CHAPTER 1

INTRODUCTION

1. Introduction

The distributed control system or DCS is a computer system, which is used to monitor and control the production process of a factory. The DCS consists of two major parts. One is the hardware and the other is the application software. The hardware can either connect directly to the field instruments or connect to the field instruments via panels. The software is used to control these field instruments to open/close or start/stop at the time required. The DCS is widely used in wide ranges of industries. The examples of industry include petroleum, petrochemical, paper pulp, food, plastics, chemical, wastewater, electric power, and gas industry.

There are many companies that supply the DCS products in Thailand. In this thesis, I have selected one company, named shortly as ABC, for studying the DCS project execution starting from the award of contract to the time of product delivery. In order to understand the background of the ABC more clearly, the ABC products, its organisation chart, and steps of the DCS project execution in ABC are given on the following three sections.

1.1 Company Background

1.1.1 Products of ABC

The main businesses of ABC are in the areas of industrial automation, field control instruments, and test & measurement. The products of ABC include

1. Process Control Instruments (PCI)

The examples of these products are differential pressure and pressure transmitter, magnetic flow meter, vortex flow meter, controller, and control valve.

2. Test & Measurement Instruments (TMI)

The products include digital oscilloscope, industrial recorders, portable & panel instrument (meter), digital power meter, calibration product, field tester, liquid-crystal driver IC tester, and LSI test system.

3. Distributed Control System (DCS)

DCS products consist of both hardware and software. The hardware includes the field control stations (FCS) and information & command stations (ICS). Their functions are for the

control & monitoring function and for the human machine interfacing function, respectively. ABC does not manufacture the DCS hardware but orders this hardware from the ABC's factory at Singapore. The DCS software for controlling the production is created by Thai engineers at ABC. This software is created according to the customer's specification.

In addition, ABC also designs the marshaling panels, relay panels, and power distribution panels for customers. In ABC, they call these panels as NON-DCS products. The relationship between DCS and NON-DCS can be shown as below.

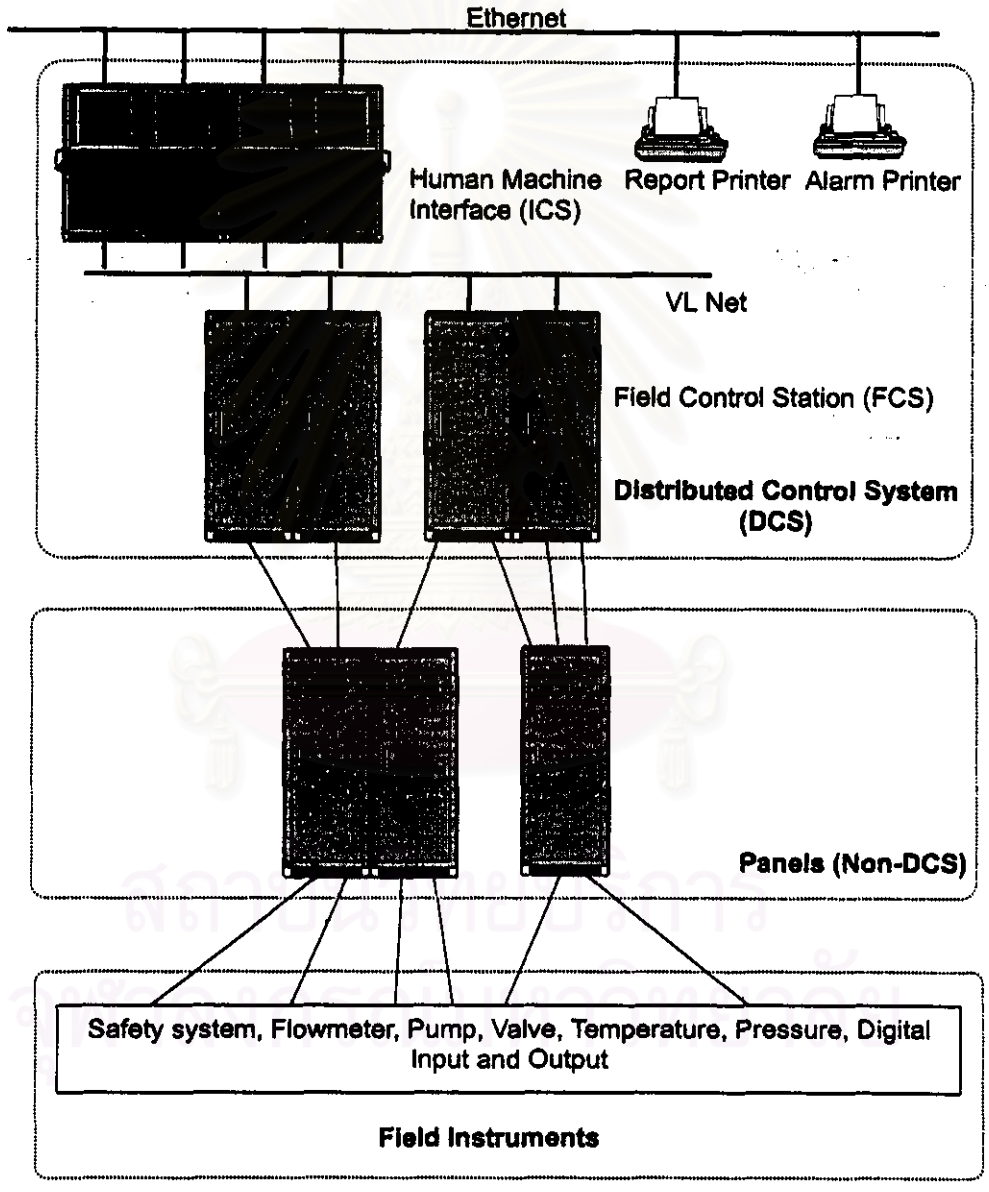

Figure 1.1 Relationship Between DCS and Panels (Non-DCS)

The panel cubicles and electrical components such as relays, switching power supply, electrical wires are purchased from ABC's suppliers in Thailand. These suppliers also do the installation and wiring work according to the ABC's panel specifications.

1.1.2 ABC Organisation Chart

The ABC organisation chart is shown on the figure 1.2 as following:

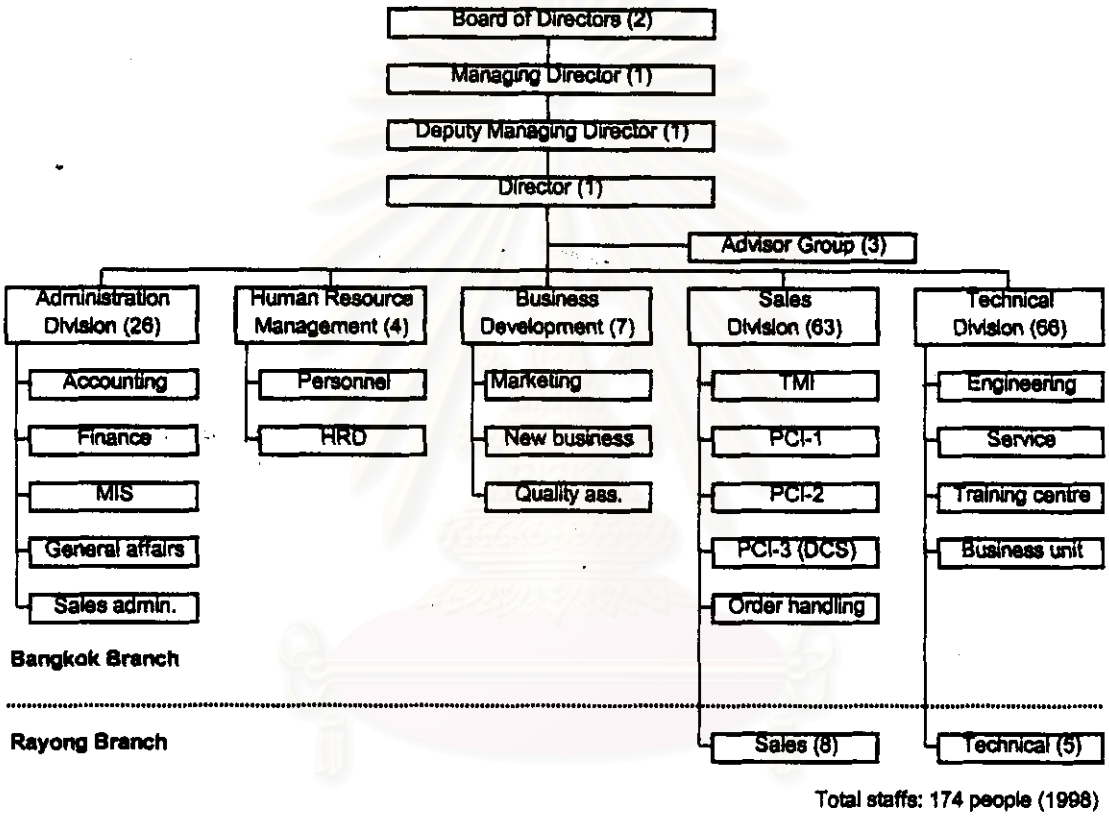

Figure 1.2 ABC Organisation Chart

The structure of ABC is a functional structure. It is divided into five important functions, which are administration, human resource management, business development, sales, and technical division.

The DCS project is initiated from the PCI-3 (DCS) department in sales division. When sales staff in this department is awarded the new DCS contract, he will send the internal job request form to the engineering department of the technical division. Then the manager of the engineering department will assign appropriate system engineers, and a project manager to execute the project.

1.1.3 DCS Project Execution in ABC

The main steps of project execution in the ABC Company are explained as following:

(1) Information Transfer from Sales to Engineering Department

After the Sales department has awarded the DCS contract, the related sales staff informs rough descriptions of the new DCS project to the manager of the Engineering department (EGD). The EGD manager then sets the project team to execute the project.

(2) 'Kick Off meeting' with the Customer

The purpose of the meeting is to confirm the scope of work of the company ABC and is used to officially indicate that the project is started. The delivery schedule of the distributed control system to the customer is also discussed during the meeting.

(3) 'Technical meeting' with the Customer (Hardware)

The purpose of the technical meeting is to confirm the quantity and types of the input to and output from the DCS. This is to ensure that all inputs and outputs used in the project are carefully considered and no hardware component is missed.

(4) DCS Hardware Specification for Approval

After the technical meeting, the project team prepares the hardware specification and submits the specification for approval to the customer.

(5) Order the DCS Hardware

After getting the approved DCS hardware specification from the customer, the project manager informs to the Order Handling department to issue the purchase order to the company ABC in Singapore.

(6) 'Technical meeting' with the Customer (Software)

After the DCS hardware specification was approved, there are several technical meetings with the customer about the software parts. The purpose is to receive the customer's requirements about the control concept, production control procedure, emergency and interlock sequence.

(7) DCS Software Specification for Approval

The engineers in the project prepare the software specification and submit to the customer for approval.

(8) Start the Design Work

After the customer has reviewed and approved the software specification, the engineers start designing the DCS software. The software includes the sequence control, DDC loop control (e.g. feedback, feedforward, cascade, ratio, etc.), graphic design, messages for interfacing with the operators, and the allocation of the tags at the information and trend displays. Note that almost the design works are in paper.

(9) Input the Design Works to the DCS Hardware

This process is called the 'generation' phase. The engineers will assign the work to their assistant engineers to entry the work designed into the engineering station (DCS hardware).

(10) Test and Debug the Software

When the generation of the software has been completed, the engineers start debugging the software according to the approved software specification. This is to ensure that there is no error or software bugs containing in the DCS software.

During this period, the DCS hardware are usually shipped from Singapore to Thailand. Therefore, the combination test between the software and the hardware is also required.

(11) Inspection by the Customer

This process is called the 'Factory Acceptance Test' or FAT. The customer is invited to test both the DCS hardware and software. Inspection the DCS hardware is to ensure that the quantity of the hardware is correct and the DCS hardware perform their function correctly. The customer also checks the DCS software to ensure that every step of the production control procedure and interlock sequence is written correctly.

(12) Deliver the Distributed Control System to the Factory

After the customer has inspected the DCS hardware and software and agreed to deliver the DCS to the site, the project manager contacts to the Administration division to arrange the trucks to deliver the system to the customer's factory.

(13) DCS Installation and Startup

The DCS hardware are installed at the place assigned by the customer. The place might be either control room or auxiliary room. The power supply is then connected to the system, the engineers power on the system and check whether there is any problem or not.

There is also the wiring work from the instrument outside the control room to the DCS. This work is usually performed by another company (a contractor). After the wiring work was completed, the total loop check starts. This is to ensure that the wiring from the field instrument to

DCS is correct. After all works are completed, the plant startups and begins to produce the products.

(14) Submit the Final Drawing to the Customer

Since there might be some changes to the specification during the plant startup, the engineers revise the document and then submit the final drawing both the DCS hardware specification and DCS software specification to the customer. The close meeting is held to ensure that the project is completed successfully.

1.2 Statement of the Problems

In order to clearly understand the problem areas in the DCS project execution easier, the flowchart of the project execution as well as the stated problems are given on the appendix I. There are problems occurring during the project execution. The main problems are discussed as below.

1.2.1 Lack of Procedures to Control the Project Execution

(1) Poor Contract Verification

There is no procedure or system to verify the customer's requirements between the client's tender and the ABC contract. Some changes in the contract, which are different from the tender, are not identified and informed to the customer at the earlier phase of the project. As a result, when problems arise at sites, the customers claim that we do not provide all customers' requirements.

(2) Product Defects and Delayed Delivery

There is no system to monitor and control the project's progress. Each project usually has a short period of time for debugging phase. As a result, there are many errors occurring during the customers' inspection period and customers are not satisfied. Moreover, in some projects if there are many errors or bugs in the software, customers do not accept for the delivery of the product. We have to modify the software and set another inspection with customers again. Hence the delivery schedule could not be kept at the agreed date and some projects we were charged for the penalty of the late delivery.

(3) Incomplete Delivery

At the time of delivery, we do not have a pre-delivery review checklist to confirm things before proceeding to the shipping phase. Some equipment, such as keys of the doors, is lost

during delivery. Some instruments are forgotten to ship to the customer site. Some hardware is damaged because of the inappropriate procedure during the packaging.

1.2.2 Lack of the Document and Data Control

(1) Insufficient Procedure to Build Software Specification

There is no common procedure for engineers to create the software specification in the same format and same style. The documents created by new engineers are resulted in scrap when the project manager or the department manager checks them. The engineers have to redo the documents again and this is wastage of time and papers.

(2) Poor Document Control

Usually when we have a technical meeting with customers, we receive many engineering drawings such as process and instrument diagram (P&ID), loop drawings, input/output lists, instrument schedule, instrument data sheets. When a project is executed for couple months, these documents will be issued and revised again. Since all documents are kept in the same folder and at the same place and currently there is no document control procedure in the engineering department. Hence it takes long time to find the update document and it is wastage of time to do these unnecessary works.

(3) Design Changes

We find frequently that customers request for changes in some detail of process control after the software specification has been approved. Sometimes this specification is already designed and generated into the DCS hardware. We have to redesign and rework for these changes and this is wastage of time. This also costs company a lot of money and customers do not understand because the software is intangible. For example, the customers request for changes at the time nearly to have an inspection, we have to spend overtime to finish these changes. In addition, at the end of a project, we do not have any procedure to check whether the cost of a project is over than the estimation that sales staff has quoted for the engineering fee or not.

1.2.3 Technical Problems

(1) Capacity Problems

During the beginning of a project, we have no procedure or checklist to confirm the system specification before proceeding to the subsequent phases of the project execution. Some projects we found, after the generation phase, that the memory for storing the application

software is not enough, the details of design are much more than the memory's size and it is very difficult to do at this period.

(2) Poor Design

Some new engineers do not know how to design good software structure. When customers change their requirements, it is difficult to change or modify the software. At the design and generation phase, we should have a proper system to monitor and advise the engineers in order to design the good software for the customers.

(3) Limited Know-how

The serious problem is that the know-how or some engineering knowledge is not equalised to all engineers. When an engineer experienced new engineering knowledge or some quality problems, only that engineer knew the knowledge or solutions of the problems, other engineers do not know these. For example, one engineer has created software to convert the numeric values such as "86" and display on the graphic screen as "01:26" in a character mode with the hour and minute format. Other engineers do not know that this software has already been created. If there is a similar requirement from another customer again in the future, the engineer in charge of that project has to rethink and recreate this function again. It is wastage of time to redo this work.

In the company ABC, there is no system or procedure to record this knowledge for other people. It is better to establish a formal procedure to serve as an educational material. Therefore the quality problems can be avoided and some engineering knowledge can be reused again in the future.

1.2.4 Conclusion

ABC suffers from the above mentioned problems. Due to the economic crisis in Thailand during this period (middle of 1997), it is the policy of the company ABC to improve the quality of the DCS products in order to gain the competitive advantage in the market. Therefore, it is essential that the quality assurance activities, systematic procedures, and documentation should be established, in order to prevent the quality problems and ensure that the company ABC delivers the good DCS products to customers.

1.3 Objective of the Study

To develop the quality assurance system for the distributed control system project.

1.4 Scopes of the Study

1. The study will be conducted in the engineering department of the company ABC. The study will focus on the activities of the distributed control system (DCS) project. This study excludes the activities of the panel parts (NON-DCS).
2. This study will establish the quality assurance activities of the DCS project. This includes the activities from the beginning of the project to the time of the delivery.
3. The study will focus on the DCS design work, document and data control of the DCS.
4. The criterion for evaluating the system is a decrease in software errors and on time delivery.

1.5 Study Plan

In order to finish the thesis at the specified period, the procedures for preparation of this thesis are planned as following:

1. Literature survey
2. Study the current procedures of the quality assurance of ABC
3. Collect old data and analyse the problems occurring in the previous project execution in the company.
4. Define and establish the required quality assurance activities.
5. Implement the established quality assurance system.
6. Evaluate the results of the proposed quality assurance system comparing with the previous methods.
7. Make the conclusion and suggestion.
8. Prepare the thesis.

1.6 Benefits of the Study

The benefits of the study include:

1. To establish the standard for the project execution of the DCS products.
2. To improve the customer satisfaction.
3. To decrease the internal / external failure costs and quality problems.
4. To enhance the technical knowledge of ABC engineers.
5. To apply for any other related companies.