CHAPTER 1

INTRODUCTION

1.1 Background

Nowadays in the industrial sector through out the world, quality has become a focal point of consideration. The high competition has forced companies to supply high quality products which are closely involved with reliability and maintenance. The companies want to have smooth, continuous and correct manufacturing.

Breakdown of only one machine or equipment could bring overall manufacturing process to be halted. This can cause both of measurable losses and unforeseen losses. Measurable losses, for example, time loss, production loss and man-power loss can be measured in terms of money. Unfortunately, unforeseen losses such as company's credit, opportunities, and so forth could bring more severe effect to companies in long term. The best way to prevent severe breakdown is effective maintenance by properly selecting maintenance policies.

The effectiveness of maintenance work depends on both properly planning and taking action correctly. Maintenance engineers have to prevent machine from failure. Whilst, the inevitable machine breakdown has to be cleared at as shortest time to maintain the availability status of machine. In doing so, maintenance engineers have to take proper action before the breakdown of machine will occur. One of the mean which can reduce downtime of machine is to perform condition based monitoring.

The precise prediction of machine failure will lengthen the machine service time before breakdown. Many techniques and tools have been used for prediction of machine failure. The list of those techniques and tools can be quoted as below.

1. Thermal Monitoring
2. Lubricant Analysis
3. Vibration Analysis
4. Non-destructive Test
5. Leak Test
6. Corrosion Analysis
7. Flow Analysis
8. Stress Analysis
9. Acoustic Emission Analysis

Since most of the machine failures have been found in rotating machine, the most popular technique is vibration analysis. The vibration analysis can be done while machine is operating without requiring for shutdown. It can be used for diagnosis of many irregular symptoms of machines.

Generally, the system of machine, especially rotating machine, has two major parts: the driver and the driven. The driver part is either electrical motor or combustion engine. The driven part is the load of the driver part, such as water pump, air compressor, belt conveyer, and forth. In most manufacturing plant, if the power supply from authority is not their problem, the driver part should be electrical motor. The reason behind this is the lower cost of electricity.

Failure of the machine can be caused by either from the electrical motor itself or the load side. However, the electrical motor has a little bit higher chance of failure since it involves with the conversion from electrical energy into mechanical energy while load side is just driven.

Vibration signals can indicate potential problems caused by poor bearing condition, unbalance of system, damaged stator insulation, rotor unbalance, misalignment, and so forth. Many sorts of data will be used to predict time to failure of the motors as well as manufacturing process. Hence, maintenance has to be planned in advance to correct the problem before breakdown occurs, which will cause tremendous damages to manufacturing.

1.2 Statement of the Problems

To diagnosis failure of motor from vibration signal, two means can be used. The first is to diagnose from deep knowledge of structure or model of the system. This way is very difficult to perform since it requires all the affected factors to simulate in the mathematical model. Theoretically, it can be done, but it is not an applicable way for maintenance engineer. The second way is based on the heuristic knowledge from human experts. It needs statistical intuition and past experience from human experts to interpret vibration signal. Actually, human experts utilize deep knowledge of structure or model of the system as the basic background while the heuristic knowledge is utilized to solve the practical diagnosis problems.

When human experts leave, retire or change their job, they take the invaluable experience in vibration diagnosis and their remained works with them. Until someone comes in to take over their works, remained works have to be done by people who may not have enough experience and unfamiliar with the existing manufacturing process. This can let wrong diagnosis happened, then cause the severe breakdown of motors that leads to halted manufacturing. The tremendous loss may occur.

In the large size of manufacturing plant, for example, cement factory, there are high amount of motor to drive their process. Due to lacking of human experts for diagnosis vibration signal in the plant, vibration data of motor may have to wait. In some cases, the dangerous level of vibration, which can indicate the failure of machine in the near future if properly action is not applied, is not sent to human experts in time.

If maintenance engineer can bring data to consult with the computer, work load of human expert will be significantly reduced and motor will be taken properly action in time.

On the other hand, if engineer can interpret vibration signal by themselves, the work load of human expert will be significantly reduced. The precise diagnosing come from the right interpretation of vibration signal. The process of vibration signal can be shown in figure 1.1.

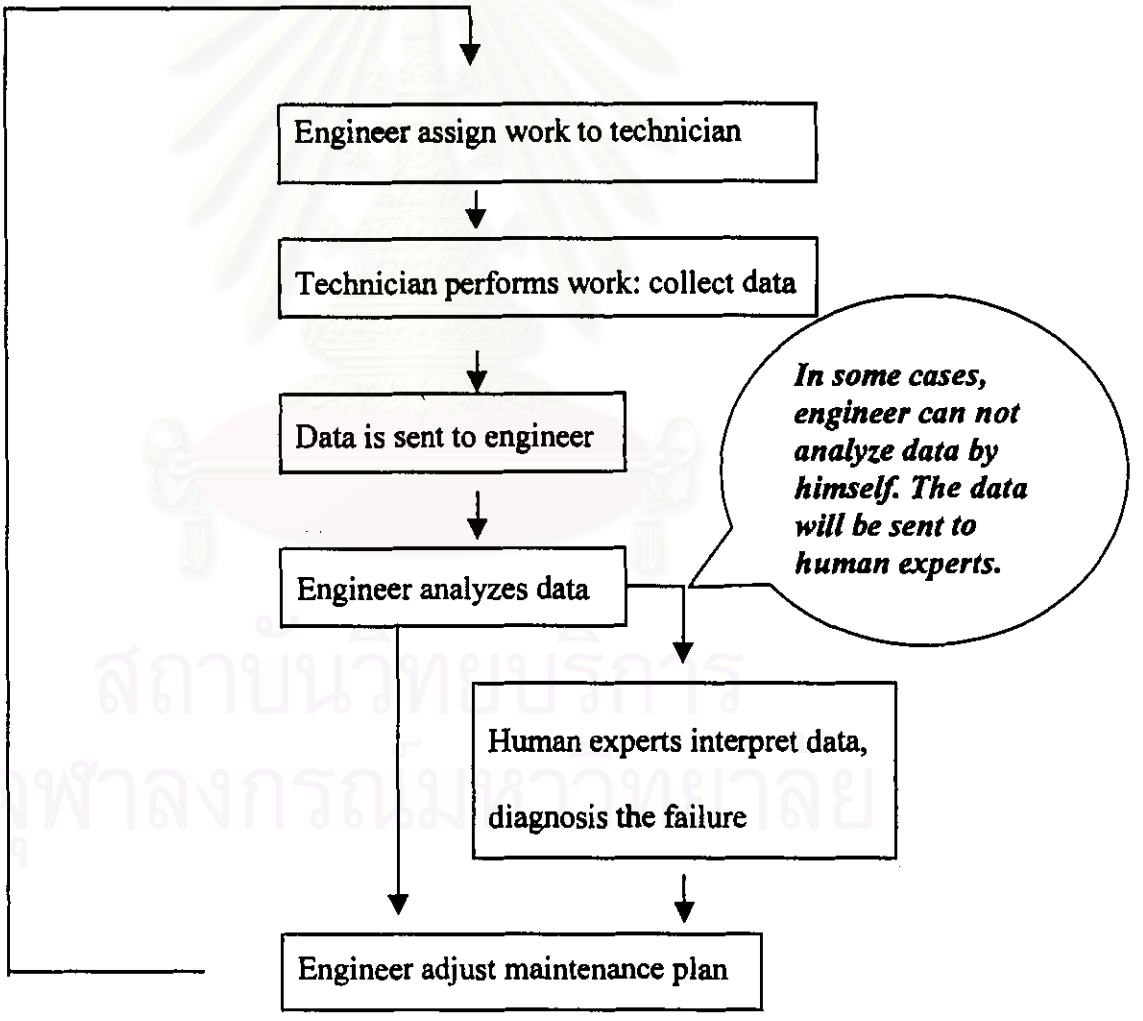

Figure 1.1 Process of vibration signal in maintenance work.

Therefore, development and expert system for diagnosis vibration signal can alleviate the problem from human experts. By storing the knowledge based and steps of diagnosis in the computer, maintenance engineer can diagnosis the failure of motor from vibration signal ant any time as they want.

Vibration signal analysis can be employed in any type of rotating machine in the manufacturing factories. Apart from precise speed controlling in some work, the most popular used of rotating machinery is AC. induction motor since it require less maintenance work than other types. Due to its widely use in industrial factory, this research will develop an expert system for AC induction motor vibration diagnosis, named ESMVD.

ESMVD can help and support maintenance engineers and technicians in diagnosis the vibration signal from AC induction motor more correctly and instantly.

1.3 Objective

The objective of this thesis is to present the applicability of expert system in diagnosis the failure of AC induction motor from vibration signal. Furthermore, it has followed the below objectives:

1.3.1 To understand how an expert system can be developed and utilized in machine failure diagnosis area

1.3.2 To develop an "Expert System for AC Induction Motor Vibration Diagnosis", ESMVD, in order to assisting decision makers in maintenance program.

1.4 Scope of Research

Scope of research are as follows:

1.4.1 In this research, the point of focus is on AC induction motor. Normally, the size of AC induction motor is very wide. Some large size of AC induction motor require special device for vibration monitoring while some small size can not be diagnosis by vibration signal. Thus, this research will scope at AC induction motor, ranged from 10 kW to 1,000 kW.

1.4.2 Knowledge based for the expert system will be obtained by various types of sources as follows

1.4.2.1 Interviewing and consulting human experts from two large size industrial plants.

1.4.2.2 Historical data of motors

1.4.2.3 Manual of vibration data collectors

1.4.2.4 Relevant research

1.4.2.5 Internet; both official and unofficial sites

1.4.2.6 Training document and VDO tape

1.5 Expected Benefits of Research

Expected benefits of research are as follows:

1.5.1 An expert system, called ESMVD, will help maintenance engineer in order to solve complicated expertise problems correctly and effectively.

1.5.2 Human expert dependence in maintenance work will be decreased.

1.5.3 Technician and Engineer can use ESMVD for consulting, assisting, and learning about vibration diagnosis of AC induction motor.

1.5.4 ESMVD will help industrial plants in reducing their maintenance cost as well as human resources' training cost.

1.5.5 ESMVD will be a basis for further development in relevant machine. The expansion of knowledge based system can be done on ESMVD to cover vibration diagnosis in relevant machine train.

1.6 Procedures and Methodology of Research

Procedures and methodology of research are as follows:

1.6.1 Surveys of related theories and related research

1.6.2 Interview of human experts and surveys of documentation of the related equipment.

1.6.3 Collecting data from historical case study and information on internet.

1.6.4 Analyze information and design the system

1.6.5 Program software

1.6.6 Validate the system with historical data

1.6.7 Summarize the improvement and further development

1.6.8 final examination

1.7 Organization of the Report

The first three chapters present the background and overview of the research while other chapters present the developed expert system, validation of the expert system, and conclusion and recommendation. The detail of each chapter is shown as follow.

Chapter 1 covers the general information of the thesis.

Chapter 2 introduces the overview and basic knowledge in AC induction motor, overview of vibration signal, and diagnosis technique. Furthermore, related literature survey and useful sources of vibration knowledge on Internet are provided.

Chapter 3 presents the overview of expert system and its application, i.e. inference engine, backward chaining, and so forth. Moreover, the introduction of expert shell, related literature survey, and useful source on internet are included.

Chapter 4 presents the procedures in developing the expert system called ESMVD. The structure of ESMVD is shown as well as the demonstration of the program.

Chapter 5 covers the validation of the ESMVD. The procedures and conclusion of the validation are discussed in this chapter.

Chapter 6 provides the conclusion and recommendations for further research.

Appendix A present the knowledge base for overall value

Appendix B present the knowledge base for spectrum analysis

Appendix C present the explanation and characteristic of symptom failure

Appendix D present the terminology used in vibration analysis