoftware.com)

Henning Software Inc. has developed a ERP/Shop management software (Visual EstiTrack™) for windows platform. This software industrial has 13 years of experiences of providing innovative and cost effective manufacturing solutions to manufacturers and distributors. Visual EstiTrack™ is a completely integrated ERP System beginning with Estimating through Shop Orders, Sales Orders, Job Costing Tracking, Visual Scheduling, Inventory, Purchasing and so on. It is well known and proven for its user-friendly system designed to keep customers or manufacturers much more competitive, accurate and value-added in business.

Visual EstiTrack™ software consists nine main modules such as Customer Management, Quotations(Job Estimating), Orders & Releases, Shop Orders, Operation Scheduling, Production Management, User Maintained Database Files, Material Management and Vendor Maintenance. Each of these main modules has its own sub features. Our focus is on production module, so Visual EstiTrack™ Production

Management module will be the subject of the discussion. Table 2.2 shows the list of sub features provided by Visual EstiTrack™ Production Management modules.

Table 2.2 Production Management sub features

Production Management	
- Job Card Maintenance	- Review Summary Report
- Batch Job Card Processor	- Weekly Efficiency Report
- Daily Production Monitoring	- Daily Production
- Daily Operator Monitoring	- Worksheet
- In-Process Monitoring	- Shop Order Hours Report
- Daily Production Report	- Assigned vs Unassigned Hours Report
- Daily Operator Report	- Daily Employee Report
- Production Tracking Report	- Weekly Employee Report

Visual EstiTrack™ is not a generic solution for manufacturers. It needs to perform customisation for customer who adopted this solution. The interfaces of the system are clearly user-friendly and well organised and depicted as figure 2.9 and 2.10. This module is use by authorised personnel who is on duty at the shop-floor. It collects relevant data to for management level to perform further review or analysis.

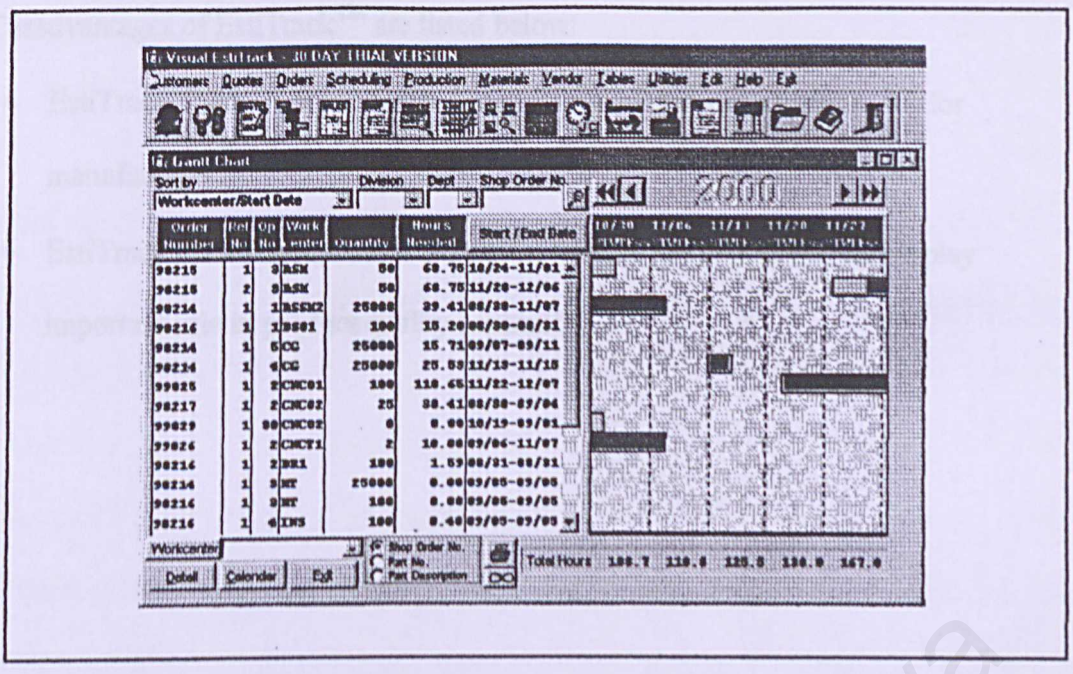


Figure 2.9 Production Management Interface (henningsoftware,2003)

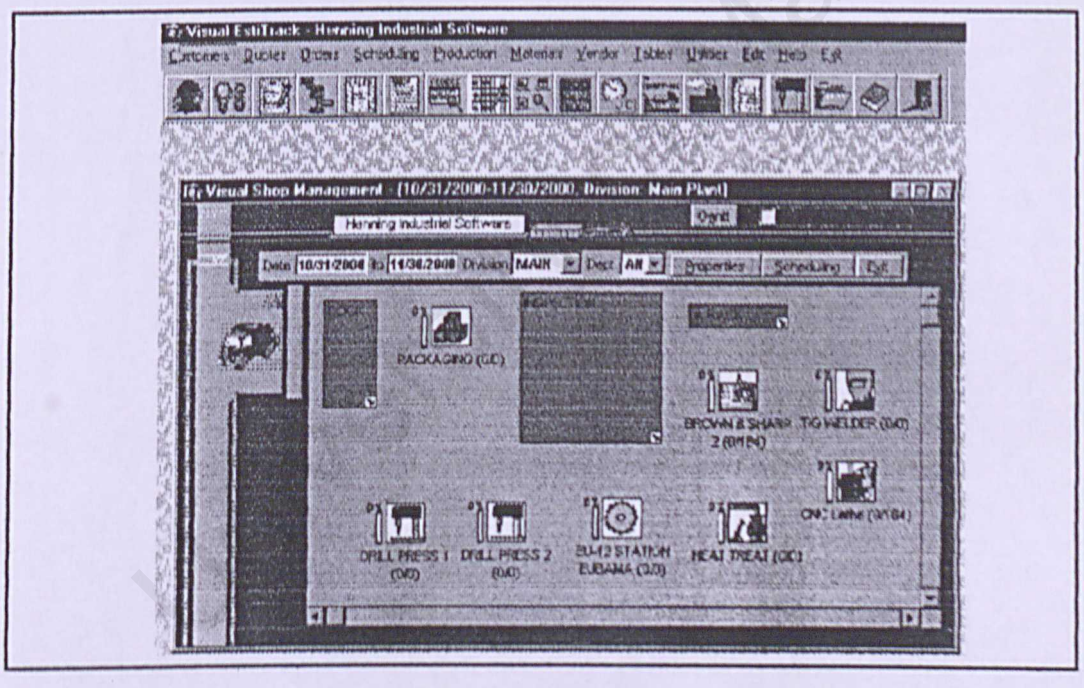


Figure 2.10 Production Management Interface (henningsoftware,2003)

Advantages of EstiTrack™ are listed below:

- Provide a proven user-friendly interface.

Disadvantages of EstiTrack™ are listed below:

- EstiTrack™ does not provide maintenance management which is vital for manufacturer.
- EstiTrack™ does not provide Statistical Process Control (SPC) which play important role in product quality assurance.

2.13 COSS

(URL:http://www.coss-system.com)

COSS System Inc. is well-known of providing loaded features to small and mid-sized manufacturers. Simply Manufacturing™, COSS SBE and COSS Manufacturing are three distinct operation scales provided by COSS. These three operation scales able to deliver strength and backbone to keep manufacturer business extending and grow. COSS is expert in solving manufacturing concerns in environments like Job Shops, Aerospace, Tool and Mold, make to order and more. COSS continually enhances its solutions in response to customer demand and the rapidly and evolve changing and intensely manufacturing marketplace. Figure 2.11 depicted the COSS full feedback mechanism across the organisation.

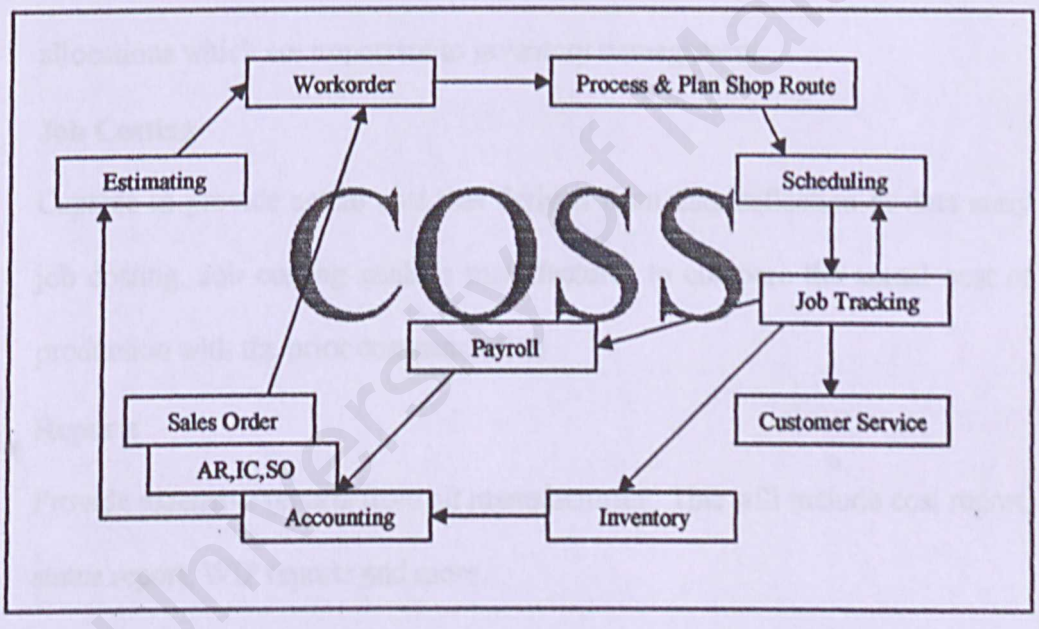


Figure 2.11 COSS mechanism (Coss, 2003)

COSS includes a comprehensive set of tools and wide array of features, including estimating and quoting, work order, process planning, job tracking and costing, parametric configurator with dynamic material and advanced shop floor

scheduling, data collection and bar coding, time and attendance, utilisation, human resources, customer service and preventative maintenance.

COSS considers core products as tools that serve the basic business cycle of a manufacturer. It begins with estimating follow by Bills of Manufacturing (BOMs) to work orders and job costing. The core products are the following:

- **Estimating**

  It provides assistances for manufacturers to estimating and quoting for custom and modified jobs.

- **Work-order**

  It consists of work definition which defines the work process plan. The work definition comprises of Bill of Material (BOM), calculations and material allocations which are important to inventory management.

- **Job Costing**

  Capable to provide actual cost that derived from data collection or data entry job costing. Job costing enables manufacturer to compare the actual cost of production with the prior cost estimation

- **Reports**

  Provide extensive reports from all manufacturing. This will include cost report, status report, WIP reports and more.

- **Preventative Maintenance**

  COSS has designed the maintenance module to give manufacturer flexibility to draft maintenance schedule for production machine. Maintenance is vital because it can avoid any machine breakdowns that could effect the on-going production.

- **Time Attendance**

  It collects employee's attendance which is important for financial department to generate payrolls at the end of the month.

COSS data collection module provides user-friendly interfaces that have depicted at figure 2.12.

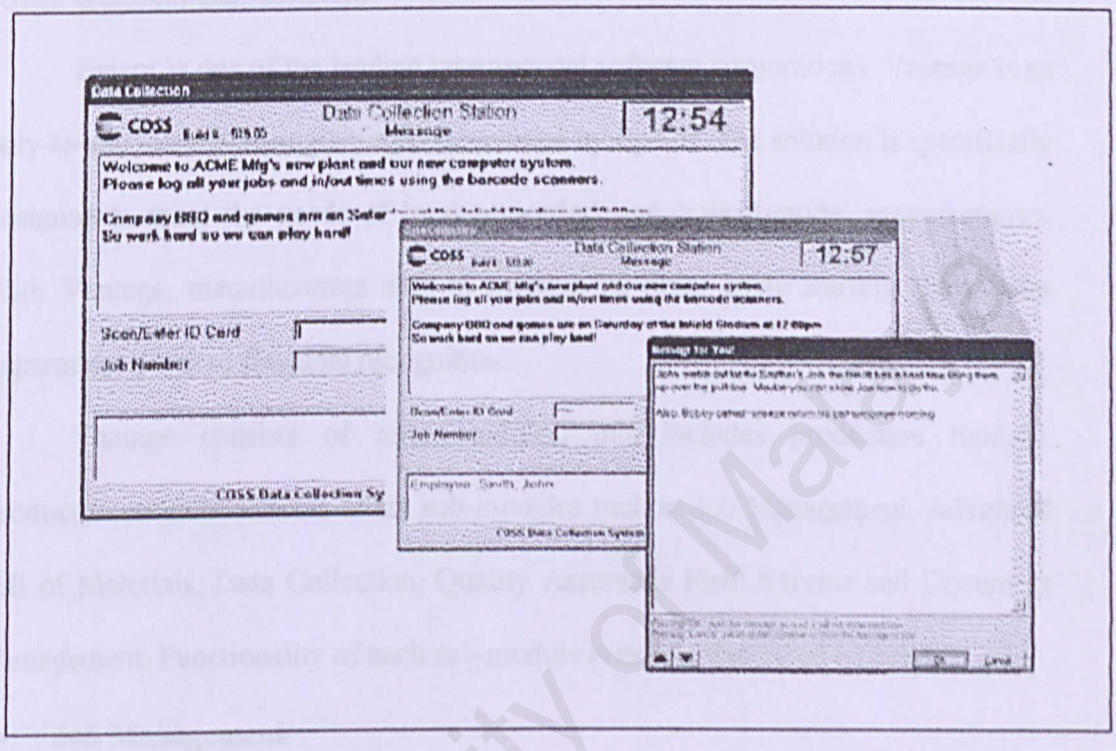


Figure 2.12 COSS Data Collection Interface (Coss, 2003)

Advantages of COSS manufacturing software are listed below:

- COSS has the powerful and significant modules or features that can serve the manufacturer needs.
- COSS parametric configurator features that able to bridge the customer and manufacturer requirements. The configurator builds product configurations and productivity based on customer defined requirements.
- COSS provides preventative maintenance that is vital to manufacturer to establish maintenance schedule for their machinery.

Disadvantages of COSS manufacturing software are listed below:

- COSS does not provide Statistical Process Control (SPC) that is important for manufacturer to monitor the quality of the ended-product.

2.14 Epicor Vantage

(URL: http://emfg.epicor.com)

Epicor is one of the leading international software corporations. Vantage is an easy-to-use manufacturing solution developed by Epicor. The solution is specifically designed to meet the needs of 'make-to-order' and 'mixed-mode' manufacturers. With Vantage, manufacturers able to manage its order cycle starting from Sales department down to financial recognition.

Vantage consists of nine modules, this includes production module. Production module consists of six sub-modules such as Job Management, Advanced Bill of Materials, Data Collection, Quality Assurance Field Service and Document Management. Functionality of each sub-module is briefly described as below:

- **Job Management**

  It is the control module specifically designed to handle routing, scheduling, job costing and tracking the information of production on the shop floor.

- **Advanced Bill of Materials**

  It describes the structures and the material of a finished good.

- **Data Collection**

  It collects relevant data or information such as labour, job status, inventory transaction and so on. This information will be valuable and vital to Job Costing and Job Status.

- **Quality Assurance**

  It ensures all finished good conform to its quality and removes the bad.

- **Field Service**

  This sub-module is designed to store information of maintenance teams. It also enables manufacturer to plan and deploy its maintenance regime.

- **Document Management**

  Reducing document control cost will be the principle of this sub-module. It enables user to easily retrieve relevant document such as quote, productivity reports and much more.

2.15 Plexus Online

(URL:http://www.plex.com)

Plexus Online is a web-based solution for manufacturing companies. Familiar point-of-click, easy to use, and requires minimal training are the factors that turn the solution into web-based. Adopting this solution does not require any software installation into client personal desktop. Since Plexus Online is a web-based, it supports multiple sites and establishing communication with customers, suppliers, and employees through internet.

Table 2.3 Modules integrated in Plexus Online solutions.

Plexus Online Modules	
- Engineering	- Tool Tracking
- Sales/CRM	- Maintenance
- Materials	- Purchasing
- Inventory	- Accounting
- Production	- Human Resources
- Costing	- Communication
- Scheduling	- EDI
- Shipping	- Distribution
- Quality	- Assembly Systems
- Program Management	- Pocket PC

- System Administration	Advanced Technologies
- Web Site Utilities	

In this section, we are only focus on Plexus Online Production Module. This module consists of Production Tracking, Control Panel, Workcenter Tracking, Workcenter List, Shift Setup, Job Tracking System, Job Tracker, PLC/Machine, Integration, Settings/Recipes, Shop Assignment screen, Heat Treat Manager, Material, Control Manager, Weigh Scale - Integration, Shop Screen, and Shop Floor Call System.

Advantages of Plexus Online are listed as below:

- It provides simple and easy-to-use.
- It is also support for geographically-dispersed.
- It does not require higher hardware requirements and any software installation.

Disadvantages of Plexus Online are listed as below:

- The system is not reliable because web-based systems are likely to experience downtime.
- Higher chances of virus attack or intrusions.

2.16 Hertzler System Inc.

(www.hertzler.com)

GainSeeker SPC 7 is one of the core products developed by Hertzler System Inc. Besides GainSeeker, Hertzler System Inc. also offers GainSeeker DMS, GainSeeker WebSPC, and GainSeeker WebCPK. GainSeeker SPC 7 is a software tool to help user to manage and share quality data at all level. This software tool is able to provide automatic data acquisition, real-time charting, document delivery, root-cause analytical tools, comprehensive reporting tools, generate chart for process or parts, and support multi-user network.

GainSeeker SPC 7 provides flexible data acquisitions, it supports a variety of types data entry such as weigh scales, digital scales, ASCII text and SQL table file manipulation and others. It provides extensive reporting resources for user to perform analysis. Charting and analysis options include XBar & R, X Bar & S, Pareto analysis and much more.

Besides that, GainSeeker SPC 7 provides real-time alarm and automatic feedback. It automatically analyze the new data with thirty out-of-control conditions. Any variation in statistical, an alarm will generate to the operator. Multiple reports format is provided to the user to make professional-looking reports. Last but not less, GainSeeker SPC 7 provides security control to protect corporate data or information.

CHAPTER 3

METHODOLOGY

3.0 Introduction

This chapter describes about the development methodology that chosen to develop the e-Manufacturing system. It is important during developing a large system on hand. System developer should have or understand well about the development process in whole before development process got started. Besides that, few development methodologies will be explained in this chapter.

3.1 What is Development Methodology?

System development methodology refers as a formal and precise development process which defines a set of activities, best practices, procedures methods, deliverables, and automated tools to facilities system developer to develop and maintaining the software quality. (Pfleeger, S. L. *et al*, 2001)

In nature, there is no single precise approach to develop a system. Every development method has its strengths and drawbacks. Adopting a development method will depends on the external and internal factors of development activities such as hardware, people, developing environment, time and etc.

3.2 What is a Process Model?

Process Model is an abstract representation of a software process. Software process refers as a set of activities and associated result which produce a software product. (Sommerville, I., 2001) Software specification, Software development, Software validation, and software evolution are the four fundamental process activities. . There are various types of software process models, which associated with different kinds of strategies. Among the software process models are Waterfall Model, Prototyping, Incremental, Iterative, Spiral, and so on.

Below are the reasons to advocate why process model is crucial for a software development:

- Process model will act as a guideline for the project team member to identify and to eliminate inconsistencies, redundancies, and omission in a particular process.
- Each of the process models encompasses detail description for each development phases, activities, and methods. This includes the objective, scope, requirement, implementation and design. Thus, confusion, contradiction in the team will be eliminated.
- Process model will be reviewed as time goes on in order to adapt development environment changes.

3.2.1 Waterfall Model

Waterfall Model is a simple and well-defined development process in which one phase has to be finished before the next phase. The model is relative simple to apply. This model only can apply when the system requirements are well understood and defined.

Requirement analysis, system and software design, implementation and unit testing, integration and system testing, and operation and maintenance are the principal stages in Waterfall Model.

However, this model is difficult to respond to changing customer requirements. When system requirement is changed, the whole life cycle will have to start all over again. In this case, commitments must be made at the early stage in the process. The following figure illustrates the Waterfall Model

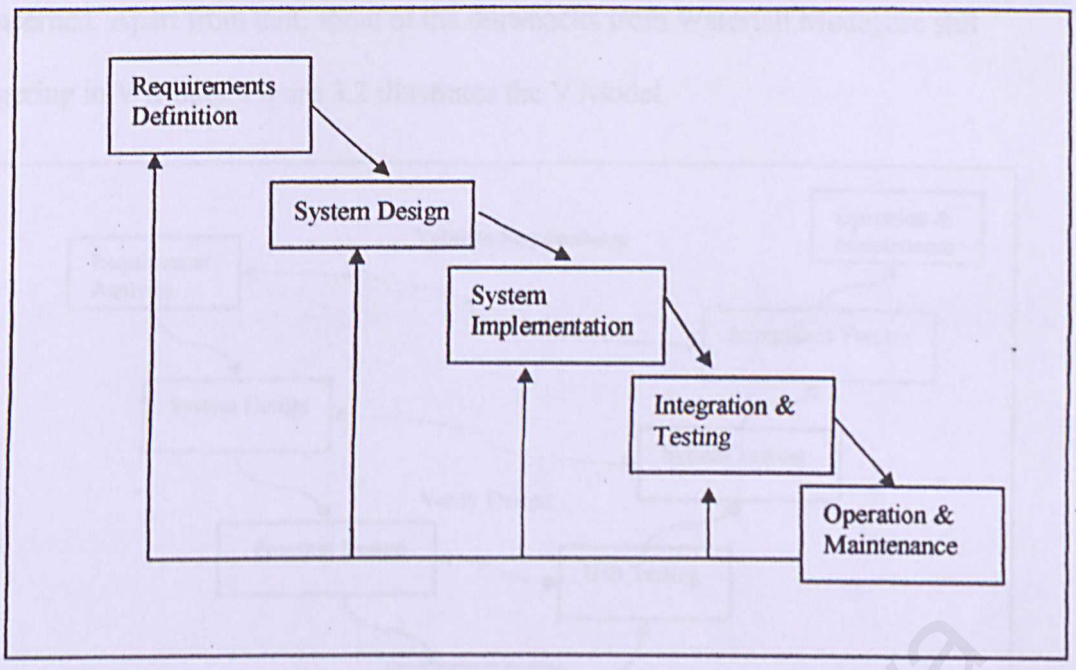


Figure 3.1 Waterfall Model

3.2.2 V Model

V Model evolves from the waterfall model. The difference is that each test phase matches each development phase. This includes requirements with system testing, high-level design with integration testing, and detailed design with unit testing.

V model is an improved version of waterfall model. V model does not run into the problem that the software is impossible to be tested because system test, integration test, and unit test are planed at prior. For example, when a requirement is planned, system test case for the particular requirement will also be drawn. Therefore, when the system is built, we have a whole set of test cases for system testing.

The advantages for this model are more or less similar to Waterfall Model. However, extensive testing may not be cost effective is one of issue that need to be

concerned. Apart from that, some of the drawbacks from Waterfall Model are still lingering in V Model. Figure 3.2 illustrates the V Model.

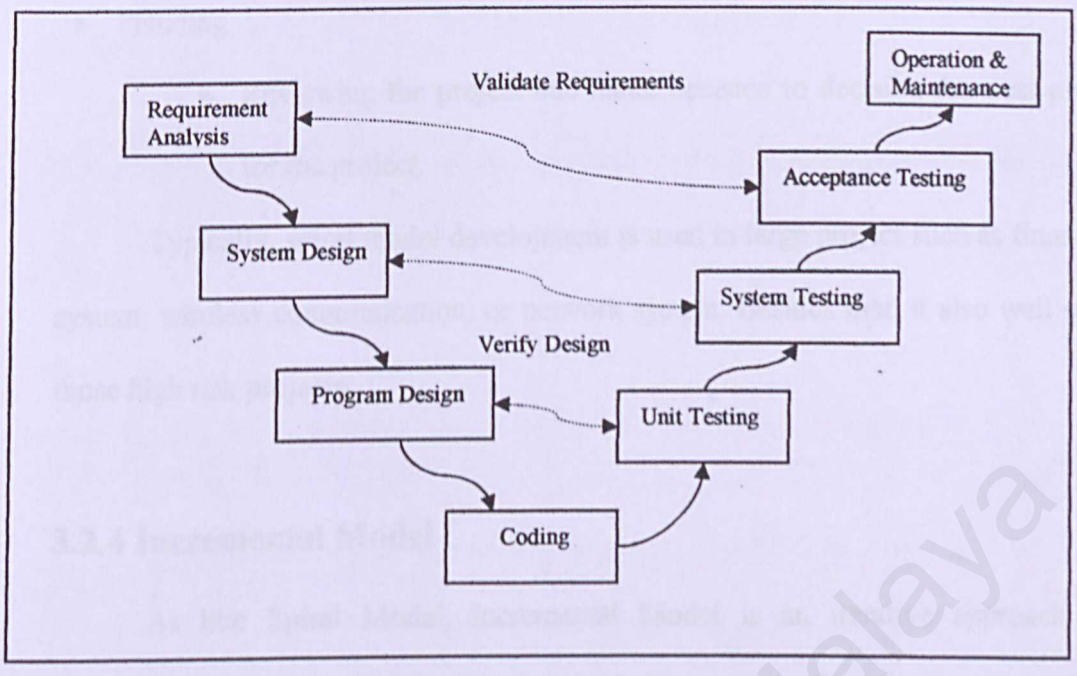


Figure 3.2 V Model

3.2.3 Spiral Model

Spiral model is one of the iterative approaches. The main focus of this model is risk assessment, where the risk of each part of development will be evaluated. Each loop of in the spiral represents a phase of software process such as feasibility study, requirement definition, design, implementation, and so on.

Each loop in the spiral encompasses of four sectors. Following are the four sectors associated with brief description:

- Objective Setting
  - » Objectives and constraints for a particular phase are identified.
- Risk assessment and reduction
  - » Risk assessment and risk monitoring are carried out

- Development and validation
    - » Adopting a suitable and most appropriate development model.
- Planning
    - » Reviewing the project and make decision to decision the next phase for the project.

Typically, spiral model development is used in large project such as financial system, wireless communication, or network system. Besides that, it also well suits those high risk projects.

3.2.4 Incremental Model

As like Spiral Model, Incremental Model is an iterative approach. In Increment Model, the system will be subdivided into series of subsystem. Each of the subsystem will be developed incrementally according to stage. Deliverables are set to each phase of the development in each subsystem.

Incremental Model has advantages over other development model. Here are the advantages:

- System is divided into subsystems which are developed in stages.
- Each of the subsystems has its own requirements.
- Extensibility for each subsystem is an easy task.

Figure below illustrates the Incremental Development Model

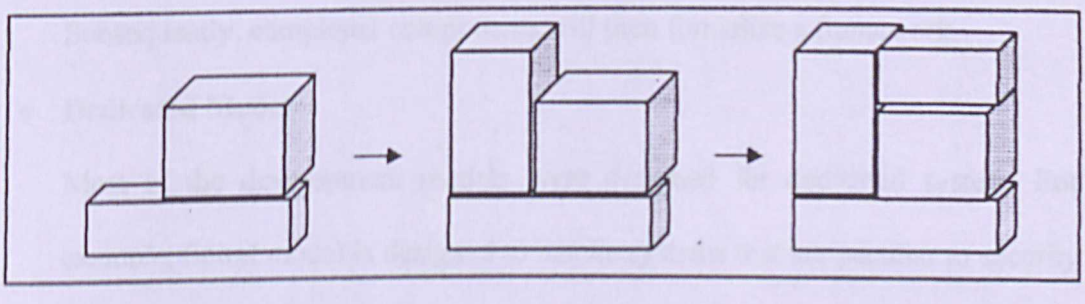


Figure 3.3 Incremental Model

3.2.5 Iterative Model

In Iterative model, then entire system were developed at the early stage. Subsequently, the system will undergo series of modification and enhancement under the perfect system is developed. Feedback is very crucial for system enhancement phases. This feedback will constantly collect from the certain party such as system user, system tester, developer, and so on. The feedback will then set as the idea and design for the next phase.

3.3 Methodology Chosen

Combination of incremental and iterative development model will be most appropriate development methodology for developing e-Manufacturing system. The advantages for incremental and iterative development model will add value into the system development.

Here some the substantial reason to adopt this combination development model:

- **Nature of the application**

  Since the framework for e-Manufacturing system is a large system, concept of 'Command and Conquer' will be the best method to deliver such system and on time. The framework in nature is complemented with components, for that reason Incremental model is suitable to develop components accordingly. Subsequently, completed components will then formalize a framework.

- **Dedicated Model**

  Most of the development models were designed for dedicated system. For example, Spiral model is designed to handle systems that are peculiar to security such as financial system, Waterfall model for well defined requirements systems

and so on. In nature, development environment and requirements are tending to be changed. If the changes are far more than the boundary, the applied model will not suitable to the current project any more. For that reason, combination of development model will have the advantages.

- **Uncertainties**

  The development team does not have enough skills and experience on developing a framework. Besides that, requirements uncertainties due to large system that leads incremental and iterative development model as the best development model. It provides flexibility to enhances and modify a subsystem on next phase.

- **Time Constraint**

  Time constraint is one of the major concerns to develop this system. 6 months duration is given to complete all tasks such as system study, analysis, system design, development, and implementation. In that case, any delay in development will cause late of delivery.

- **Flexibility**

  Incremental and iterative development model provides a great flexibility for system developer to modify and enhance a particular subsystem. This is where incremental and iterative model has more advantages than other models.

3.4 UML

UML is the abbreviation for Unified Modeling Language. UML is a language that provides a vocabulary and rules to present the conceptual and physical representation of a system. (Jacobson, I. *et al*,1999). Modeling will yield understanding of the system.

UML is able to construct a model for a system that can be viewed from a number of perspectives. Different stakeholder might need different dimension to overview the system. In the case, UML manage to hand these different viewpoints

Figure below depicts the five viewpoints that defined from the framework of e-Manufacturing system by using UML. The viewpoints are Use Case View, Design View, Process View, Implementation View, and Deployment View.

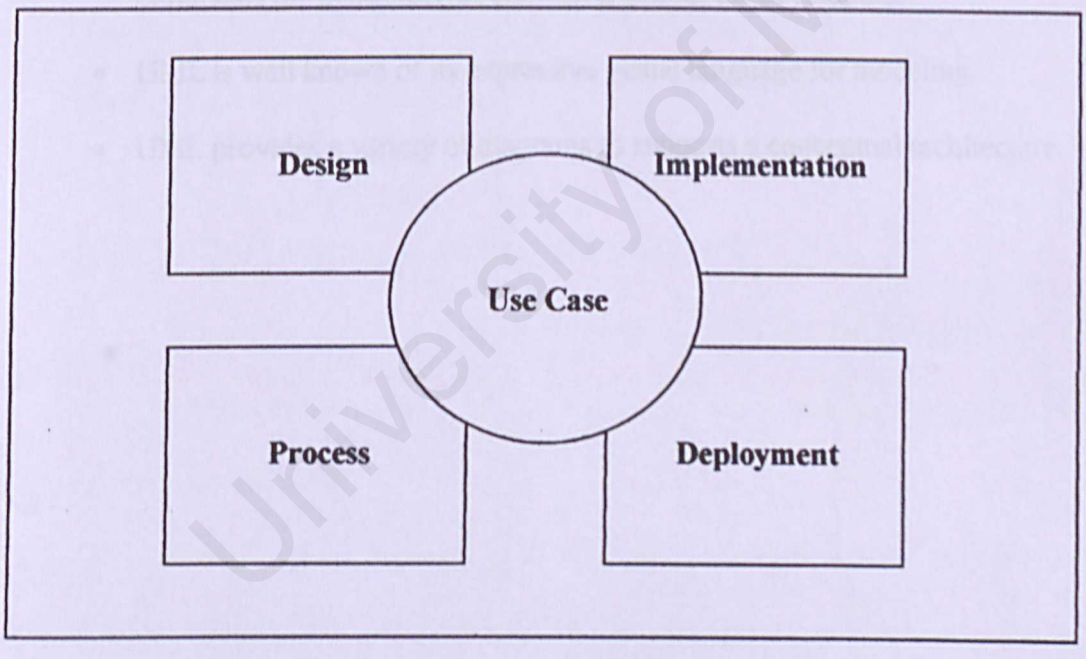


Figure 3.4 Framework Architecture in five views

Use Case View : Describes the behavior of the system as seen by end user.

Design View	:	Comprises of the classes, interfaces, and collaborations that form the vocabulary of the system problems.
Process View	:	Diagrams that describe the flow control of the system.
Implementation View	:	Diagrams that describe how the subsystems incorporated to form a physical system during implementation
Deployment View	:	Diagrams that emphasize on the configuration of the software, hardware and other peripherals.

Below are the substantial reasons to use UML to visualise the whole architecture for the proposed system.

- A set of unified notation in UML able present system well understood. Thus, it eliminates the possibility of confusion among the developers.
- UML is well known of its expressive visual language for modeling.
- UML provides a variety of diagrams to supports a conceptual architecture.

3.5 Fact Finding

Fact finding techniques are the formal or informal process to gather and collect important information and requirements of a system going to be developed. It is also known as information gathering or data collection. Sampling existing documents, site visits, interviewing, observing, questionnaires, prototyping, Rapid Application Development (RAD) and Joint Application Development are various types of fact finding techniques. Actually fact finding is crucial to two development phases, which are systems planning and systems analysis phases.

Raw data or information should be examined and analysed in order to develop a system that fulfils the core requirements. There is no single precise fact finding technique. Is not a matter which techniques were deployed during fact finding as long as complete information or data is collected. In fact, combination of appropriate techniques is implemented will increase both effectiveness and efficiency in gathering factual information.

3.5.1 Utilise Internet & Electronic Material

Internet has getting fame in the early of 1993. As the time goes by search engines are getting advance in the internet. It provides ease, high accuracy and fast information retrieving.

Internet is getting blooming as time passes, it provides immeasurable amount of information whether is about science, technology, art, entertainment, sports and much more. Apart from that, it also provides substantial academic information such as electronic journals, electronic articles and so forth.

It is undeniable to internet has provides me immeasurable substantial information in this project. With internet, I can gain more knowledge of about

manufacturing field. Besides that, I could get some overview of e-Manufacturing systems that provided by international companies. Apart from that, I get to know more about component-based approach besides study from printed material such as book. On the other hand, I could gain more relevant information from available forums and group discussions.

3.5.2 Utilise Printing Material

There are a wide variety of printed materials available to obtain information. This ranges from books, encyclopaedias, almanacs, yearbooks, periodicals, magazines, handbooks, manuals, dissertations, directories, dictionaries, government document and policies, statistics and others.

With these printed resources especially journal, articles, and books, we are able to find the definition, terms, and concepts about e-Manufacturing system. Apart from that, we can even find some of the basic requirement about our system.

3.5.3 Discussion

Since this project is undertaken by a group of four members, discussions are held frequently in order to exchange ideas. On the hand, problems that arise during the project is on going can voice out and solve it in group. Besides that, I often hold discussion with my supervisor in order to have more ideas or information about this project. I even gain some of the valuable advice and solutions from my supervisor to solve certain problems.

Chapter 4

System Analysis

4.0 Introduction

System analysis is a problem solving technique which decomposes a system into its component pieces for the purpose of studying how well those component parts work and interact to accomplish their purpose. (Whitten, J. L. *et* al, 2002) System analysis is one of the early phases in system development where it identifies functional and non-functional requirements of the system. Development tools, language, and environment will be discussed and determined for the development of the proposed system.

4.1 System Requirements

During system analysis is implemented, use case model is used to identify the requirements of the proposed system. It is much easier to perform analysis based on use case because it is simple, presentable and easy to understand. The outcome of the analysis will serve as a guideline for system developer to outline the design of the proposed system. In nature, there are two types of requirements which are functional requirements and non-functional requirements. Detail description about these two requirements will be described at following sub-topics.

4.1.1 Functional Requirements

Functional requirements are statements of services the system should provide, how the system should react to particular inputs and how the system should behave in particular situations (Sommerwille, I., 2000). Functional requirements for the proposed system will be divided into framework functional requirements and production module functional requirements. In each of the functional requirements will be sub-divided into system developer and system user.

Table below illustrates the functional requirements are divided into modules

Framework	Production Module
System Developer	**System Developer**
- Authentication - Database Connector	- Setup SPC - Setup Shop Floor
System User	**System User**
- Login	- SPC subsystem - Shop Floor Subsystem

Table 4.1 System Functional Requirement

4.1.1.1 Framework Functional Requirements

Since the proposed system comprises of four main modules such as Sales, MRP, Production, and Material Management modules, the framework functional requirements will be shared among the four modules.

Stated below are the framework functional requirements according to system developer module and system user module.

System Developer Module

- **Authentication**

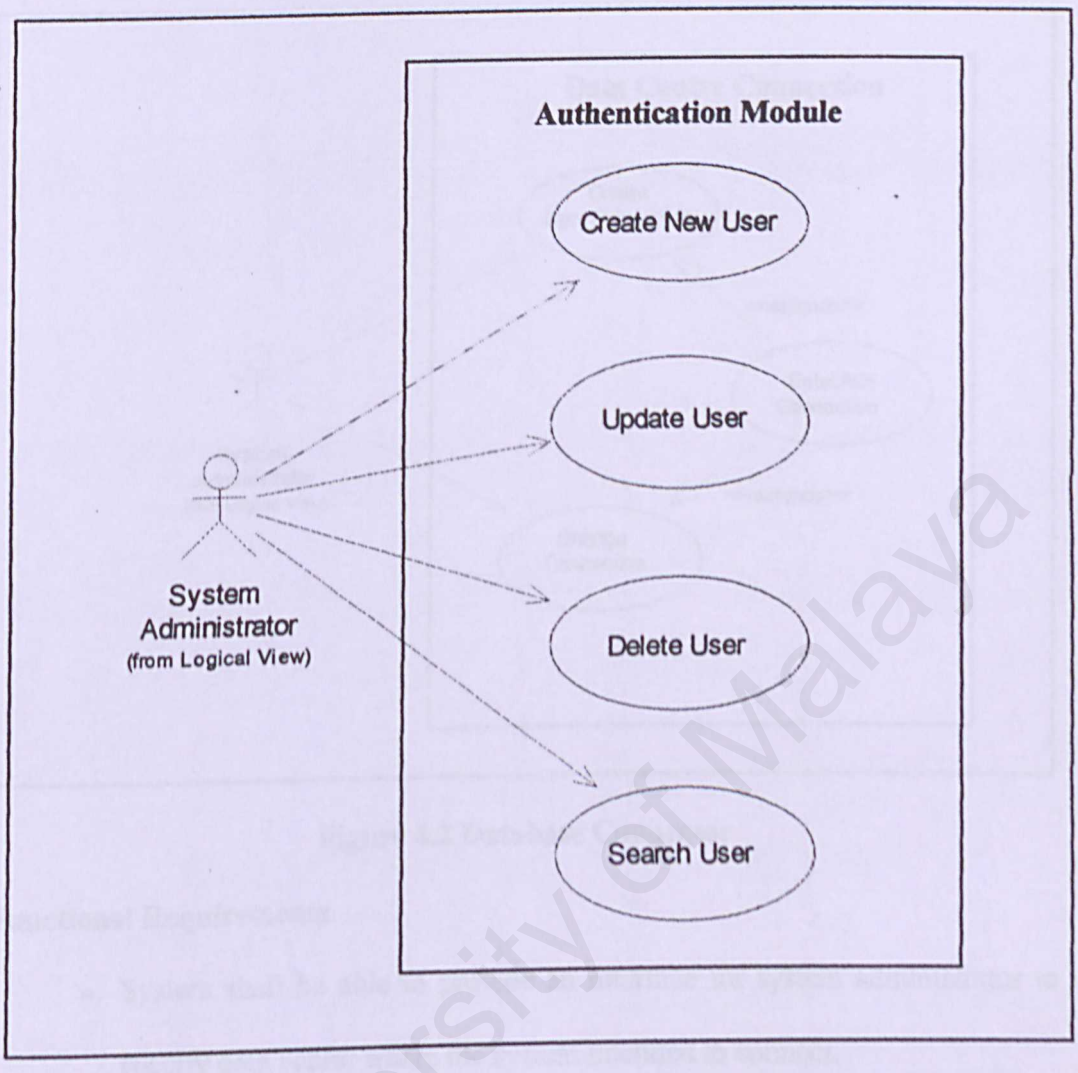


Figure 4.1 Use Case Diagram for Authentication Module

Functional Requirements

» System developer / administrator shall be able create new user.

» System shall provide administrator to edit or update system user preferences such as type of user, login password and username.

» System developer shall be able to delete existing system user and system administrator

» System developer shall be able to update its own preference such as user name and login password

System Developer Module

- **Database Connector**

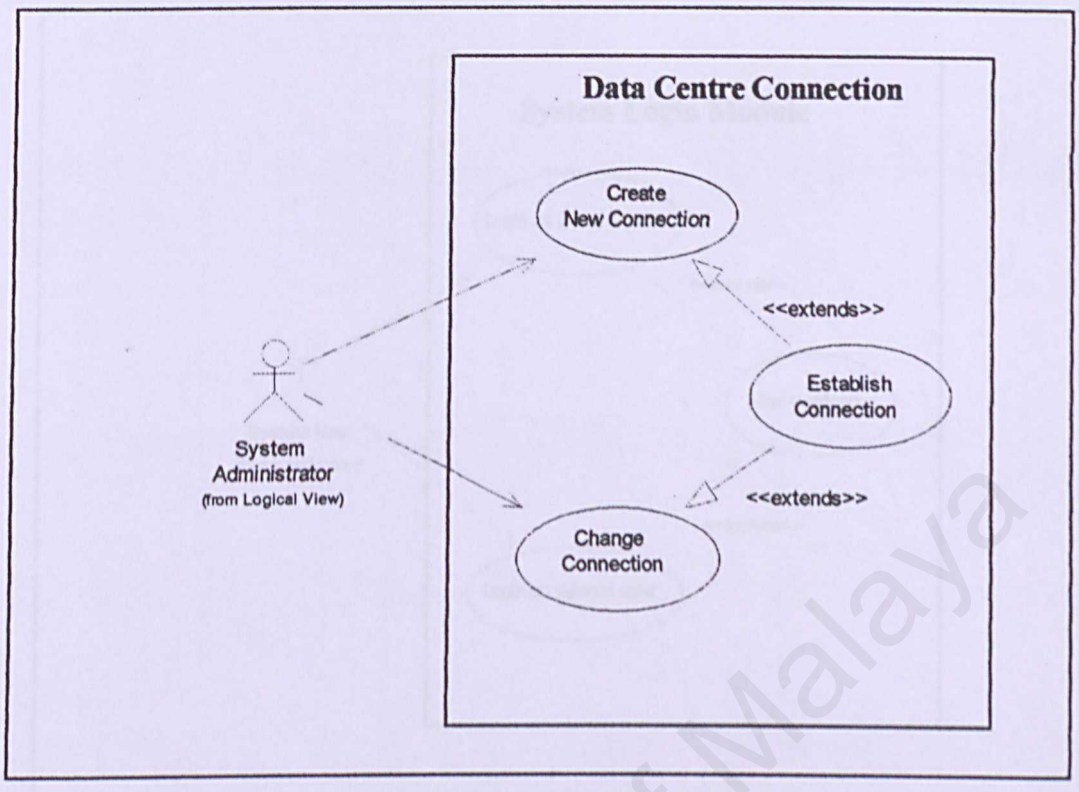


Figure 4.2 Database Connector

Functional Requirements

» System shall be able to provide an interface for system administrator to specify data center where the system intended to connect.

» System shall be able to verify a connection whether is a valid connection or invalid connection.

» System shall notify system administrator when invalid connection occurred.

» System shall prompt system administrator when the framework is connected to any data center.

» System shall save connection properties into dbconn.xml file

System User Module

- **Login**

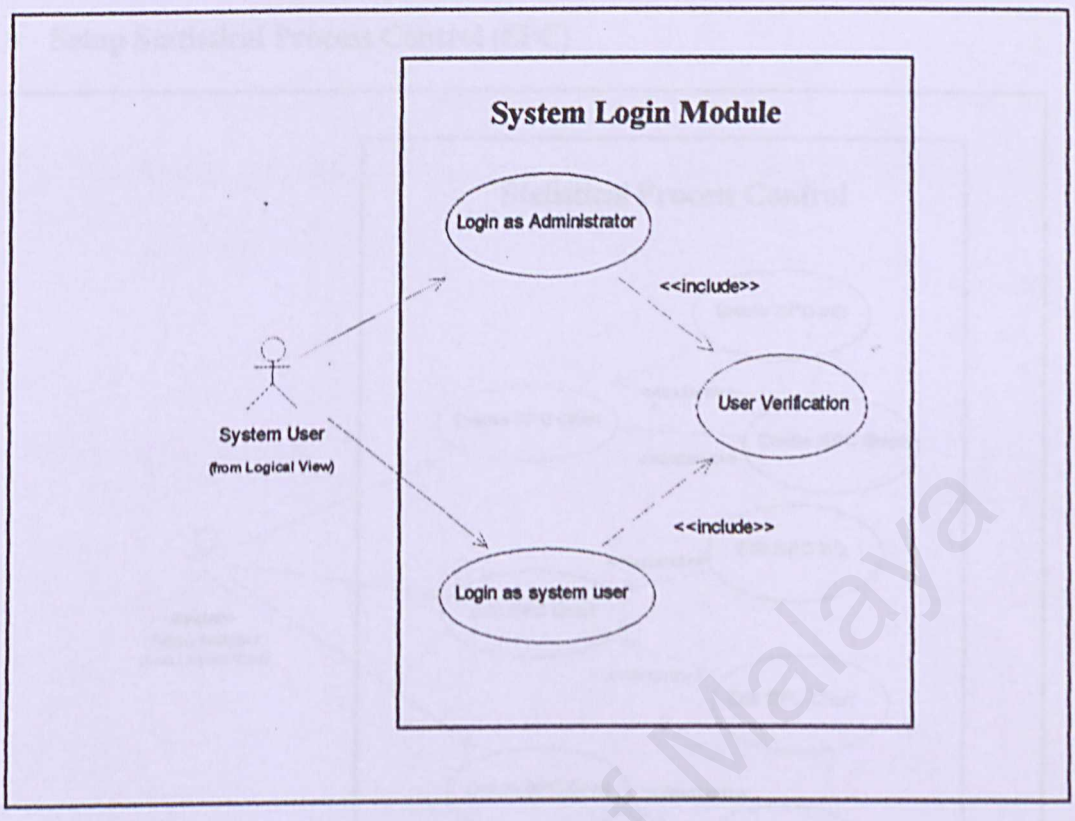


Figure 4.3 Use Case Diagram for System Login Module

Functional Requirements

» System user has to key in username and password. Invalid username or password will prompt the system user to key in the username and password again.

» System shall be able to identify the authority that the user possessed who log in to system. Administrator tool bar will be presented if the user who log in to system is an administrator.

» System shall disable all the tool bars when user log out.

4.1.1.2 Production Module Functional Requirements

System Developer Module

- **Setup Statistical Process Control (SPC)**

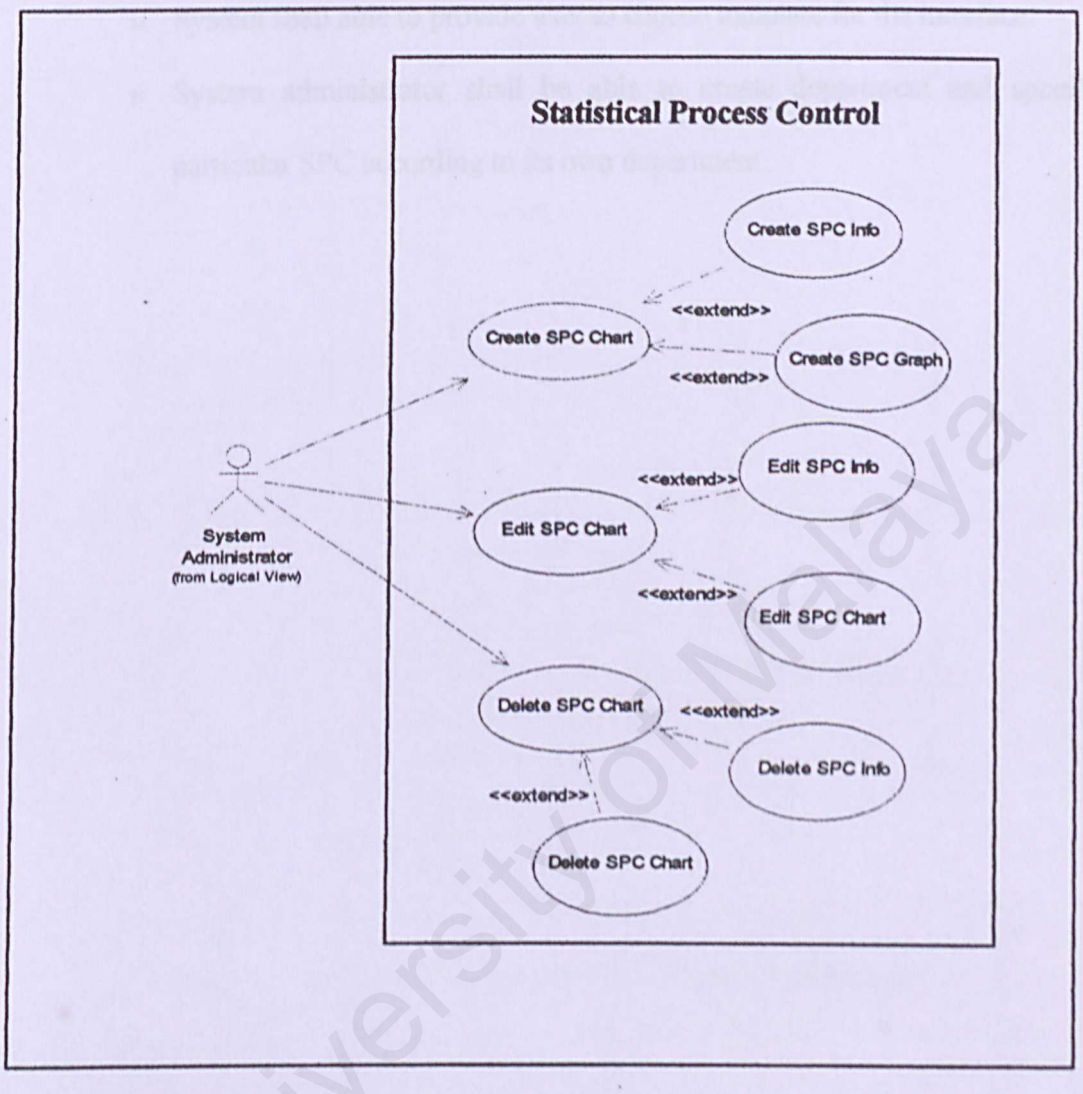


Figure 4.4 Use Case Diagram for Statistical Process Control

Functional Requirements

» System administrator shall be able to create new SPC mean chart or range chart for a particular product.

» System shall let system administrator to define its own table for the particular SPC.

» System administrator shall able to perform editing or modify the SPC chart properties such as Y and X-axis scale, axis labeling, upper control level, lower control level and so on.

» System shall able to provide user to choose template for the interface.

» System administrator shall be able to create department and specify particular SPC according to its own department.

System Developer Module

- **Setup Shop Floor Subsystem**

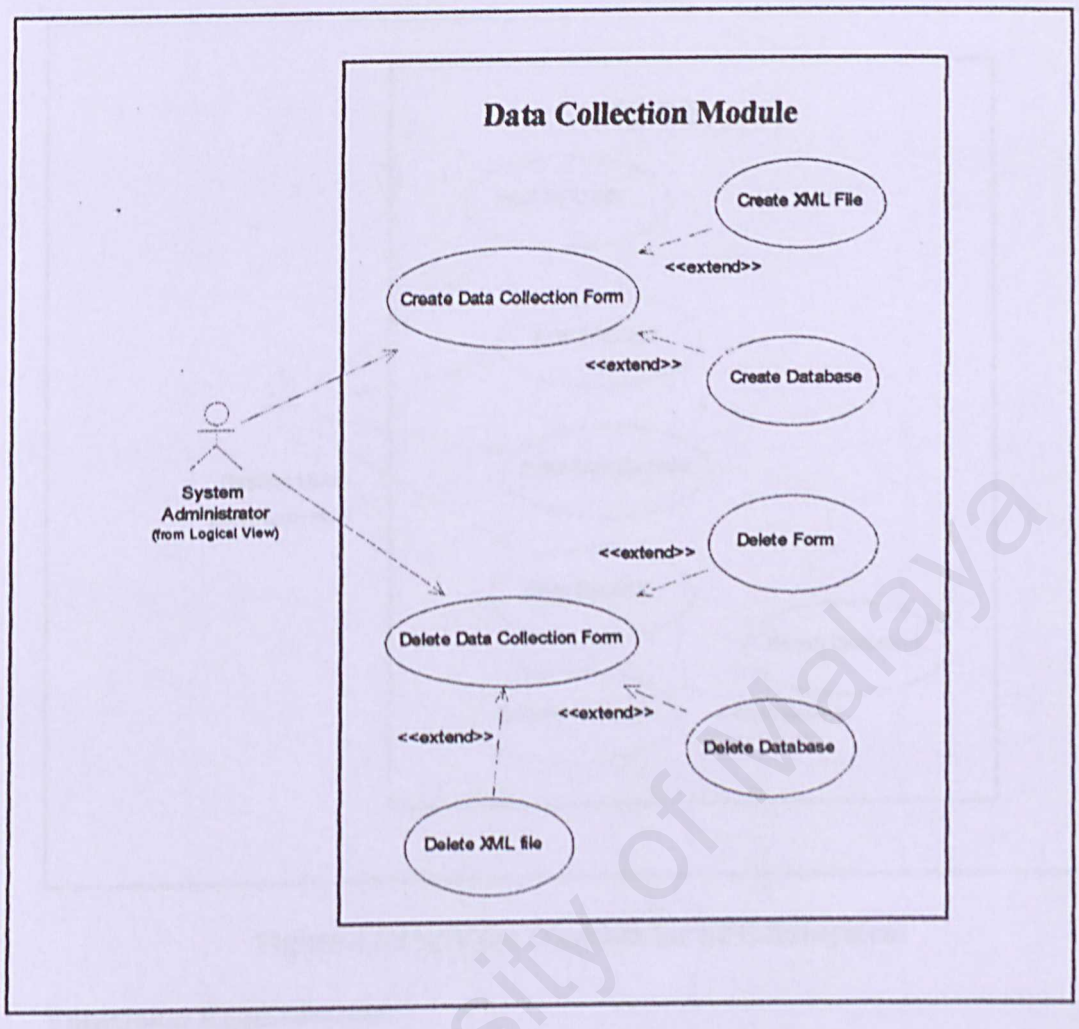


Figure 4.5 Use Case Diagram for Data Collection Module

Functional Requirements

» System administrator able to create new field, update field, renaming field and delete field for production table.

» System shall provide templates for system administrator to choose best suits interface for shop floor subsystem.

» System shall be able to store interface controls properties into xml file. For example, properties for a textbox are name, position, size, text and so on.

System User Module

- **SPC Subsystem**

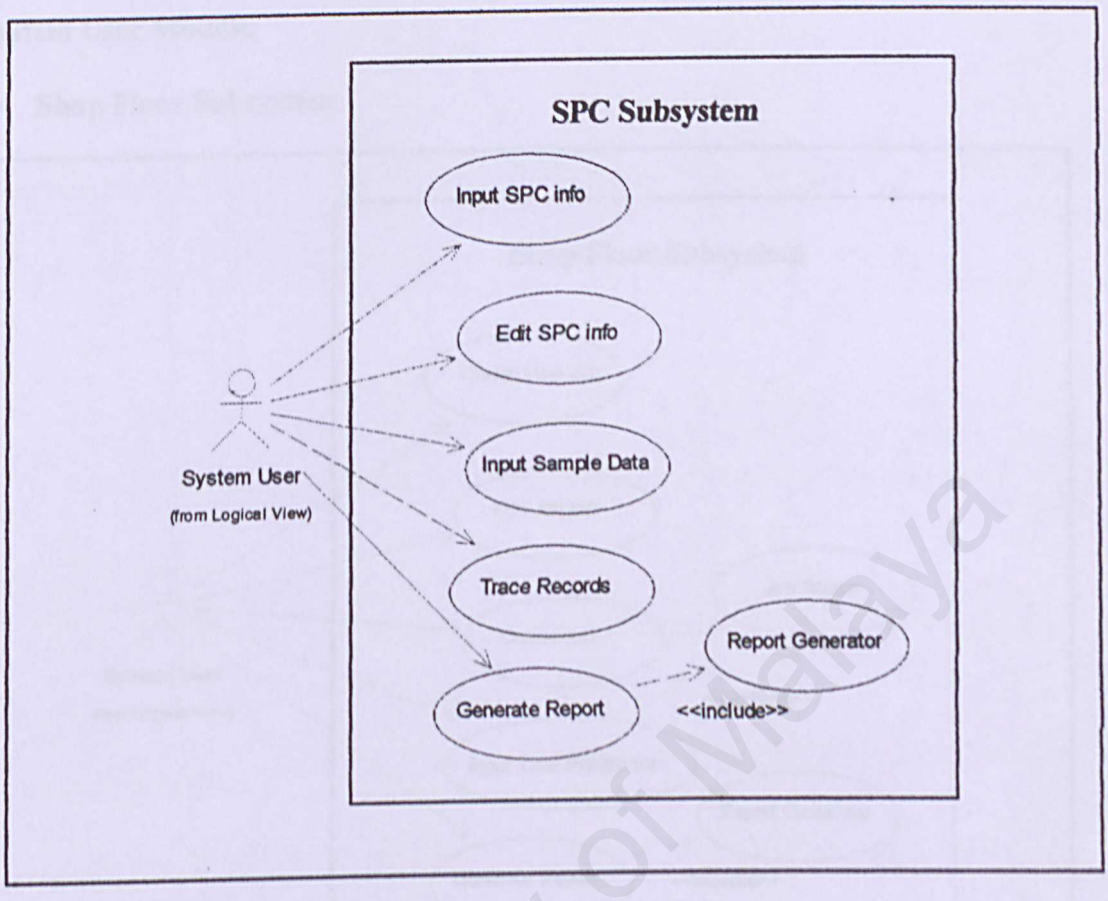


Figure 4.6 Use Case Diagram for SPC Subsystem

Functional Requirements

» System user shall able to save and edit SPC info

» System user shall able to input sample of data.

» System shall able to perform mean or range calculation to generate a SPC chart.

» System shall able to verify sample of input whether is a number or a character.

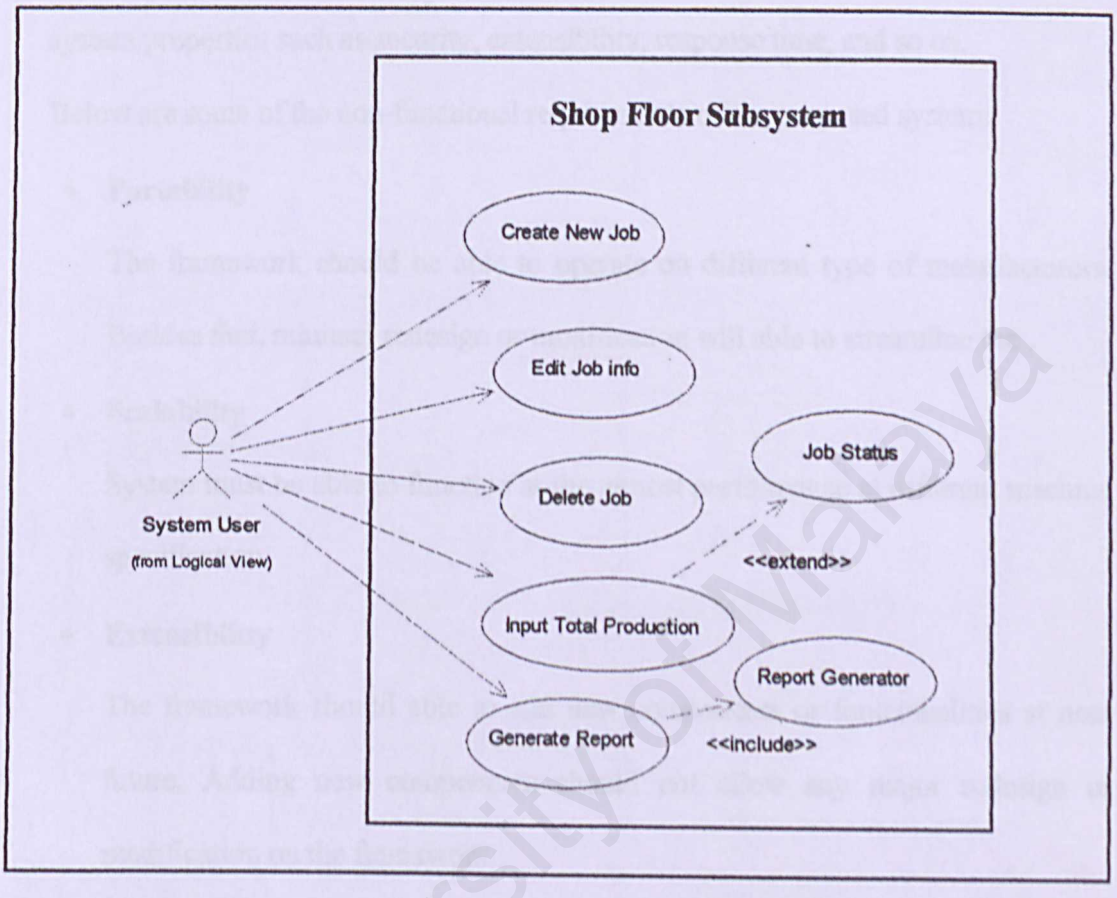
» System shall able to display alert frame when outlier is detected on the SPC chart.

» System user shall able to trace back previous records.

» System user shall able to generate report about the SPC chart.

System User Module

- **Shop Floor Subsystem**



Functional Requirements

» System user shall able to create new job

» System user shall able to edit and delete job information

» System user able to insert daily production.

» System user able to generate production report based on product.

» System shall able to calculate production status for each job.

4.1.2 Non-Functional Requirements

Non-functional requirements, as the words speaks from literal perspective, it means those requirements which are not directly concerned with the specific functions delivered by the system.(Sommerville, I., 2001) It refers to the proposed system properties such as security, extensibility, response time, and so on.

Below are some of the non-functional requirements of the proposed system:

- **Portability**

  The framework should be able to operate on different type of manufacturers. Besides that, minimal redesign or modification will able to streamline the .

- **Scalability**

  System must be able to function at the utmost performance at different machine specification.

- **Extensibility**

  The framework should able to add new components or functionalities at near future. Adding new components should not allow any major redesign or modification on the framework.

- **Flexibility**

  The proposed system should provide flexibility to system user to choose data center of the system. Besides that, system developer should have the flexibility in choosing the type of report to generate and the interface to be generated.

- **Modularity**

  The system is decomposed into logical and manageable modules. Thus, system testing and maintenance will be a great ease to system developer. On the other hand, modularity will avoid any contradiction between component's functions.

4.2 Run Time Requirements

4.2.1 Hardware Requirements for Developer

Developer should have the following hardware and software requirements so that the process of the development will swing smoothly.

Hardware Requirements	
Processor	Intel Pentium II, 450MHZ (minimum) or higher
Memory	128MB or higher
Hard Disk Capacity	8GB (minimum)
Monitor	VGA or higher resolution
Pointing Devices or Keyboard	Required

Table 4.2 Hardware Requirements for Developer

4.2.2 Software Requirements for Developer

Table below shows the software requirements for developer to develop application with Visual Studio .NET.

Software Requirements	
Operating System	Microsoft Windows 2000 or higher
Programming Tool	Visual Studio .NET 2000 or higher version
RDMS	Microsoft SQL Server 2000

Table 4.3 Software Requirements for Developer

4.2.3 Hardware Requirement for user

Hardware requirements have to take into consideration because it will give effect to the framework application that runs on it. In order to have a better performance, user has to meet the minimum hardware requirements which are stated at the table below.

Hardware	Server	Client
Processor	Intel Pentium II 450Mhz or higher	Intel Pentium 166Mhz or higher
Memory	192MB	64MB
Hard Disk Capacity	10GB	8GB
CD-ROM	Required	Optional
Pointing device & keyboard	Required	Required

Table 4.4 Hardware Requirement

4.2.4 Software Requirement for user

Below is the list of software requirements for user.

Server	Client
Windows Server 2000 or higher	Windows 98 or higher version
SQL Server 2000	SQL Server Client
.NET Framework	.NET Framework

Table 4.5 Software Requirement for User

4.3 Operating System Chosen

Windows 2000 professional is chosen as the development environment due to several substantial reasons. Apart from that, Windows 2000 has more advantages as compared to other operating system such as Linux and UNIX.

Below are the reasons why Windows 2000 Professional is being chosen:

- .NET Framework is used during system development. Only Windows 2000 or higher are able to support .NET framework.
- Windows 2000 provides user friendly approach compared to others operating system. GUI helps users to manage the system easily.
- Compatible with other development tools such as Crystal Reports and SQL Server 2003.
- Windows 2000 provides stability because it was built on NT technology plus with improved features.

4.4 Database Management System Chosen

Microsoft SQL Server 2000 is considered as the data repository for the proposed system. Below are the substantial reasons why SQL Server 2000 is being chosen rather than Microsoft Access.

- SQL Server 2000 able to handle more user than Microsoft Access. Since e-Manufacturing system is considered a large system, Microsoft Access is suitable to handle applications that are relatively small. Access only can support 255 users concurrently at a time.
- SQL Server 2000 is a client/server database where the server handles all the requests sent by clients. The server will process the request and return back the result. Thus, client does not directly read from or write to the database file. For that reason, communication overhead will be avoided because only queries and results are transmitted through wires.
- SQL Server 2000 provides advance security features than Access. Apart from that, SQL Server 2000 enable user to create multiple user with difference password.
- SQL Server 2000 provides fault tolerance where it ensures all the data in consistent state.

4.5 Why Visual Basic .NET?

- Component Creation is using .NET framework.
- Visual Basic .NET produces high quality application in the shortest time.
- Drag and Drop function has eased application developer to build interface compare to Java.
- Since SQL Server 2000 has been chosen as the DBMS of the application. VB .NET will provide higher integration with SQL Server 2000 because both are Microsoft solutions.
- In terms of performance, VB .NET byte codes are much faster than Java bytes codes because java bytes codes need to be interpreted before execution.

Chapter 5

System Design

5.0 Introduction

System design is a process to convert the conceptual ideas from requirement specification in system analysis into detailed computer-based solution. It is also known as physical design.

The contrast between system analysis and system design is system analysis emphasised the business problem, system design focuses on technical problem. In system design phase, requirements that gather during system analysis will be translated into technical representation of the system. The output of the system design would serve as an abstraction or blueprint of the implementation phase.

5.1 System Architecture

Three-tier architecture is the underpinning architecture for the proposed system. As we know, three-tier comprises of three main separate layers which are presentation layer, logical layer, and middle tier.

Presentation layer is the top layer where Graphical User Interface (GUI) plays a crucial role as a terminal to interact with system user. Before proceed on, I would like clarify the term 'system user'. It refers to both system developer/administrator and end user. The main task of this layer is to capture or collect data from system user for business processes. Apart from that, it also presents the output to system user.

The second layer known as middle tier or logical layer is where all the business logics are kept. In nature, all reusable components will be resided on this layer. Data layer will be the last layer, which encompasses of database management system (DBMS). Usually, data access technology such as ODBC or OLE DB

associates the middle layer with data layer. Figure below shows the three-tier architecture.

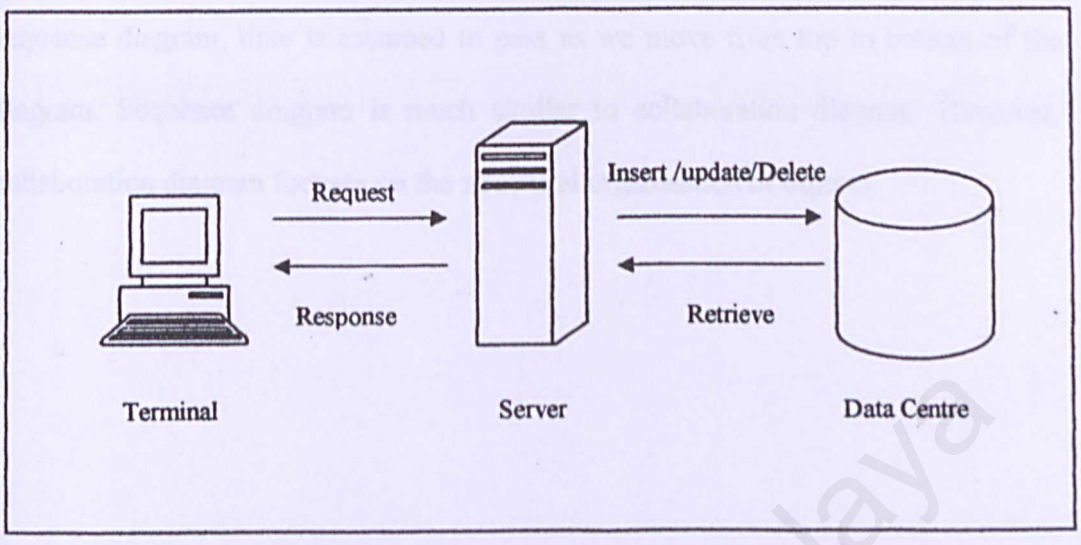


Figure 5.1 Three-Tier Architecture

Below are the substantial reasons to choose three-tier as the proposed system architecture:

- **Maintainability**

  Any changes on the business layer will not affect other layers. This is because layers are separated.

- **Extensible**

  Since presentation and data centre layers are separated, the logical layer could be extended by add new components easily.

- **Reusable**

  Each component can be reused and shared by different terminal which send their request.

- **Security**

  Since data centre is separated, DBMS security features will provide a secure and safe place for important data to reside on.

5.2 Sequence Diagram

Sequence diagram is an interaction diagram that emphasise the messages that send between objects in time ordering in order to realise a use case. Based on the sequence diagram, time is assumed to pass as we move from top to bottom of the diagram. Sequence diagram is much similar to collaboration diagram. However, collaboration diagram focuses on the structural organisation of objects.

5.2.1 Sequence Diagram for Production Module

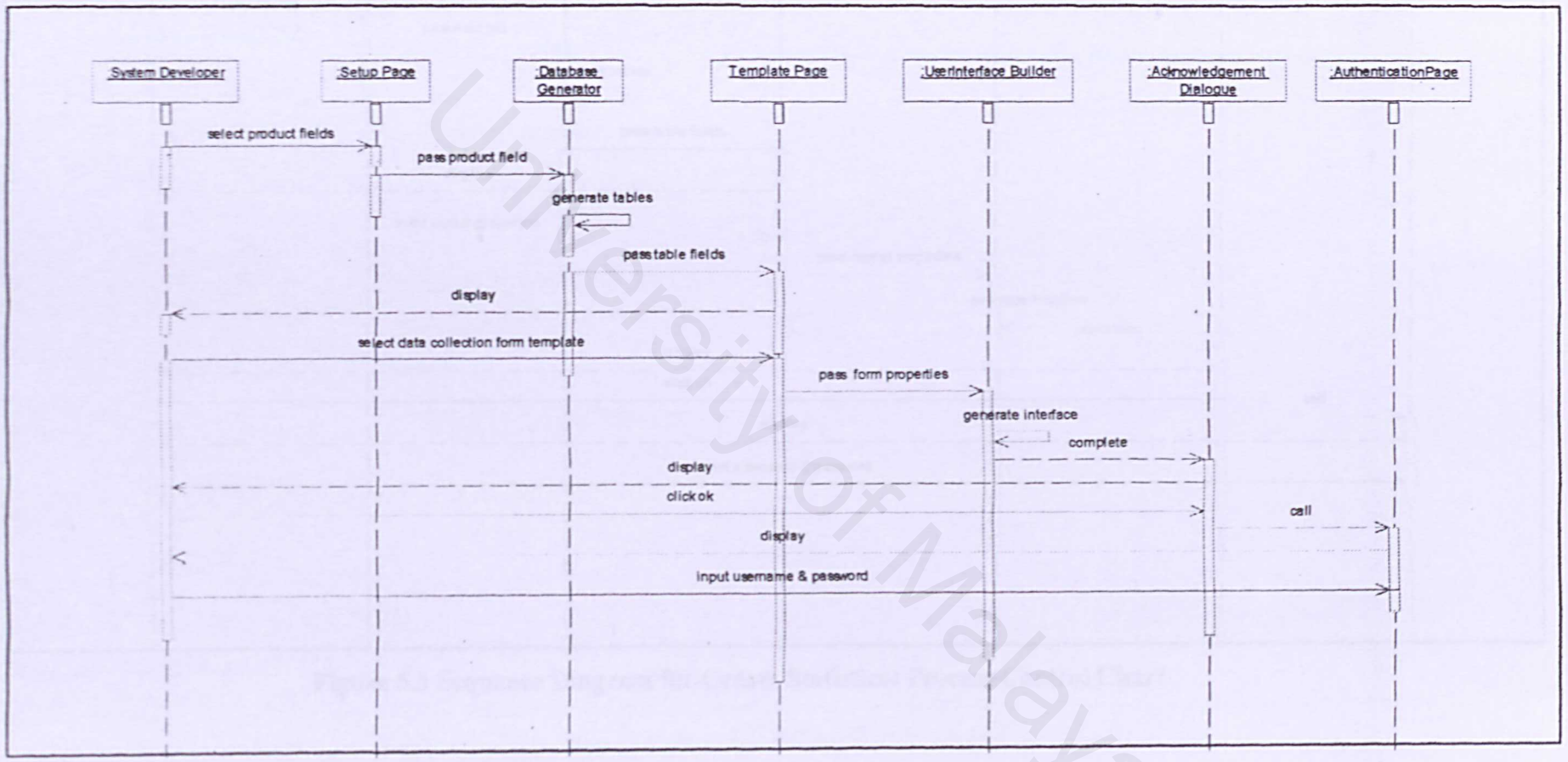


Figure 5.2 Sequence Diagram for Create Data Collection Form

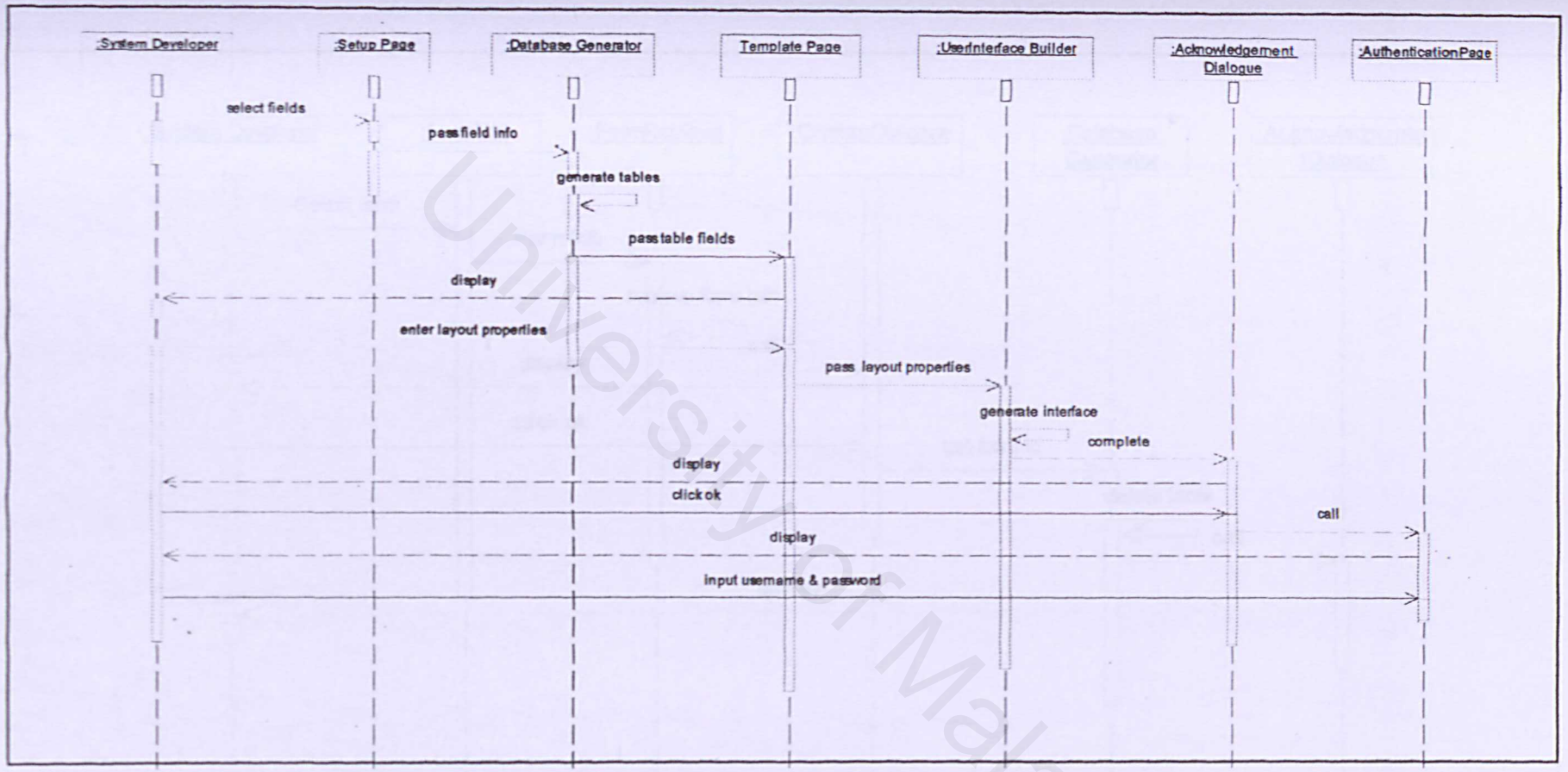


Figure 5.3 Sequence Diagram for Create Statistical Process Control Chart

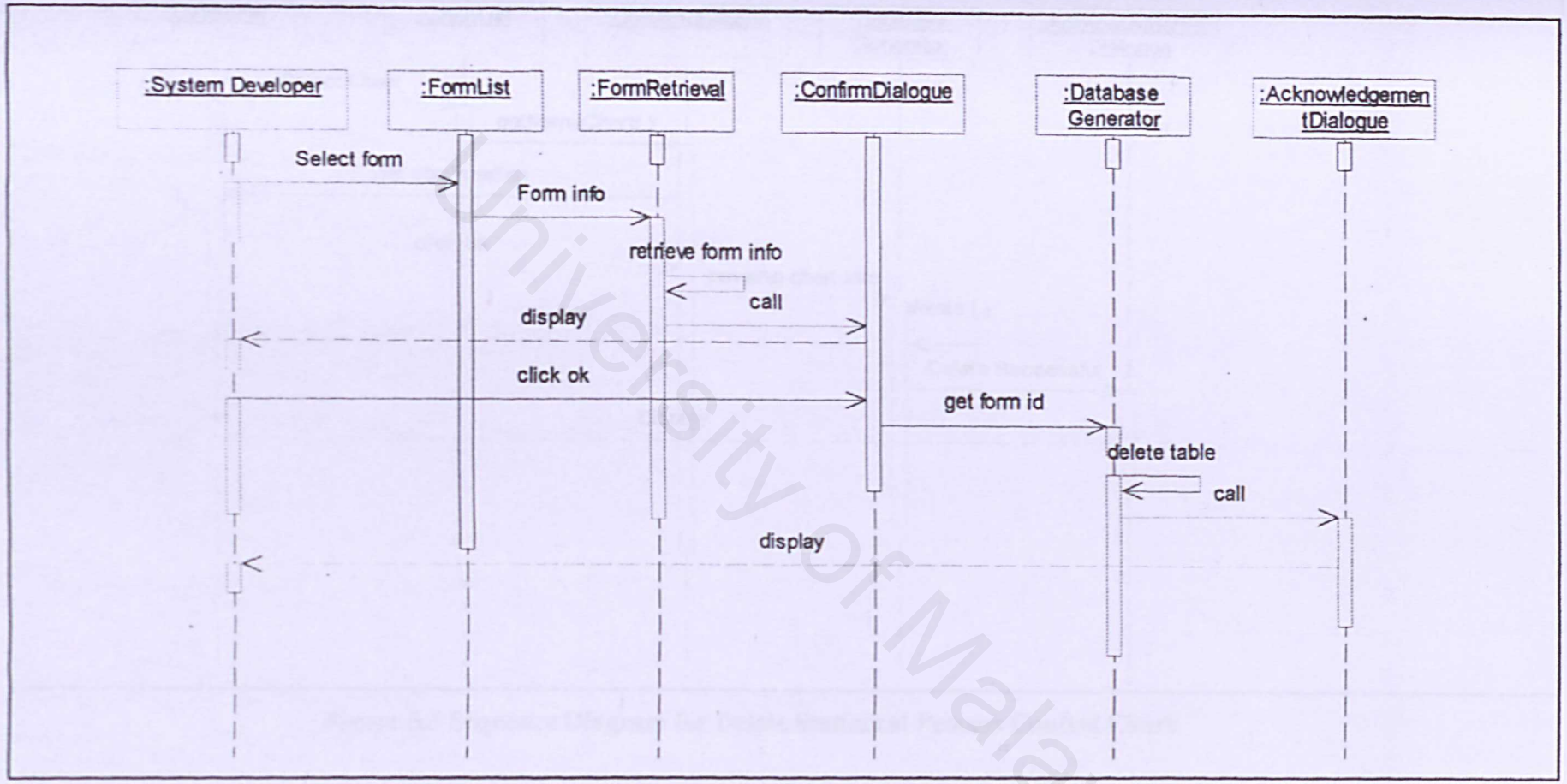


Figure 5.4 Sequence Diagram for Delete Data Collection Form

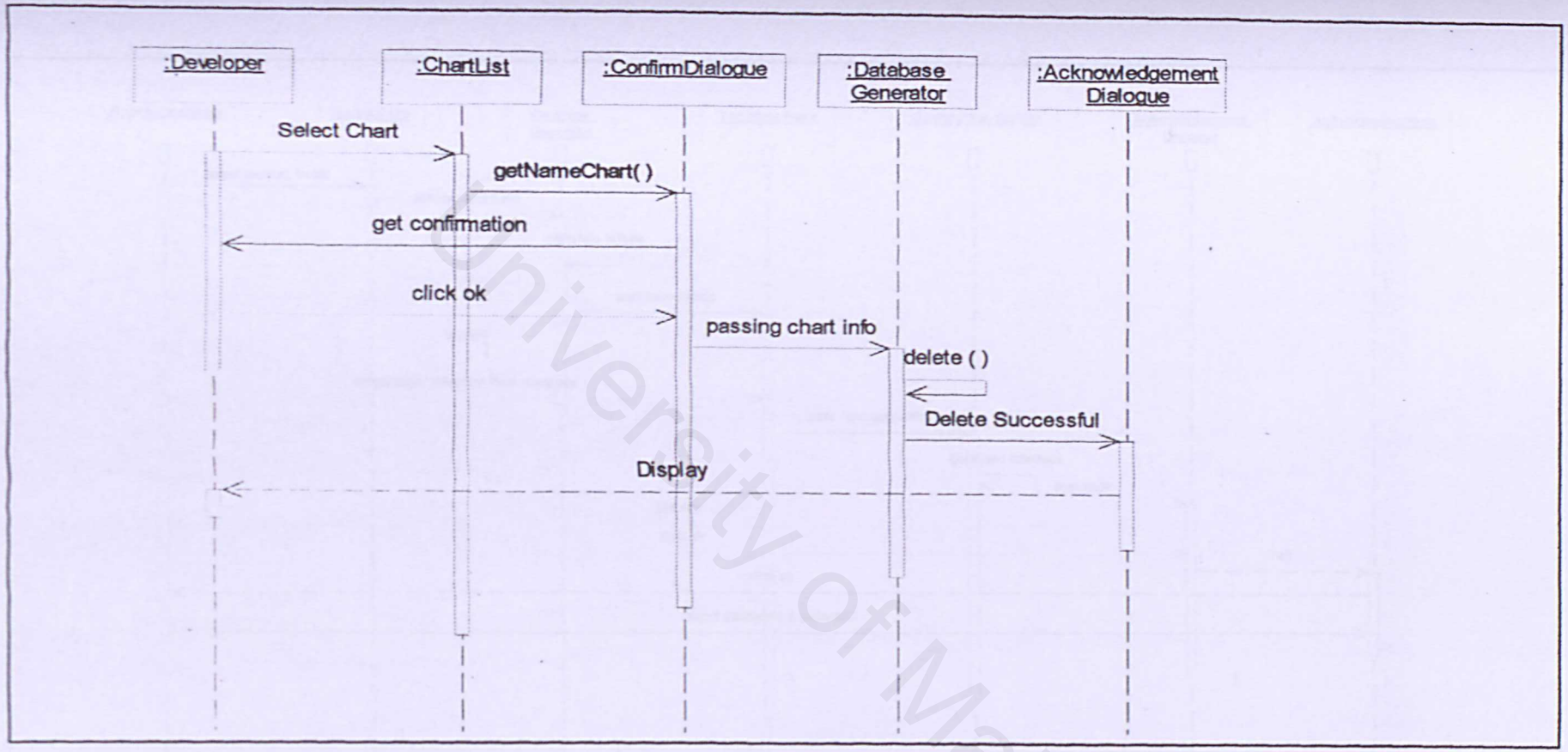


Figure 5.5 Sequence Diagram for Delete Statistical Process Control Chart

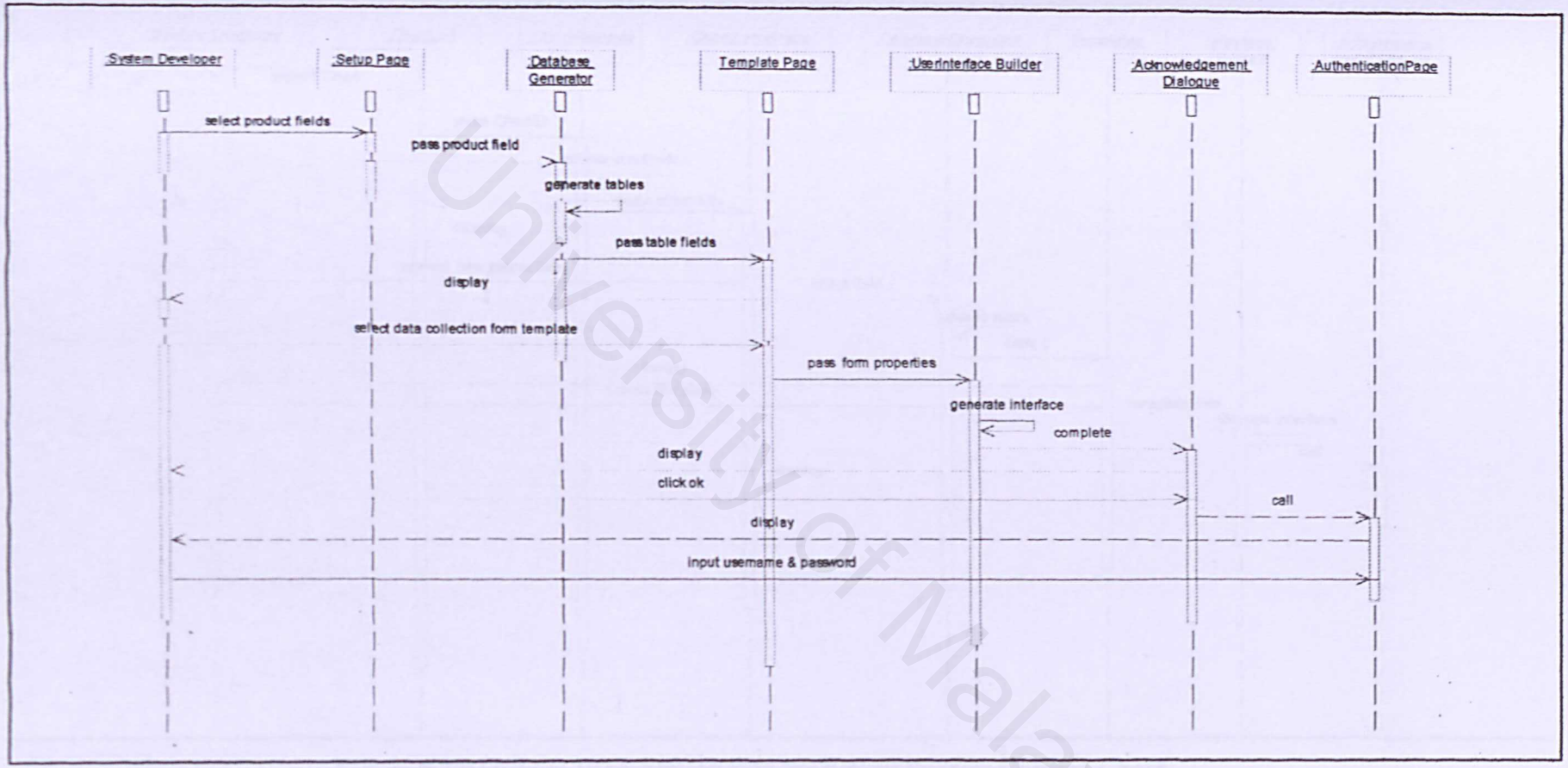


Figure 5.6 Sequence Diagram for Edit Data Collection Form

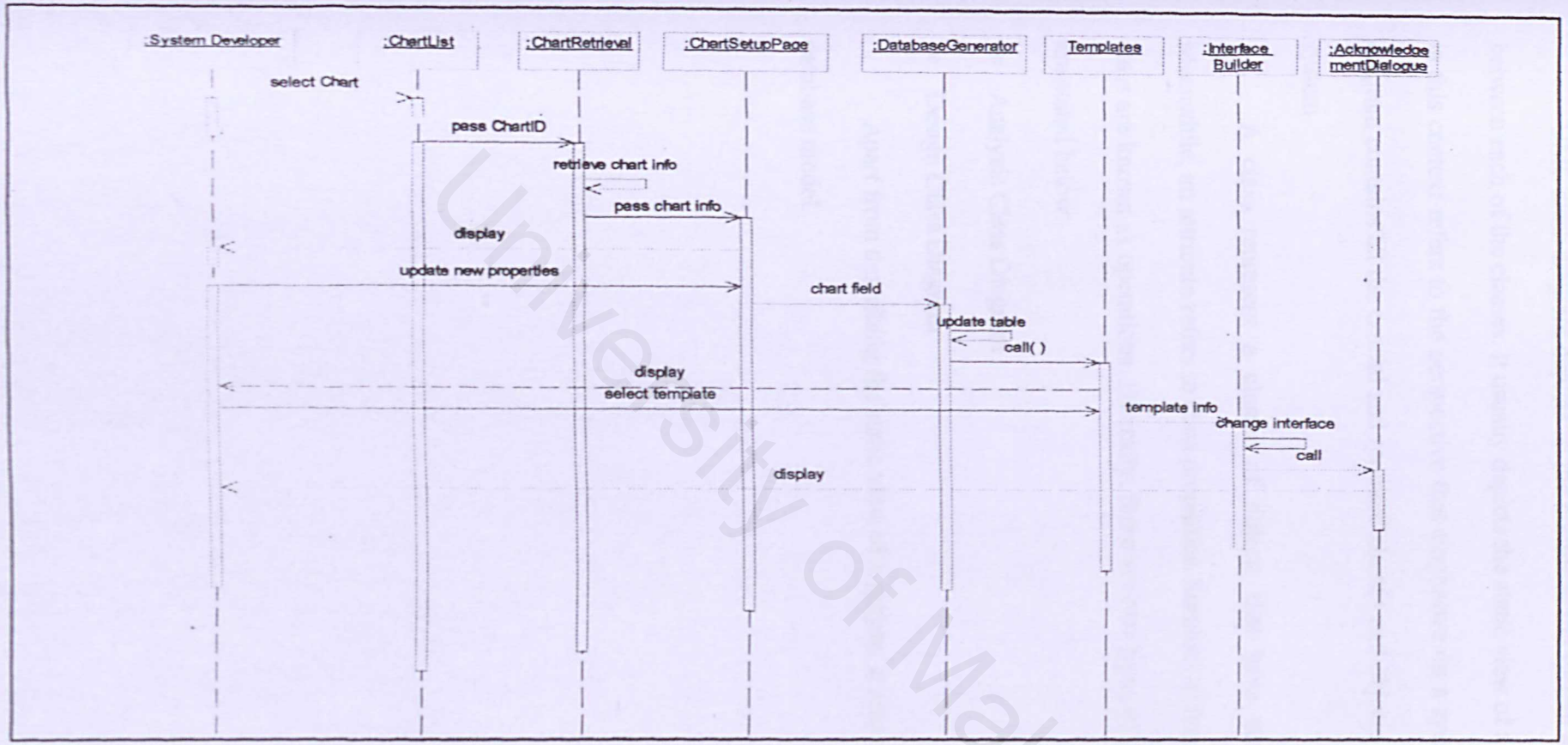


Figure 5.7 Sequence Diagram for Edit Statistical Process Control Chart

5.3 Class Diagram

UML class diagram depicts all the classes in the system and the relationships between each of the classes. It usually depicts the static view of a system. Static view in this context refers to the perspective that emphasize on a system structure. Class diagram contains all the crucial and required classes and objects that involved in the system.

A class represent a cluster of objects that have similar characteristic. Meanwhile, an attribute refers to class properties. Services or functions provided by a class are known as operations. Basically, there are two types of class diagram which are stated below:

- Analysis Class Diagram
- Design Class Diagram

Apart from describing the static view of a system, it also used to serves as the database model.

5.3.1 Class Diagram (Production Module)

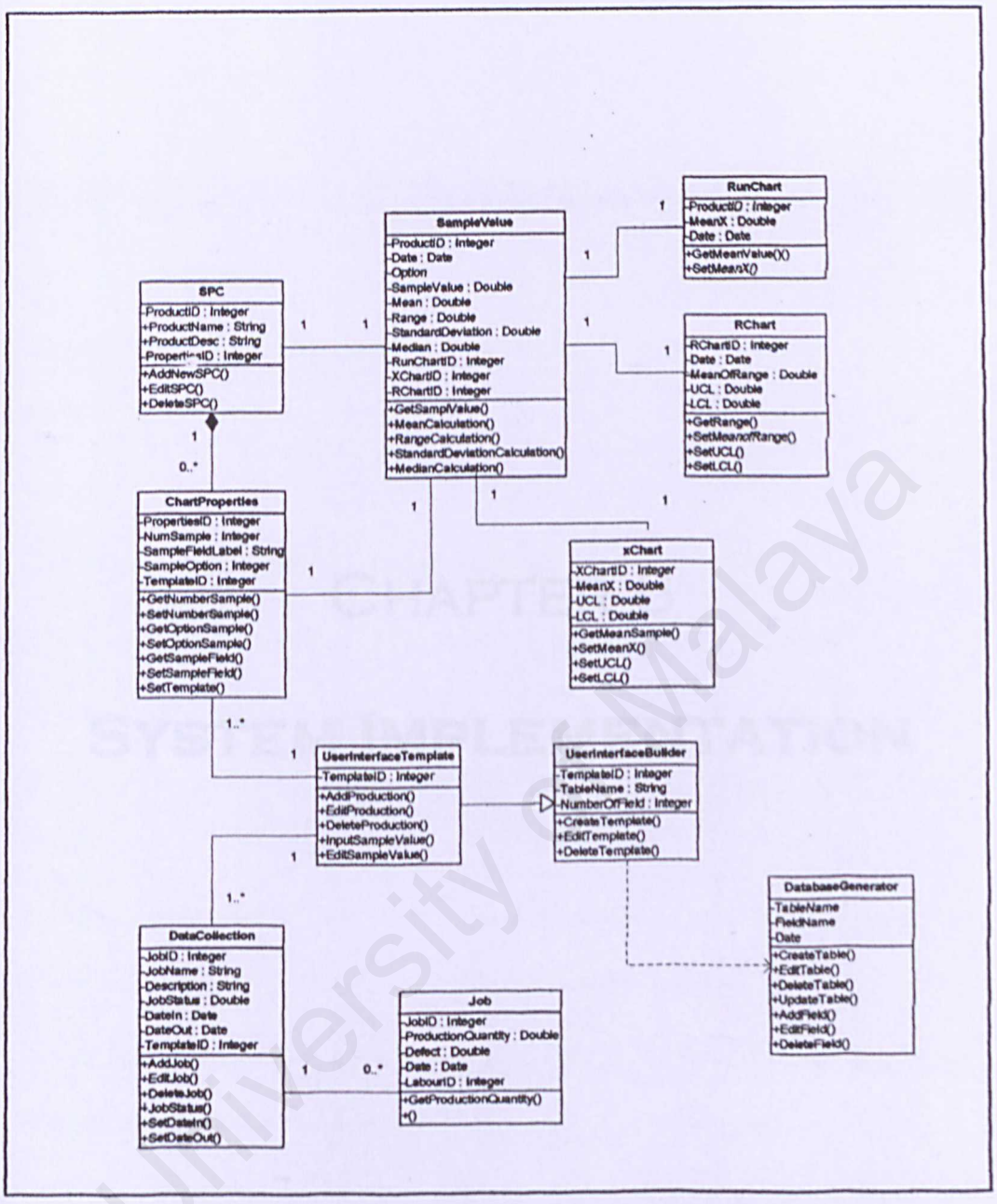


Figure 5.8 Class Diagram for Production Module

Chapter 6

System Implementation

6.0 Introduction

System implementation is a process to convert the system requirements and design into program codes. In this chapter, it describes how Component-Based e-Manufacturing System was constructed and implemented. It also describes development environment, development tools and development strategies were deployed during the development of various modules in the system. This will encompass the methods, and programming coding techniques used in the system construction.

6.1 Overview of System Implementation

The following are the steps taken to construct the e-Manufacturing System:

- Installing development tools such as Microsoft Visual Studio .Net 2003, Microsoft SQL Server 2003 and much more to develop e-Manufacturing System.
- Building components that will be embedded into system such as DBGenarator.dll, InterfaceGenerator.dll, SpcGraph.dll and more.
- Design interface for each form with coding behind. Each of the controls on the form such as button, combo box, list box need to be programmed.
- Test the completed use case or modules. Debug codes if errors are detected by using step-through debugging.
- Integrating the modules, modification and adjustment to the module are necessary if needed.

6.2 Deployment of Development Tools

Microsoft .NET Framework facilitates the development of software with improved reliability, scalability and reliability will be chosen as development environment. .Net framework is an important new component of the Microsoft operating system. It provides a development environment that enable software developers to be more productive.

Table below shows the development tools that are required to develop the system. The system will not function properly if one of the software below is not available.

Software Name	Description
Visual Studio .NET 2003	Integrated Development Environment (IDE)
Microsoft SQL Server 2003	Database Management System

Table 6.1 Software for System Development

6.3 Programming Principle

During the development of the system several principles are applied. This is to ensure and enhance the quality and well proper structure coding. These principles include of the following:

- **Readability**

  Readability plays a vital role when it comes to the future enhancement of the system. Code should be in well structure this includes the indentations for blocks of codes, new line, each block of functions should be associated with comment. This is to ensure programmer able to fully understand the whole system in a niche time when system enhancement is in the event.

- **Maintainability**

  In terms of maintainability, code should be in the way that can be changed without affecting other business functions. For example, connection to database should initialise once the system runs. It will be very hassle if connection has to be initialised at each function that needs to connect to database.

- **Robustness**

  Whether is semantic or syntactic error of coding, the whole system will be grounded. In order to avoid system down, code should be written in the way that able to enhance the system robustness. Error of handling plays a vital role in capturing the errors that might cause the system function inappropriately. For example, a single quotes (‘) of input without replacing it other characters able to terminate SQL statement.

6.4 Coding Methodology

Basically, there are two approaches in coding methodology. Top-Down and Bottom-Up are the approaches. During the development process, these two approaches have been adopted.

Top-Down

This approach starts by looking at the large piece of the system. Subsequently, it moves to smaller parts or subsystems. In this approach, it ensures that the most crucial requirements or modules are developed and evaluated at first.

Bottom-Up

This is contrast to Top-Down approach where it focuses on the smaller parts of the system first and then moves to higher modules. During lower modules development, higher modules act as empty shell that calls these lower level modules.

6.5 Coding Style

6.5.1 Programming Conventions

Programming conventions refer as specified syntax or representation assigned to certain properties or variables before programming takes the course. Thus, it will maintain the program readability and increasing consistency during programming. In nature, programming conventions focus on naming the variables and user interface controls. For example, every textbox control is named with a prefix of 'txt' , combobox control with a prefix of 'cbo', listbox control with a prefix of 'listbox' and much more. On the other hand, programming conventions will also ensure a greater ease during system enhancement phases.

6.5.2 Programming Commenting

Besides well structured program codes are important but comments do play vital role. Although comments do not determine the system operation but it will enhances the readability and provides high maintainability of the whole programming codes. Different types of sign are used to initialise a line of program comment. Comment has to begin with double slash (//) for C++ programming language. In VB.Net, a line of program comment has to begin with sign quote (‘). The program comment I s highlighted in green colour. Below an example of comment that has written in the e-Manufacturing system.

```
'get DeptID for last recordset
```

Figure 6.1 Commenting Statement

6.5.3 Inheritance

Inheritance is a key feature of an Object-Oriented Language. Inheritance refers as the ability to define new classes using existing classes as a basis. New classes are not only able to inherit the attributes but the behaviours of the base classes as well. The main concept of inheritance is to mapping out the complex system into hierarchical structure. It provides great understand of the complex system to software developers. In addition, it provides a framework for software reuse or reusing coding. Figure 6.2 depicts the Vehicle hierarchy in order to give a clear view about inheritance concepts.

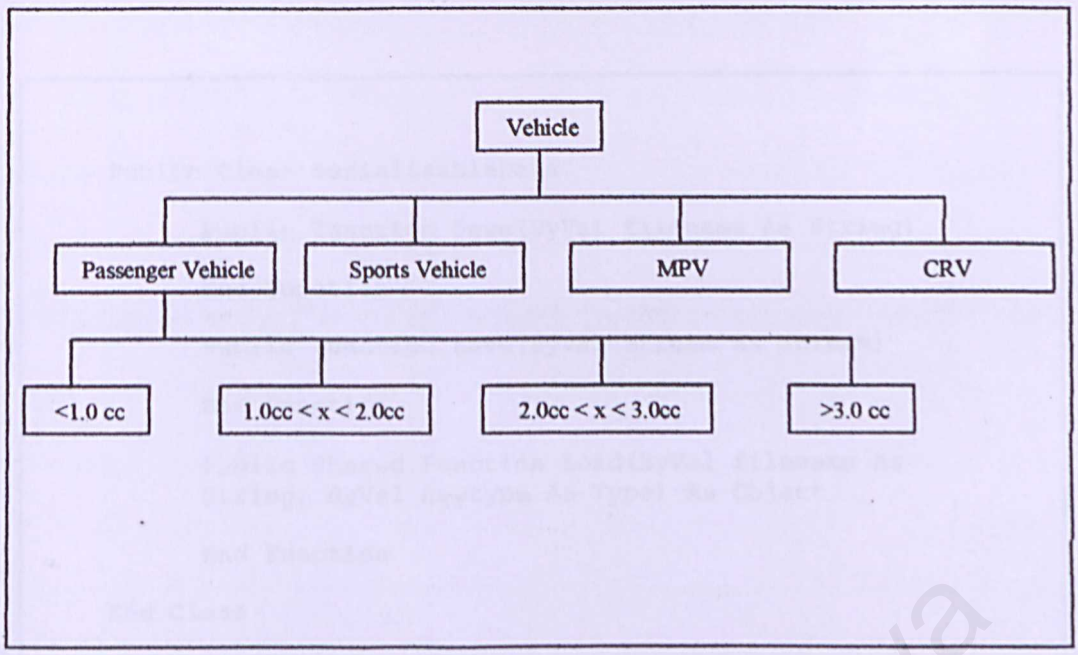


Figure 6.2 Vehicle Hierarchy

Since e-Manufacturing system is so complex, inheritance able to enhance the readability and maintainability the coding of the system. Before inheritance deploy during the construction of the system, the highest abstraction need to be considered first. In other words, inheritance organise the abstractions in a top-down approach. Interface Generator is one of the e-Manufacturing components where inheritance applied. The following coding is the coding for InterfaceGenerator.dll:

```
Public Class SerializableData

        Public Function Save(ByVal filename As String)

        End Function
        Public Function Save(ByVal stream As Stream)

        End Function

        Public Shared Function Load(ByVal filename As
        String, ByVal newtype As Type) As Object

        End Function

    End Class
```

Figure 6.3 SerializableData Class

```
Public Class PropertiesPage
                Inherits SerializableData

    Public Function AddFrmProperties() As FormProper

    End Function

    Public Property PropertiesList() As FormProper()

    End Property

End class
```

Figure 6.4 PropertiesPage Class Inherits SerializableData

6.5.4 Function Overloading

What is function overloading? It refers as create several functions of same name that possess different behaviour. It is important when we need to write function that perform similar tasks but need to on different data types. Like many other programming languages, VB.Net also supports function overloading. Typically, the function overloaded depends on the reference parameters whether is an object, integer, string or others type. Figure below depict an overloaded **Swap** function:

```
'Integer version
Public Sub Swap (byval x As Integer,byval y As Integer)


End Sub

'Double version
Public Sub Swap (byval x As Double,byval y As Double)


End Sub
```

Figure 6.5 Overloaded Swap Function

Function overloading also applied into e-Manufacturing system. For example, SerializableData object contains two overloading functions which are Save and Load function. Save function overloaded into two functions which receive string and stream reference parameter respectively. This is similar to Load function too. Figure 6.6 shows the Save and Load functions are overloaded in SerializableData object.

```
Public Shared Function Load(ByVal filename As
String, ByVal newtype As Type) As Object

    ------ function ------

End Function

Public Shared Function Load(ByVal stream As Stream,
ByVal newtype As Type) As Object

    ------ function ------

End Function

Public Function Save(ByVal filename As String)
    ------ function ------

End Function

Public Function Save(ByVal stream As Stream)
    ------ function ------

End Function
```

Figure 6.6 Overloaded Save and Load Function

6.5.5 Built-in Reference in Visual Basic .Net

One of the appealing features of Visual Studio .Net is provides a rich library of object references. What is an object reference? It refers as a reusable object that performing certain functions such as system.drawing object, system.data object and so on. In order to use object references, it needs to be imported to the project. Some of built-in references are added into e-Manufacturing system such as system.data, system.drawing, system.io and more. Certain object references have to be developed to deal operations of database, interface generator, SPC graph and others. Similar to built-in references that need to be added to the project before the object references were used. Below are the steps to build an object reference call MeanCalculation and how it is deploy.

- Create a class name as MeanCalculation and save the file name as Calculation

```
Public Class MeanCalculation

Public Function Mean(ByVal value() As Double) as
Double

End Function


End class
```

- Debug and build the class into .dll file.
- Add the MeanCalculation object reference into desire project .
- Deploy the object reference into project by calling the class.

```
Dim MC As New Calculation.MeanCalculation

Public Sub GetValue()
      Dim Value(1) As Double,Result As Double

      Value(0) = 2
      Value(1) = 5

      Result = MC.Mean(Value)

' Result = 3.5

End Sub
```

6.5.6 Interactions between Functions / Subroutines

Normally, a complex task or operation cannot be carried in a single function. It needs to be done through a sequence of functions or subroutines. In that case, interactions between functions or subroutines are important. Function is refers as a block code that process input and return an output to the callee. However, subroutines do not return any output. In e-Manufacturing system, a lot of functions and subroutines were implemented. Figure 6.7 shows the ValidateCheck( ) function

that has been implemented in the system. It checks whether there are any redundant field name specify the user. False flag will be raised when field name redundancy occurred and likewise for the True flag. Typically, function does not only return boolean type, it also returns other types than boolean such as integer, string, object, double, and so on. Below are certain functions and subroutines that implemented in e-Manufacturing system.

```
'check any redundant field being added
 Public Function ValidateCheck() As Boolean
   Dim found As Boolean = False
   Dim i As Integer

 If ListDepartment.Items.Count <> 0 Then
    For i = 0 To array.GetLength(0) - 1
       If String.Compare(array(i, 1).ToLower,
             (TxtDepartment.Text).ToLower) = 0 Then
                found = True
        End If
          Next
 End If

    Return found
 End Function
```

Figure 6.7 ValidateCheck Function

6.5.7 Coding for Connection to Database

Based on the figure 6.3.6.1, it shows the coding to create connection between the system and database. Basically, there is a function call CreateConnection provided by component DatabaseGenerator. The purpose of the function is to connect the system to the desired database. The function require four references or parameters; Server Name, Table Name, UID, and Password. Typically, these four parameters are essential elements to bridge the system to database. In e-

Manufacturing system, it involves 3 elements to connect the system to database. Function for each element is shown in the table 6.2

Elements	Functions
SerializableConn	▪ Module that contains XML serializer.
ConnProper	▪ Module that contains four global variables such as ServerConn, DBconnection, UIDConn, and DBPassword
CreateConnection	▪ Create database connection

Table 6.2 Database Connection Elements

The purpose of XML serializer is to read any values from the xml file. After loading the XML file, the values will be used to create database connection.

```
Dim conn As ConnProper = SerializableConn.Load(tempfilename,
GetType(ConnProper))

            ServerConn = conn.ServerConn
            DBconnection = conn.DBconnection
            UIDConn = conn.UIDConn
            DBPassword = conn.DBPassword

DB.CreateConnection(ServerConn, DBconnection,
UIDConn,DBPassword)
```

Figure 6.8 Database Connection Coding

6.5.8 Coding for Retrieve Data

```
    Dim DR As System.Data.SqlClient.SqlDataReader
    Dim myDataAdapter As New SqlDataAdapter
    Dim myDataSet As DataSet = New DataSet

    Dim ArrayCount As Integer, count As Integer, temp As Integer
    Dim strSQL As String

        strSQL = "SELECT * FROM TblDepartment"
        myDataAdapter = DB.ExtractData1(strSQL)
        myDataAdapter.Fill(myDataSet, "TblDepartment")
        myDV = New DataView(myDataSet.Tables("TblDepartment"))
        If myDV.Count > 1 Then
            ArrayCount = myDV.Count - 1
```

```
        Else
            ArrayCount = 0
        End If

        myDataSet = Nothing

        DR = myDataAdapter.SelectCommand.ExecuteReader

        ReDim array(ArrayCount, 1)

        count = 0
        Do While DR.Read
            array(count, 0) = DR.Item(0)
            array(count, 1) = DR.Item(1)
            count += 1
        Loop


        DR.Close()
        myDataSet.Clear()
        myDV = Nothing
        myDataAdapter = Nothing
```

Figure 6.9 Coding for Retrieving Data

6.5.9 Coding for Insert New Data Record

```
Dim strSql As String, temp(1) As String, i As Integer

strSql = "INSERT INTO TblDepartment
        (DepartmentID,DepartmentName) VALUES (@0,@1)"

temp(0) = LastDeptID
temp(1) = Trim(TxtDepartment.Text)

DB.UpdateDataSQL(strSql, temp)
```

Figure 6.10 Coding for Insert New Data Record

6.5.10 Coding for Updating Data Record

```
Dim List(1) As String
Dim str As String = "UPDATE SpcList SET LayoutID = @0 WHERE
StatisticalID = @1"

    List(0) = Layout
    List(1) = a.SPCID.ToString
```

```
DB.UpdateDataSQL(str, List)
```

Figure 6.11 Coding for Update Data Record

6.5.11 Coding for Deleting Data Record

```
For i = 0 To ListDelete.GetLength(0) - 1
                        'Delete Graph Properties

sql = "DELETE FROM SpcGraph Where StatisticalID = " & "'" &
ListDelete(i, 0) & "'"

DB.DeleteDataBySql(sql)

Next
```

Figure 6.12 Coding for Deleting Data Record

6.5.12 Error Handling

In nature, error-handling code varies among programming languages.However, all of them have the similar notion that is catch all types of exceptions or unpredictive errors. This will make the programs more robust by reducing or handle errors occur in the program. According to most of the programming books, exception handling is designed for dealing with *synchronous errors* but not *asynchronous errors.* An attempt to divide by zero during execution of program is considered as synchronous error. *Asynchronous errors* such as I/O completions, network message arrivals, keystrokes and so on.

In VB.Net, *On Error Statement* and *Try..Catch..Finally* are two types of Error-Handling being introduced. However, only *Try..Catch..Finally* is depolyed in production module e-Manufacturing system. Code that might have higher possibility to generate an exception will be enclosed in Try block. In catch block, it enclosed appropriate handlers that deal all the exceptions that have been thrown from the Try

block. Figure below shows the coding of Try..Catch..Finally that is deployed in the e-Manufacturing system.

```
Try
   DB.InsertDataBySql(str)

Catch ex As Exception
   MessageBox.Show(ex.Message)

Finally

   Call QuitFunction()

End Try
```

Figure 6.13 Try..Catch..Finally blocks

Chapter 7

System Integration

&

Testing

7.0 System Testing

This chapter describes techniques that are deployed to evaluate the system in and to verify the system is bug-free. Besides identifying faults, it also ensures the system that able to fulfil system requirements. System testing is divided into several parts; unit testing, module testing, and system testing. Unit testing is the lowest system testing.

7.1 Unit Testing

In this testing phase, test will be conducted against each individual functions, subroutines, classes, blocks and service packages. This is to ensure it is error-free and deliver its appropriate function or result. The main objectives to conduct unit testing is to pinpoint two common errors; algorithmic & computational and syntax errors. These errors are capable to cripple the system in whole if they are undetected.

Traditionally a unit test consists of structural testing (white-box testing) and specification testing (black-box testing). Structural testing or white-box testing means that the structure of the unit is known and the testing is designed according to the unit's structure. As for black-box testing is the opposite where the testing is based on the specification of the externally visible behaviour of the unit.

7.1.2 Algorithmic & Computational Error

Algorithmic & Computational errors are errors that are caused by wrong processing steps in a function or subroutines. Inappropriate branch diversion in control structures refers as Algorithmic Error. Conditional Structures such as 'If..Else..Then' statement, 'Select' structures, "While' repetition structures, and much more are considered as control structures. Figure below illustrates

inappropriate branch diversion in control structures with codes. Based on the following codes below, supposingly when Validate function returns True value system should save the input. However, this is not the case for the codes below.

```
'Incorrect branch diversion
    IF Validate(input) = True Then
      MsgBox("Invalid Input!",MsgBoxStyle.Critical ,"Error")
    ELSE

      Call SaveIntoDB()
    END IF
```

Figure 7.1 Incorrect Branch of Diversion

This error not only confine to 'If..Else..' structure but it might occur in any other conditional structures. An algorithmic error able to obstructs the system from delivering desirable output.

An attempt to divide by zero is categorised as computational error. This error might totally cease down system's operation. Besides that, an array with index out of bound is considered also as computational error. Array with index out of bound means system requires data from an array element that is not defined in prior. Figure below illustrates an array with index out of bound.

```
    Dim count As Integer, result As Integer
    ReDim Array(5)

    For count = 0 To Array.Length - 1
    'When count = 5 system requires 7th elemen from Array
        Result + = Array(count + 1)
    Next
```

Figure 7.2 Array with Index Out-of-Bound

Below are some of the causes to algorithmic & computational error:

- Unintentional error of branch diversion.
- Miscalculating number of loops.
- Miscalculating number of elements of an array that can hold, therefore overflow problem takes place.
- Computational algorithm itself is wrong.

Below are steps taken to reveal algorithmic and computational errors:

- A variety of data combinations are input into the system and evaluate the output.
- Test every branch condition in conditional structures such as if..else and select structures.
- For loop structures such as For Loop and While Loop, number of loops will be counted and compare to the one that specified in the coding.
- Comparing manually calculation result with the actual program output.

7.1.3 Syntax Error

By using .Net framework as development environment, syntax errors usually would not occur. When syntax errors occur in a program, compiler will prompt user when compiling the program. Besides that, syntax will be corrected automatically in the sense of upper and lower case. However there are certain syntax errors that are unable to detect by IDE. SQL statement syntax error is one of the syntax errors that cannot be detected. In program codes, the SQL statement will be accept by the compiler as a normal string data type. The compiler will accept whatever SQL statement and pass it to DBMS. Error would occur if the accepted SQL statement was wrong.

Here are some of the steps taken to ensure system free of syntax errors:

- Using try..catch..finally block to determine correct SQL statement send into the system.
- Checking the output of the system by using the intermediate window. This window was provided by Visual Studio.NET IDE where it allows users to check the values of a variable. A line of statement precedent with a question mark "?" followed by variable name type into the window. Result will be produced by the system.

7.2 Module Testing

A module consists of a collection of dependent components inter-related with each other to perform a particular function. Different test cases were designed and applied to a specify module. Test results will be used to verify the module. Unexpected test results will be used to initialise debugging process to a certain module. Besides that in this testing, it also evaluates the connectivity between components.

Here are some of the modules testing:

- Login Module
  - » A valid user with be login into system. System will verify the user and valid users are allowed to access into system.
  - » Invalid username and password, system will prompt user a message to notify user.
  - » Different toolbar or menu bar will present when different type of user access into system.
  - » System administrator is able to add new, delete, and edit system user.

- Database Connectivity Module
  - » Test whether application layer able to establish connection to a specify data center.
  - » Alert message will be prompted to user when system failed to establish any connection.
  - » Test whether connection properties are save into connection.xml file.
  - » Connection box will be prompted if the system failed to establish connection until user drop the system.

7.3 Integration Testing

As we know that a system is two or more interrelated modules that interact to achieve a goal. Integration testing can only be done after module testing is performed. After all modules have been verified, then all modules should be integrated and work as a system. Testing should take place after modules integration. Although all units and modules have been tested at prior but new errors will be found. The combination of modules will increase the number of possible paths exponentially. Since e-Manufacturing is comprises of four main modules, integration between these modules might produces unaccountable errors. One of the common integration errors is when a input is passed into the function that mismatch with the data type specified in the parameter of the callee function. Therefore, integration testing is an approach to discover errors associated with interfacing of different components and modules that have embedded in e-Manufacturing system.

Below are some of the elements that are evaluated during integration testing:

- Compatibility between the specified parameters type of certain functions and the inputs that received.

- Compatibility between the number of parameters of a functions and the number of inputs received.

7.4 System Testing

In this testing, the whole system will be validated. The main focus of this level testing is to ensure that the system fulfil all the functional and non-functional requirements of e-Manufacturing system that have been specified in Chapter 4. System testing not only testing the coding or program, it also includes the entire environment of the system as well such as database, hardware, and computer system.

There are several types of system testing that can be used to test a software system. However, six types of testing are performed on the e-Manufacturing system. Below are the six types of testing that have taken:

- **Regression Testing**

  This testing implemented when some small changes have made in the system. For example rectifying error, and the main purpose of this testing is to ensure the old functionality remains. This testing is important although it is time consuming. Automate the testing is the best solution to avoid time consuming.

- **Security Testing**

  Security testing is concerns about the evaluation of the security mechanism that embedded in e-Manufacturing system. It is to determine how well the security mechanism deals with improper penetration or unauthorised accessibility. Although, user verification mechanism is the only security control that deployed in the e-Manufacturing system. However, testing should be conducted on login module so that any possible penetration can be detected.

- **Performance Test or Capacity Test**

  The main purpose to conduct this testing is to measure the processing ability of the system. This testing is designed so that the performance with different loads can be measured. With this testing, we are able to measure CPU utilisation and perhaps speed of certain use case. For example this testing is applied to e-Manufacturing system where the production report loading time, time to generalize SPC graph and so on are tested.

- **Ergonomic Test**

  This testing is important for system that mean for non-computer professionals. Ergonomic aspects should be tested such as:

  » Menus logical and readability. Different level of user might have the different types of menu.

  » System message visibility.

  » User's level of understanding towards the failure message.

  » The consistency of menus position.

- **Function Testing**

  Test should be carried out based on the system functional requirements. This is to check whether the function that provided by the system executed in a proper manner. For example, to check how well SPC graph plotter produces a line graph after samples have being input into system.

- **Overload Test**

  The main purpose of this testing is to see how the system behaves when system is overloaded. The system should be able survive during the loading is peaks. For example create 50 data sample during setup a SPC graph.

7.5 Debugging

Debugging refers as an action to locate and find errors in a system program. It is easy to perform debugging in Visual Basic .NET compared to other programming language. In Visual Studio .NET 2003 (IDE), it provides a features call step through debugging. Developer is able to see the sequence of statement executed by using this debugging feature.

What is more appealing with this feature is that developer able to check the value that a particular variable bearing during execution. The IDE itself provides an intermediate window for developer to insert command. The command to check the value of all the variables at the point of execution is the variable with a '?' prefix. For example, to check the value of the variable name as NumID, the command will be '?NumID'. Subsequently the result will be shown at the following line.

CHAPTER 8

SYSTEM EVALUATION

8.0 Introduction

In this phase, system evaluation will be implemented. System evaluation is important because it serves as the objective for system enhancement in near future. Each of the system has its strengths and weakness. This is similar to my project e-Manufacturing system.

8.1 Problems Encountered During System Development

The following are the problems that I entangled during the development phase.

- **Not Familiar with Manufacturing system**

  At the beginning of this project, I'm totally lacked of knowledge of manufacturing system. Besides that, I'm facing difficulties to gather manufacturing core business or information. However, I could gain a lot of information from other resources such as books and internet resources.

- **Inexperience with Programming Language (Development Tools)**

  Visual Basic .NET is a new programming language for me. I have never used this programming language to build any stand-alone application before. However, Visual Basic .NET provides user-friendly features that help me to learn this programming language at a greater pace.

8.2 Strength

- **Framework supports reusable approach**

  This framework is supports by various components such as DBGenerator, InterfaceGenerator, SpcArray and so forth. Apart from that, the framework is not a

dedicated system for a particular type of manufacturer. The framework is designed in such way that it is capable to operate at the different type of manufacturers. Components in the framework can be recalled when the system requires them to perform a particular task.

- **Extensibility**

The framework can be extended by incorporating new components. As we have known that component is a replaceable stand-alone service provider. It can be unplugged if the system no longer requires a particular component's services.

- **Security**

Authentication module is one of the security features that the system provides. It prevents any unauthorised users to access into system. Apart from that, it also segregates system user into distinct of levels. Only system administrators have the full authorisation to handle to customise the whole framework. As for lower level system users, they are only allowed to perform certain tasks other than customising the whole application.

- **Robustness**

System is designed where it validates all the input data before processing task begins. This is to ensure that the correct type of data is sent to process rather than inappropriate type of data crashing the whole system. Besides that, exception handling was implemented in e-Manufacturing system. Any errors that will cause the system malfunction will be captured and thrown out. This strategy is deployed to ensure the system able to function properly even though minor error occurred in the system.

- **Generate SPC graph with .NET Control**

  System able to generate SPC graph without using any third-party graph builder tools. One of the components that provided by IDE (Visual Studio.Net) called 'Drawing' is capable to draw a graph.

- **User-Friendly system**

  The system interface is designed in such a way that is user-friendly and arranged logically. Apart from that, system provides wizard to guide user to setup a particular module.

8.3 Weakness

- **Lack of Security for XML file**

  Basically, the XML file is to store some of the system properties such as database connection properties. However, this file is kept in unguarded folder call connection. In this case, this file is easily to open and read by any authorised users. Any improper modification to this file will send the system into disaster state.

- **System can be deployed only with the existence of .NET framework**

  Since this framework is build with the underpinning .NET framework, this system is able to run with the existence of .NET framework. Advance computer peripherals and software is required in order to meet the minimum requirement for .NET framework.

- **Lack of flexibility**

  Most of the interface design is fixed and the system allows a little room for system user to design. Fixed interface templates are provided for system users to choose. On the other hand, system also does not provide any flexibility for user to design the report according to their preferences.

- **Form only supports text box controls**

  Each of the field created by system users is unable to convert to other control types such as combo box, radio button, check button, and so forth. For example, system user unable to set the DateTime field as a DatePicker controls. Inability to provide multiple controls for user to choose will cause the form looks uninspiring.

8.4 Future Enhancements

- **Enhance security measures on important files**

  Important files should keep in Database Management System (DBMS). Thus, those files will be protected by database security. For example, all the XML file that generated by e-Manufacturing system will be stored into SQL Server. This is to ensure those files are safeguard from being accessed by unauthorised users.

- **Provide more flexibility to user**

  System should provide two options for user to choose during form building. It is either form generated according template or user design. System administrator should able to monitor control's properties. Besides that, system administrator should able to design the report according their preferences.

- **Provide more controls during form designing**

  System should provide toolbox for users to drag-out their desire control during form building.

Conclusion

Conclusion

Generally, the project has achieved and fulfilled most of the objectives and requirements of the system. The main focus of this project is to develop a framework to build a component-based e-Manufacturing. Besides that, it is capable to support reusable approach. This framework comprises of four main modules such as Sales, MRP, Production, and Material Management. As for system user, this framework is divided into higher level user (system administrator) and lower level user (system end-user). Although this project is very huge in terms of scope, it nevertheless achieved a successful development which is the stepping stone towards the future development of the system.

During the literature review, a lot of knowledge about latest and the advancement of technologies have been acquired that couldn't be gained in studies.

Throughout the project development, complexity of system and the unforeseen problems have arose. However, the problems have been solved in systematically without affecting the system development process. It is believed that the experience of problem solving would be useful for future undertaking or endeavors.

A lot experience and knowledge about programming skills were gained during system development. This a valuable experience and helpful in future effort to developing a component-based system.

Apart from that, this project provides an opportunity to apply good practice or software engineering techniques which have been learn previously. Finally, it is believed that the e-Manufacturing system has a great potential to become hot-demand system if a series of further enhancement is taken.

User Manual

User Manual

User manual is reference to guide user to execute a system. It starts from system installation until running the system. In this user manual, it is divided into few parts that are stated as below:

- **System Installation**
- **RDBMS Installation**
- **Database Connection**
- **System User Module**
  - Create new user
  - Update System End-User
  - Delete System User
  - Edit System Administrator
- **Create SPC Module**
  - Create SPC info table
  - Create SPC chart
- **Edit SPC Module**
  - Edit SPC info
  - Edit SPC chart
- **Delete SPC Module**
- **Create Production Module**
- **Using SPC Module**
- **Using Production Module**

System Installation

Before system installation begins, computer requirements are need to be checked first. E-Manufacturing only can run under certain requirements and were stated below:

Hardware Requirements	
Processor	Intel Pentium II, 450MHZ (minimum) or higher
Memory	128MB or higher
Hard Disk Capacity	8GB (minimum)
Monitor	VGA or higher resolution
Pointing Devices or Keyboard	Required

Software Requirements	
Operating System	Microsoft Windows 2000 or higher Microsoft XP (recommended)
Programming Tool	Visual Studio .NET 2000 or higher version
RDMS	Microsoft SQL Server 2000

The following steps to install e-Manufacturing system into desktop after software and hardware requirements are met. System install will be very simple, just follow the setup wizard as it provided to you.

- Insert the e-Manufac CD into your CD-ROM
- Browse the CD then find the 'Setup.exe' file which is located at the Debug folder.
- Execute the setup file and wizard will guide you throughout the installation process.

Relational Database Management System Installation

Microsoft SQL Server 2000 is the relational database management system that used as e-Manufacturing system database. Hardware and software requirements are based on the SQL Server 2000 basic requirements.

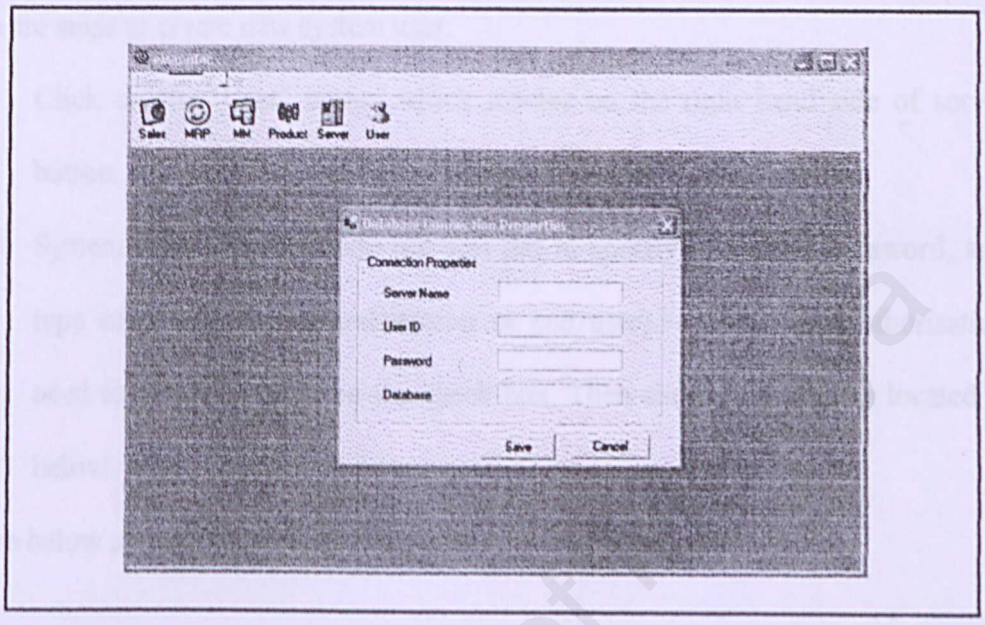
Notes: Please make sure that Microsoft SQL Server 2000 has been installed into desktop.

Steps to setup database for the e-Manufacturing system

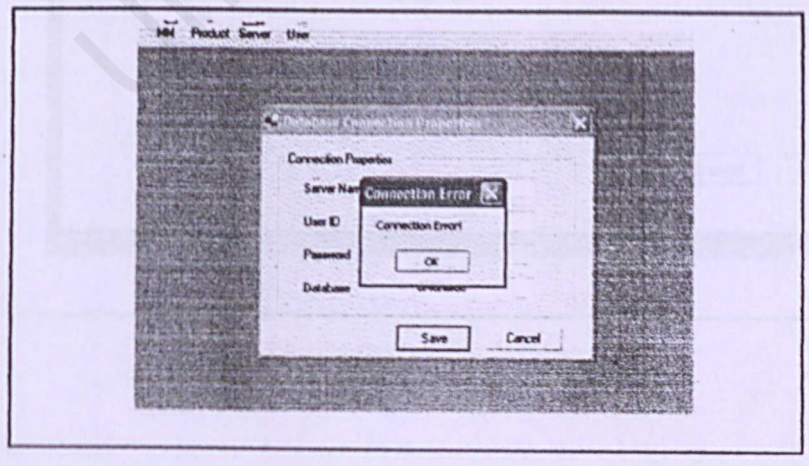
1. Please open Enterprise Manager in the program menu.
2. Create a new database in Enterprise Manager. The name for the database is free for user to choose. Please try "eManufac" if you don't have any idea.
3. Then, create a new login if you wish to or you can use back the default login that you have setup during the database installation.
4. Restore the new database with the source that provided from the e-Manufac CD.
5. Right click on the database and then mouse over 'All Tasks..' menu. Next choose 'Restore Database..'
6. Restore Database prompt will pop-up and then select the 'from device' option. Next click on 'Select Devices..' button and then click 'Add' button.
7. Select the path for the file name. The path should map to the folder called Database in e-Manufac CD.
8. Press 'Ok' until it is back to the first prompt then select 'Option' tab.
9. Check the option 'Force restore over existing database'
10. Press 'Ok' button at the bottom.
11. Finally, messagebox will appear to notify user that the database has been restored.

Database Connection

Most of the systems are associated with database or data centre in order to save crucial business information. In e-Manufacturing system, a prompt will request user to specify the data centre properties such as server name, database name, uid, and password if the system runs at the very first time.



After user has specified the data centre properties, system will test the connection whether is a valid or invalid connection. If invalid connection occurred, system will send out message to notify user. Again a prompt will send out to request user to insert valid data centre connection properties as shown below.



System User Module

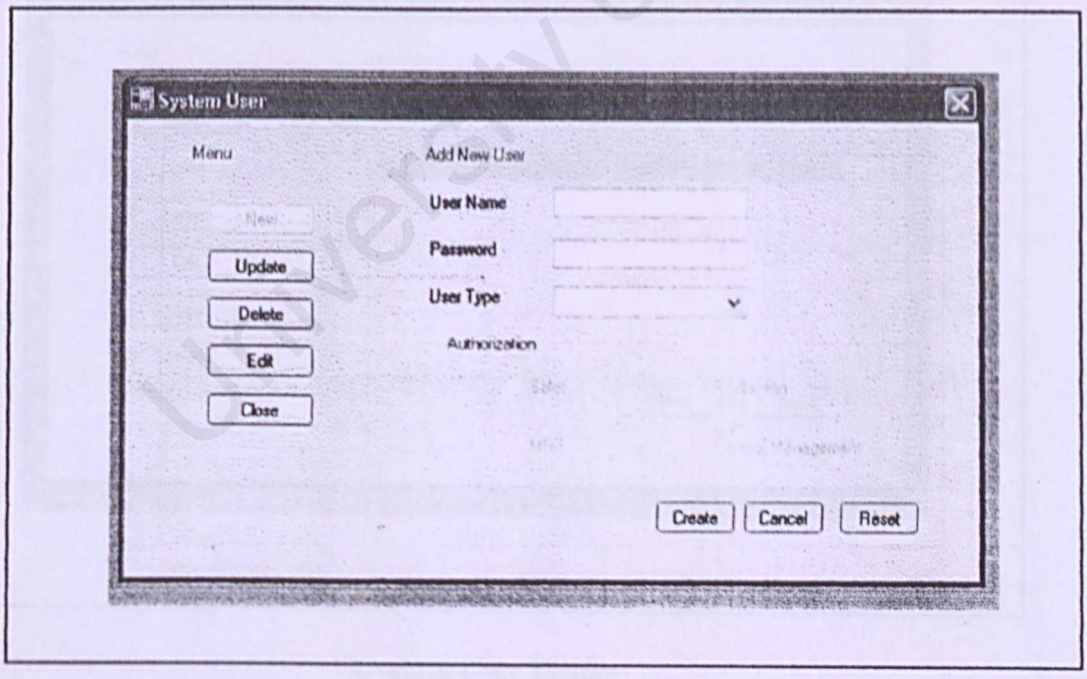
- **Create System User**

After connection between e-Manufacturing system and data centre has been established, system user has to be created. System user is divided into system administrator and system end-user such as Production user, MRP user and so on.

Here are steps to create new system user.

1. Click on the 'User' button which resides on the right hand side of server button.
2. System User form will pop up, user has to specify username, password, and type of system user (administrator or end user).For end user, authorisation need to be set by click on the check box. Then click create button located at below.

Figure below shows the System User form



System User Form

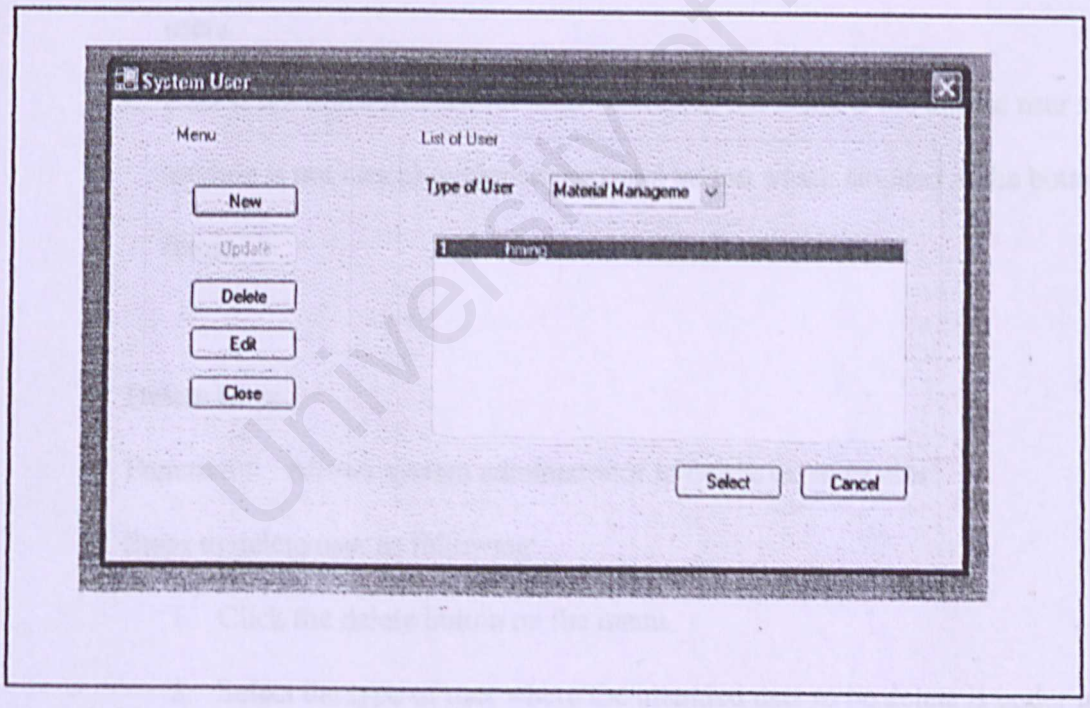
⌖ Update System End-User

Function : Change system end-user's preference such as username, password, type of user, and authority.

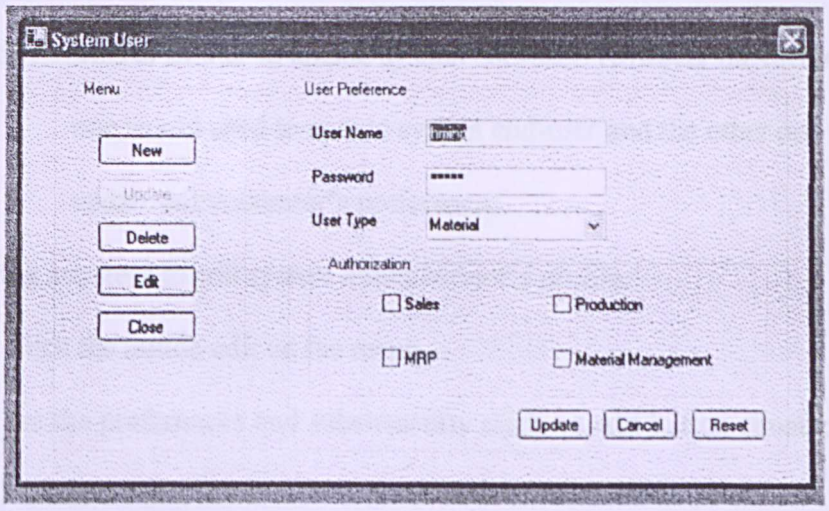
Steps to update user's preference as following

1. Click at Update button on the system user frame.
2. Select the type of user where the intended user to be changed is under in.
3. Highlight the user name that listed out on the list box then click select button.
4. Finally, update the selected user preferences and click update button located at below.

The following show the update user frames.



Update User Frame



Update User Frame

Notes:

1. This update function is applicable to system end user.
2. User name can be altered if the user name is not used by any other existing users.
3. User is not allow to click on other buttons at the menu if the update user sub-module is not cancel out by click cancel button which situated at the bottom frame.

- **Delete User**

Function : Allows system administrator to delete existing user.

Steps to delete user as following:

1. Click the delete button on the menu.
2. Select the type of user where the intended user to be delete is under in.
3. Highlight the user to be deleted then click delete button at the bottom.

⌖ Edit System Administrator

Function : This is similar to update system end-user. However the difference is one would used to update system end-user and the other one used to update administrator's preference.

Following are steps to edit system administrator's profile.

1. Click the button edit on the menu.
2. Set the preferences and subsequently click on edit button situated at the bottom.
3. Click Ok button which is next to edit button to back main frame.

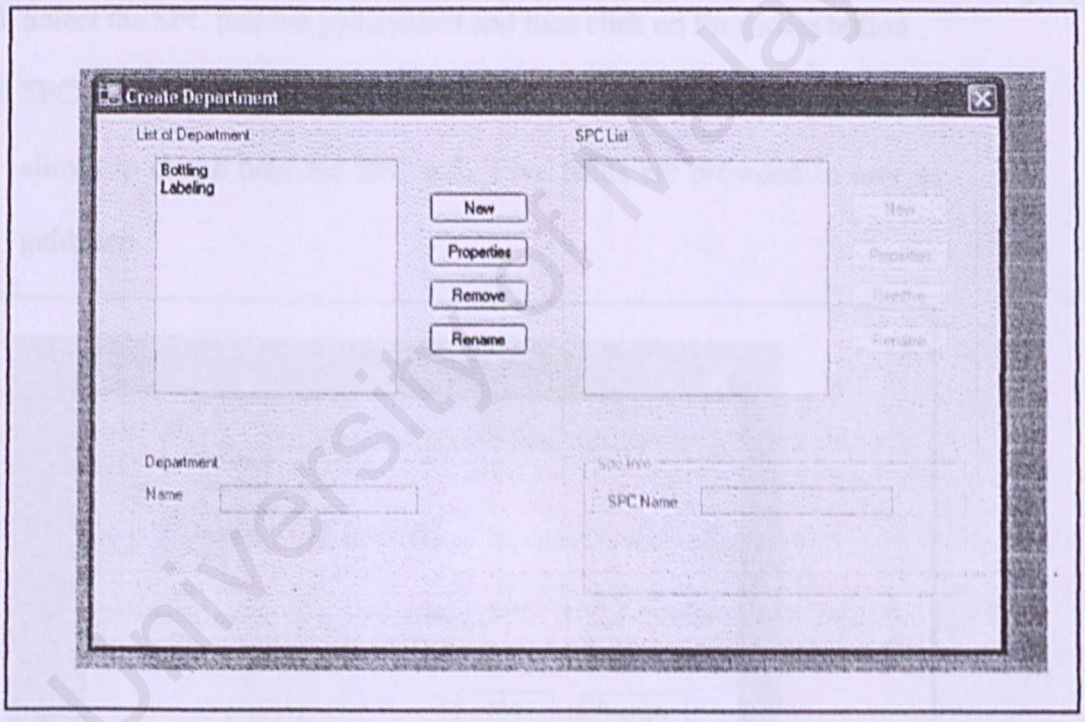
Create SPC Module

⌖ Create SPC info

Function : Create SPC info form keep record about certain SPC chart for a particular product.

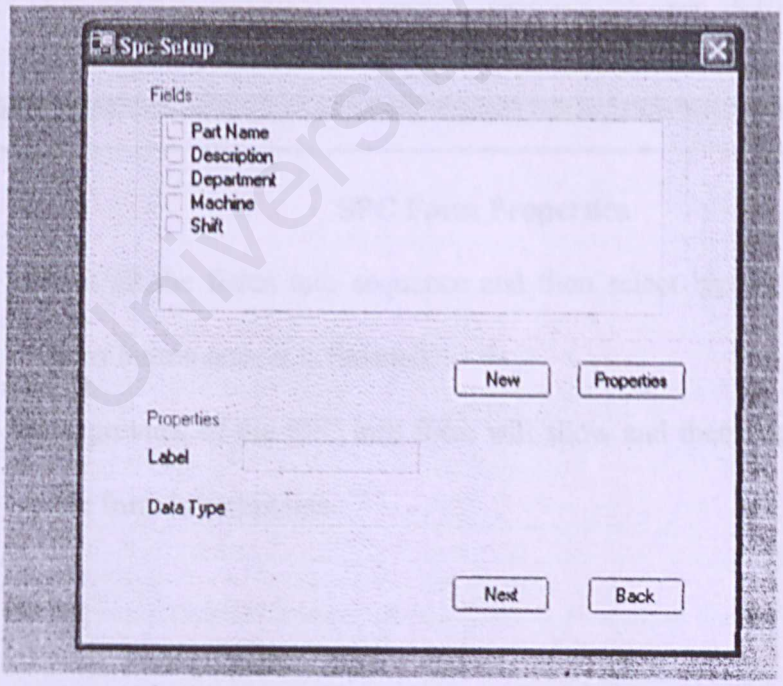
Following are steps to create new SPC info:

1. Click the button Product which located on the toolbar above.
2. New toolbar will appear which consists of four buttons and they are Add SPC, Graph Setup, S F(Shop Floor) Setup and Exit.
3. Click on Add SPC button and create department form will appear at the centre of the screen.



4. Before create any SPC chart for a particular product, department need to be created first.
5. To create a department, click on new button. Subsequently, enter the department name at the textbox below then click add button next to it.

6. System administrator is allows to rename the department and remove a department.
7. After a department has been created, highlight the department name and click properties button. SPC list on the right hand side will list out all the SPC that have been created under the selected department.
8. On the SPC list, system administrator able to create, rename, and delete a particular SPC for a product.
9. Create a new SPC for a particular product is similar to create a department. Click new button and enter SPC name at the textbox below then click add.
10. Select the SPC that has just created and then click on Properties button.
11. SPC Setup form will appear at the centre screen. In this form, user is allows to create field for SPC info. Five fields are provided to user as guidance.



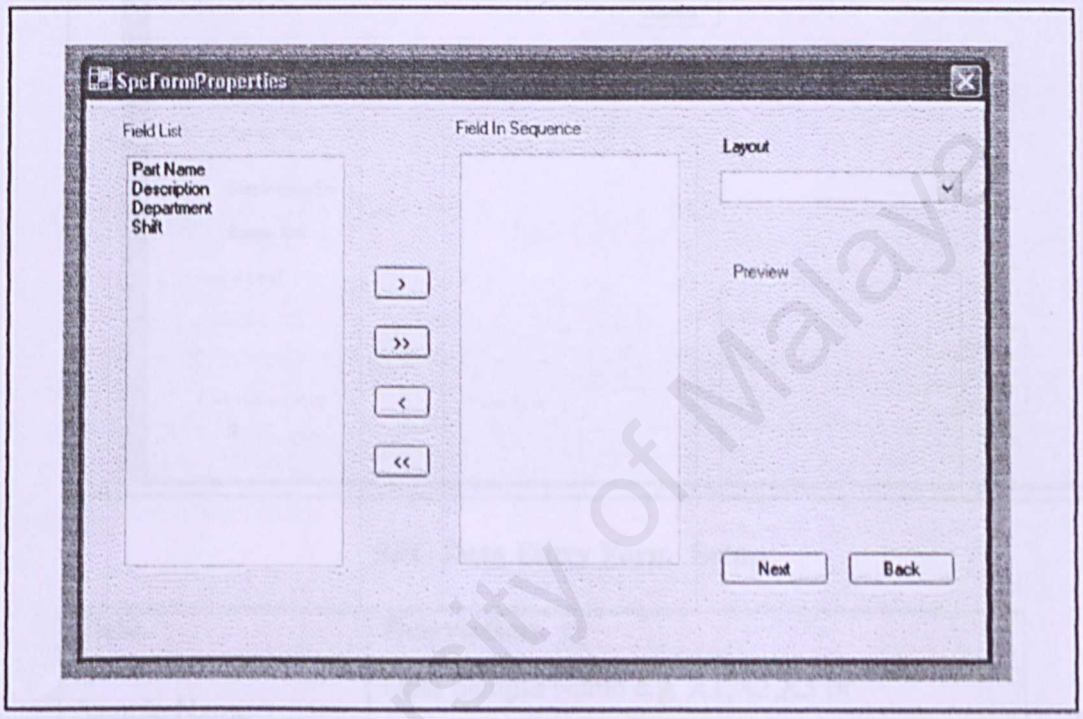
SPC Setup Form

12. User able to change the name for the pre-defined fields by highlight the field and click properties. Insert intended field name into text box below and select the field type and then click change button.

    (Please note: Currently, only text field type is available)

13. Checked those fields that are needed in the SPC info then click on next button at the bottom.

14. SPC Form Properties will appear after next button has been clicked.



SPC Form Properties

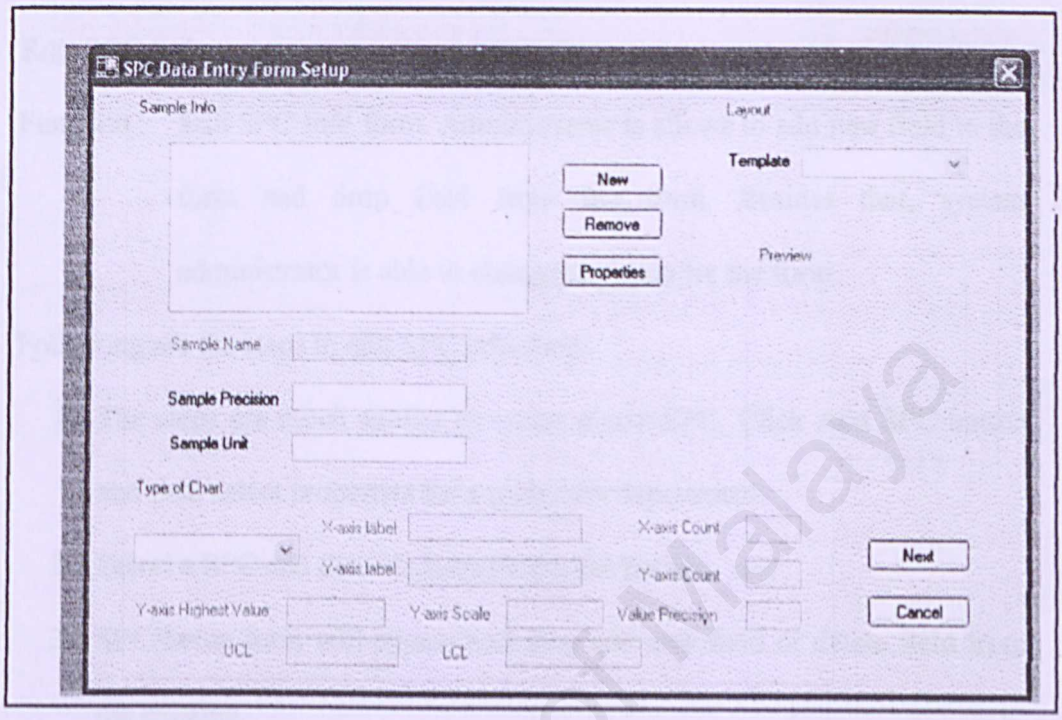
15. Put all the fields into sequence and then select layout templates. Click next button once it is finished.

16. A preview of the SPC info form will show and then click save button if the form is acceptable.

⌖ Create SPC Chart

Function : Setup SPC chart for a particular product.

Figure below is the SPC Chart Setup form which will appear after SPC info has been created.



SPC Data Entry Form Setup

Field	Description
Sample Name	Data Sample Name e.g. X1,X2,X3 or Sample1,Sample2,Sample3 and so on.
Sample Precision	Number of decimal point for data sample. Example, if the data sample value is 23.003 then sample precision is 3.
Sample Unit	Kg, g, kPa, celcius and etc.
X-axis Label	Label for X-axis bar.
X-axis Count	Number of scale on X-axis bar.
Y-axis Label	Label for Y-axis bar.
Y-axis Count	Number of scale on Y-axis bar.
Y-axis Highest Value	Highest value for Y-axis bar.
Y-axis scale	Increments value for each scale.

Value Precision	Number of decimal point for Y-axis value.
UCL	Upper Control Level.
LCL	Lower Control Level.

Edit SPC Module

- **Edit SPC Info**

Function : Edit SPC Info form. Administrator is allows to add new field to the form and drop field from the form. Besides that, system administrator is able to change template for the form.

Following are the steps to edit SPC info form:

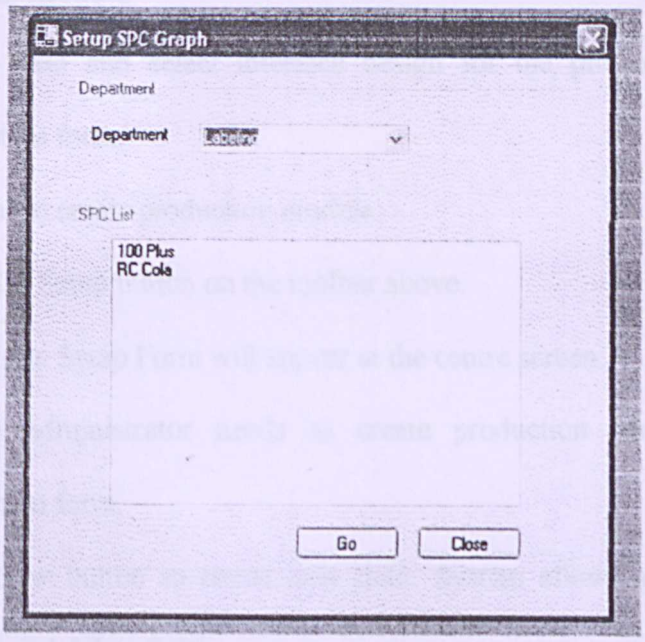
1. The steps are much similar to create a new SPC. Click Add SPC button and then select properties for a particular department.
2. Select a SPC and then click on Properties button.
3. SPC Setup form will appear and then add new field or delete field from the existing.
4. Specify the fields in sequence and choose a template for the form design
5. Press save button if the form design is acceptable.

- **Edit SPC Graph**

Function : Modify or edit the existing SPC chart.

Steps to edit a SPC graph:

1. Click Graph Setup button at the toolbar. SPC Graph Setup form will appear next.
2. Select a department from the drop-down list and then select the SPC graph that intended to edit.



Setup SPC Graph Form

3. Steps to edit a SPC chart are similar to create a SPC chart.
4. However, system will not allow user to change a Mean Chart into Range Chart.

Delete SPC Module

Function : Removing any SPC chart from the system.

Following are steps to delete a SPC for a particular product:

1. Click Add SPC button on the toolbar above. Select the department where the SPC reside on and then click properties button.
2. Select the SPC to be deleted from the SPC List and then press delete button.
3. Press yes for the confirmation box.

Notes: If a department a has been removed, all the SPC under that department will be removed.

Create Production Module

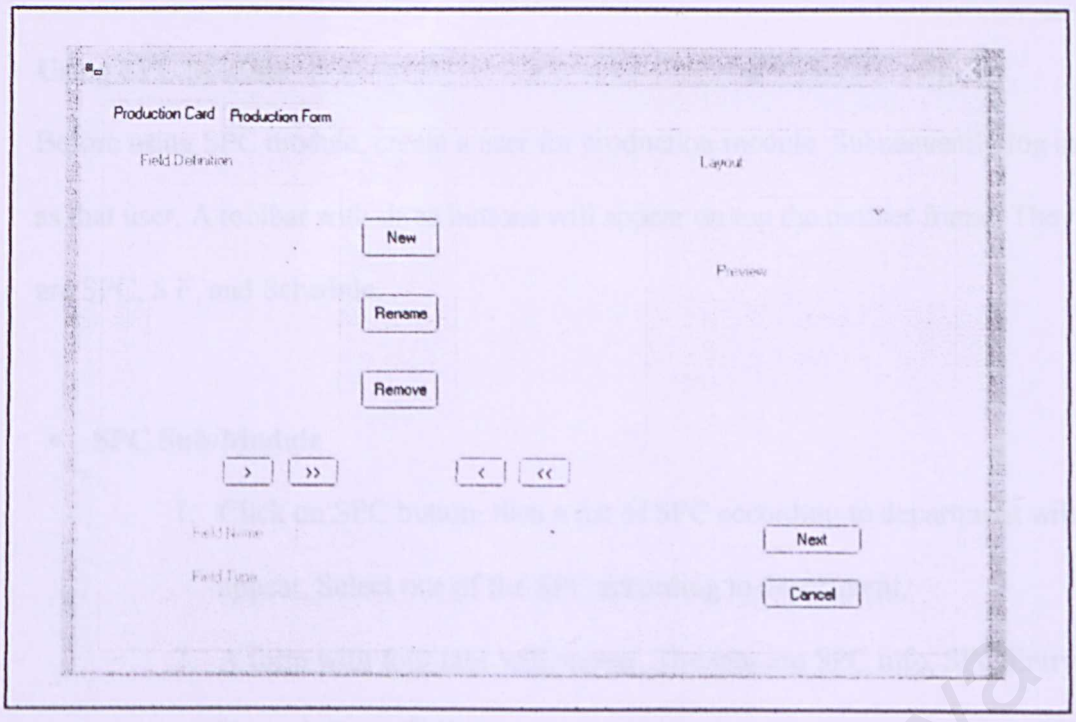
Function: Create field and select interface design for the production card and production form.

Following are steps to create production module:

1. Click S F Setup button on the toolbar above.
2. Production Setup Form will appear at the centre screen.
3. System administrator needs to create production card first before production form.
4. Click New button to create new field. System allows administrator to rename and delete field.
5. Put all the fields that have been created into sequence and then select template for production card design. Finally, press next button.
6. Next task is to create production form. Repeat step 4 and 5 create fields for production form.
7. Finally, select finish button and the system will create production form and card.

Notes: Production Card and Form cannot be edited once they were created by the system. Administrator only can create new production card and form to replace the existing one.

The following figure shows the Production Setup Form



Production Setup Form

Using SPC Module

Before using SPC module, create a user for production module. Subsequently log in as that user. A toolbar with three buttons will appear on top the mother frame. They are SPC, S F, and Schedule.

- **SPC Sub-Module**

    1. Click on SPC button, then a list of SPC according to department will appear. Select one of the SPC according to department.
    2. A form with four tabs will appear. The tabs are SPC info, SPC Entry, Traceability, and Report.

       SPC Info : A form to keep information about the SPC of a particular product

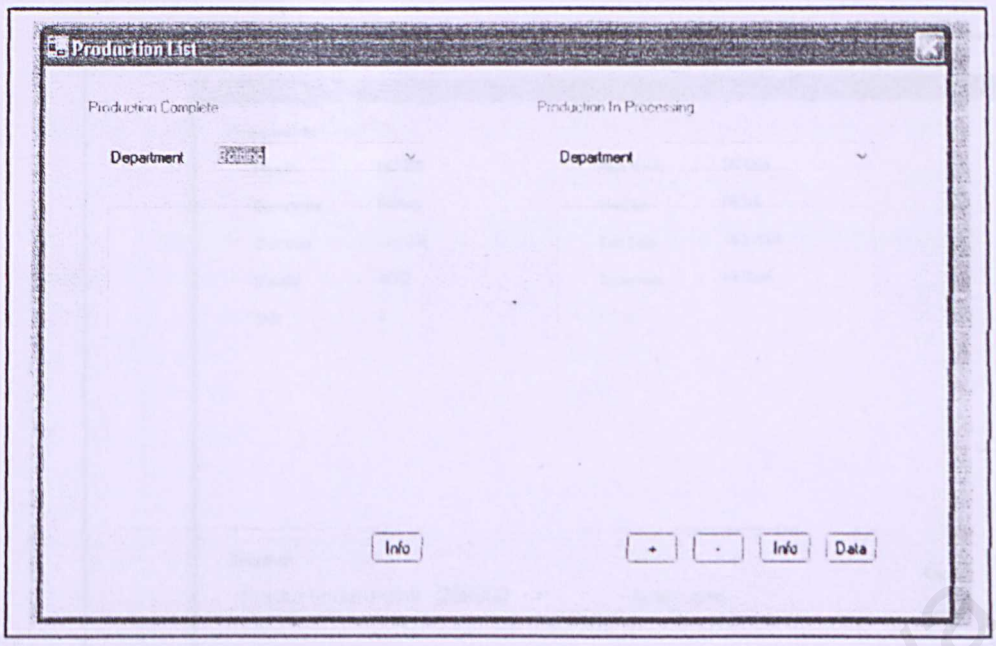
       SPC Entry : A form for user to input data samples and where SPC chart display.

       Traceability : User can look back previous data samples that have been inputted.

       Report : Allow user to generate a graph for data samples that have been collected.

Using Production Module

Function :
- > Create New Job
- > Update Job Info
- > Delete Job
- > Data Entry for Product Production
- > Generate Production Report

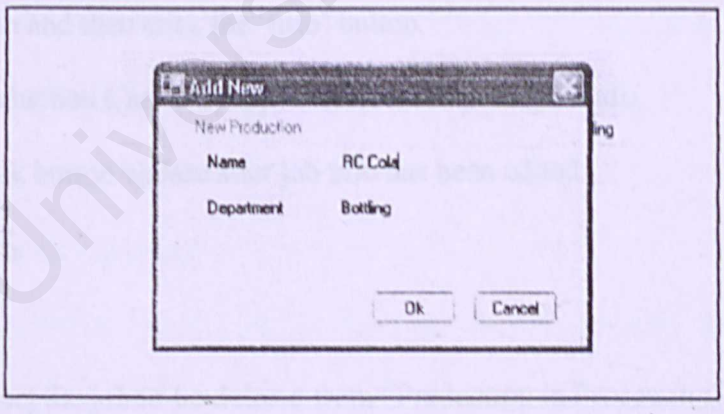


Production Main Form

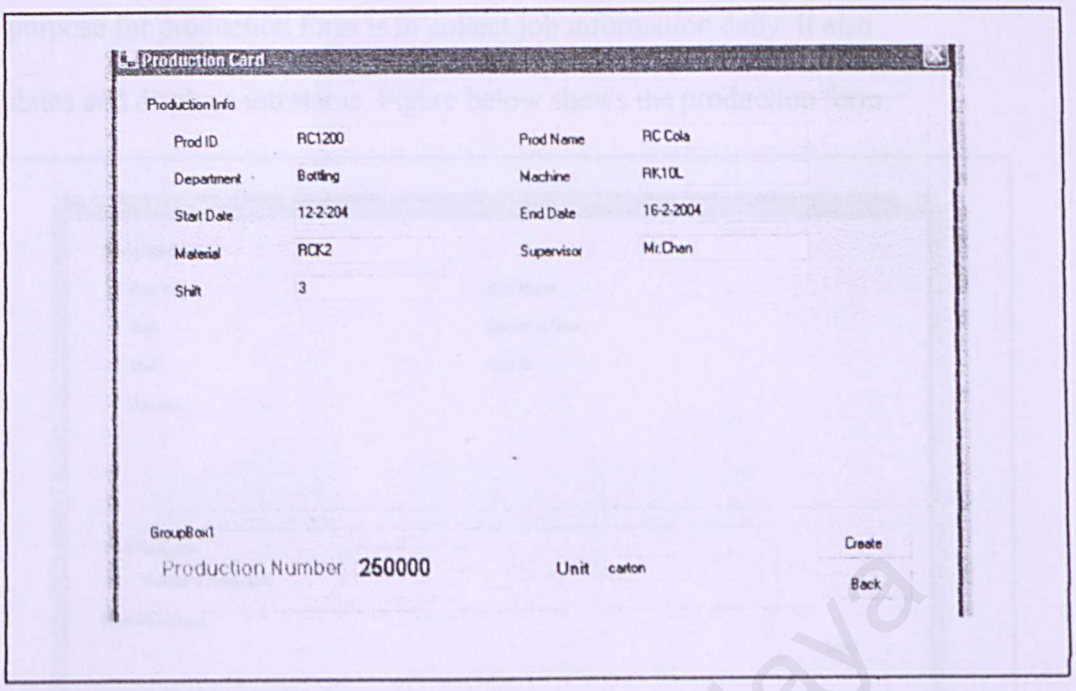
- **Create New Job**

The following are the steps create new job

1. Click on the ' + ' button situated at the bottom of the form.
2. A pop-up form as shown below will appear and user has to enter job name.



3. After new job name has been entered, production card will prompt user to enter production info. The following figure shows the Production Card.



Production Card

4. User need to specify the production number and unit for a new job.

- **Update Job Info**

Steps:

1. Select the job from "Production in Processing" list in the Production Main form and then click the 'Info' button.
2. Production Card will appear to user to update job info.
3. Click button update after job info has been edited.

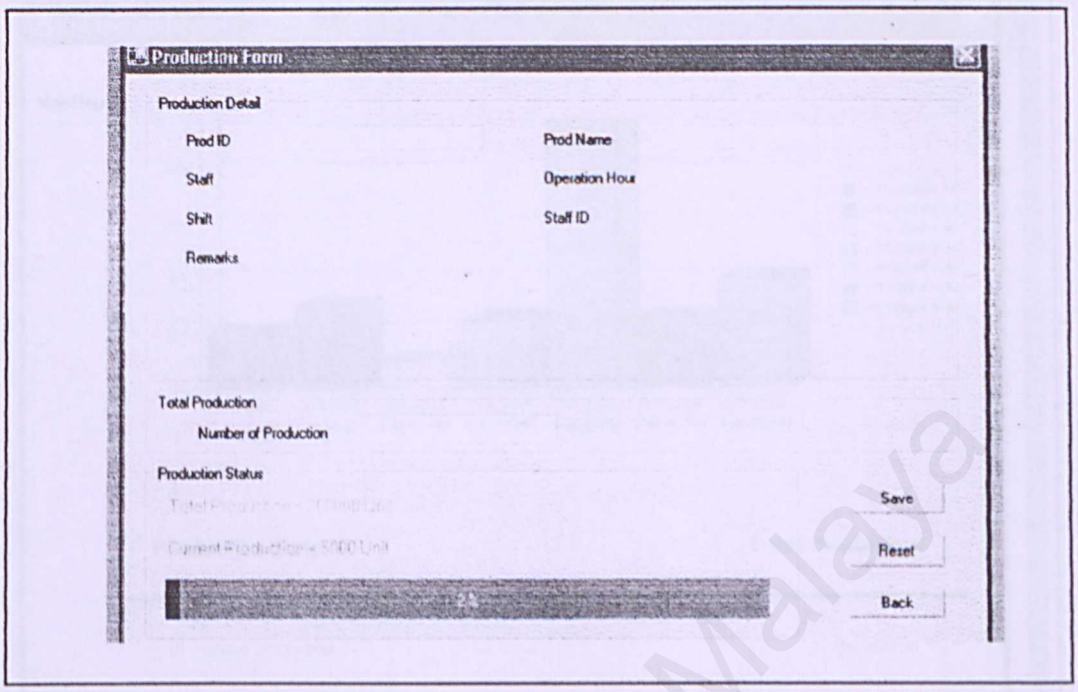
- **Delete Job**

Steps:

1. Select the job to-be-deleted from "Production in Processing" in the Production Main form.
2. Next click the button with " – " sign.
3. Finally, click Yes at confirmation box.

- **Data Entry for Production Form**

The purpose for production form is to collect job information daily. It also calculates and displays job status. Figure below shows the production form.



Production Form

User has to key in the job information according to the field. User has to enter daily production for a particular product into Number of Production textbox. System will then calculate the percentage of the job has been done. Finally, the percentage will show on the status bar.

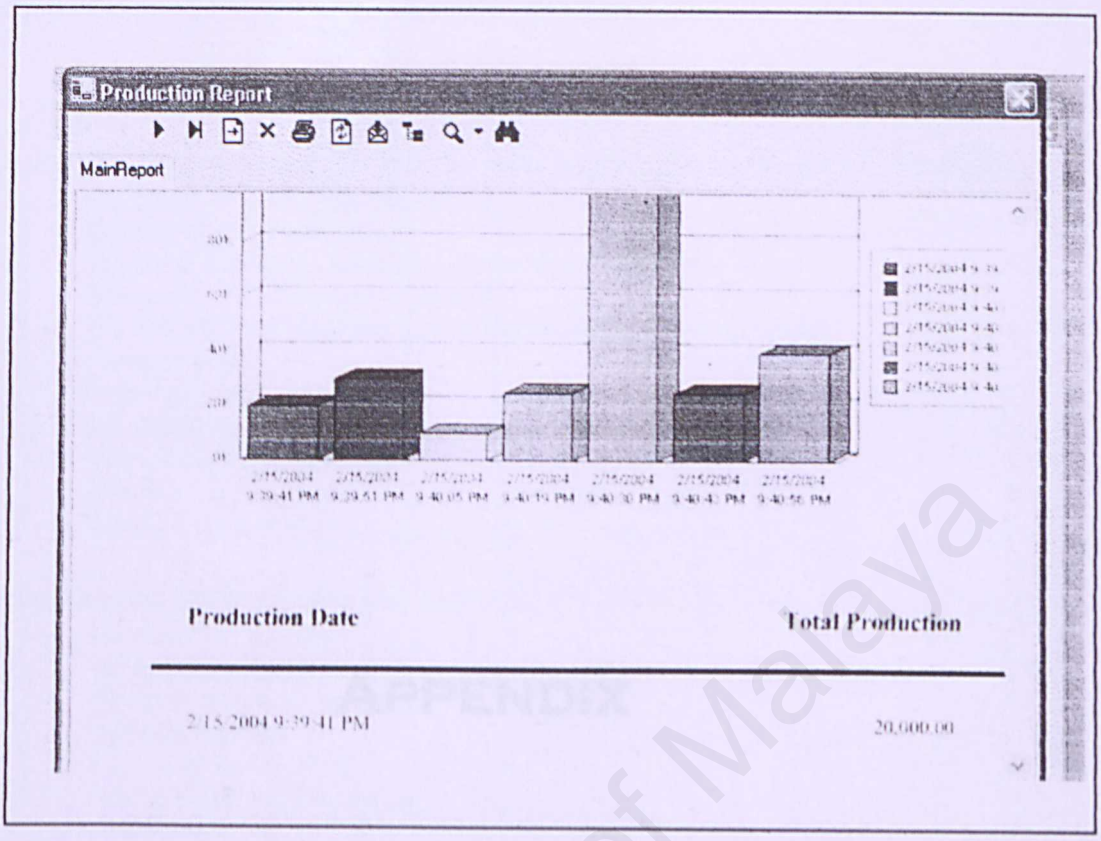
- **Generate Production Report**

User can only request the system to generate production report for those jobs that have been done.

Steps:

1. All completed jobs will display on the list situated at the left hand side of the Main Production form. Select one of the job from the list.

2. Then click the 'Report' button situated at the bottom .Subsequently, the system will generate production report as shown as figure below.



Production Report

APPENDIX

University of Malaya
Faculty Of Computer Science And Information Technology

Company Name: O.Y.L. Manufacturing Co. Sdn. Bhd.
Name : Woon Hon Wing

questionnaire:

1. In which industry would you classify your organization? (check all that apply)
   - ☐ Electronic products and components
   - ☐ Fabricated metal products
   - ■ Electrical machinery, apparatus, appliances, or supplies
   - ☐ Machinery and Transport Equipment
   - ☐ Pharmaceutical or Chemical products (including cosmetics, paints)
   - ☐ Paper products
   - ☐ Plastic products
   - ☐ Food packaging
   - ☐ Instrumentation Equipment
   - ☐ Textile
   - ☐ Other _____

2. What is your job function? (check one)
   - ☐ Materials Management
   - ☐ Inventory Control Management
   - ☐ Scheduling (Master Schedule)
   - ☐ MIS Management
   - ☐ Production Management
   - ■ Other Quality and Productivity_____

3. Is your company computerized?
   - ■ Yes ☐ No

4. Identify the systems which your Company uses:
   - ☐ Main Frame ☐ Mini PC
   - ☐ Stand alone PC's
   - ■ LAN PC's linked to central computer
   - ☐ Others_____

5. Identify the areas in which your Company is computerized: (can selected more than 1 answer)
   - ■ Invoicing ■ Accounts Payable
   - ■ Inventory Management
   - ■ Internal Requisition Process for Customer Orders
   - ☐ Statistic Process Controls (Includes performance tracking)

6. Does your company currently implementing e-manufacturing system?
   - ☐ Yes ☐ No

7. What kind of modules are include in your current system?
   - ■ Sales ■ Scheduling
   - ■ Production ■ Inventory
   - ■ Financial/Account ■ MRP
   - ■ Human Resources ☐ Others_____

8. Credit limits is an issue in sales management, how much is the credit limits that you give to your customers on buying your products? :_____

9. When you deal with your customers, which type of payments they practice and which one is more convenient for you?
   - ☐ Cheque (sum)
   - ☐ cash (sum)
   - ☐ installments
   - ☐ bank drafts
   - ☐ online banking

10. Does your company currently have or is your company currently implementing a MRP (Manufacturing Resource Planning) or ERP (Enterprise Resource Planning) computer system?
    ■ Yes ☐ No
    If the answer to question 10 number is "No" then please proceed to question 15. Thank you.

11. It is critical to implement and practice MRP effectively among the manufacturers. Do you agree with statement above?
    - ■ Agree
    - ☐ May be
    - ☐ Not really

12. In what year was your current MRP system installed? _____
    If your organization is currently implementing a new system, for which year is the installation scheduled to go on-line?

13. Will you rely totally on the result from the calculation of Material Resources Planning (MRP) to release replenishment orders for material in terms of date and quantity of the required material?
    ■ Yes ☐ No

14. Which do you think are the most suitable measurement for MRP performance?
    - ☐ Inventory accuracy
    - ☐ BOM accuracy
    - ☐ Routing accuracy
    - ■ Delivery performance
    - ☐ MPS performance
    - ☐ Inventory investment

15. Is there a computer inventory system to identify the:
    - Amount of the item in stock?
      ■ Yes ☐ No
    - Location of the item in stock?
      ☐ Yes ■ No
    - Are the sites linked electronically?
      ■ Yes ☐ No

16. What is the basis to determine stocking quantities? It is:
    - [■] Experience
    - [ ] Mathematical Formula
    - [ ] Combination

17. If mathematical, is the system computerized?
    - [ ] Yes
    - [ ] No

18. If yes, identify the values that are calculated?
    - [ ] Stock Level (Max)
    - [ ] Stock Level (Min)
    - [ ] Re-order Pt.
    - [ ] Economic Order Quantity
    - [ ] Turns per Item
    - [ ] Turnover rate for all stock
    - [ ] Other_____

19. Are controls, such as tagging, used to segregate different types of material as well as material in different stages of incoming inspection (i.e. hold, accept, reject).
    - [■] Yes
    - [ ] No

20. Does your company currently implement MES (Manufacturing Execution System)?(if your answer is no please skip to question 22)
    - [ ] Yes
    - [■] No

21. Based on your experience, does MES (Manufacturing Execution System) plays a vital role in manufacturing field?
    - [ ] Yes
    - [ ] No

22. Do you know, what is Statistical Process Control (SPC)?
    - [ ] Yes
    - [■] No (Proceed to question 24)

23. Please rate the effectiveness of Statistical Process Control for a manufacturer to increase the quality of its end product?(The highest 5 to the lowest 1)
    - [ ] 1 [ ] 2 [ ] 3 [ ] 4 [ ] 5

24. Please check at below the information from the shop floor that is important for management level?
    - [ ] Labor Information
    - [ ] Labor Attendance
    - [ ] Job Status
    - [ ] Daily Production Report
    - [ ] Product's Quality Report
    - [ ] Job Costing

25. Does your company currently adopting Maintenance Management System?
    - [ ] Yes
    - [■] No

Thank you for your participation. Please return the questionnaire ASAP.

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