Feasibility Study of Thickness Measurement System

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CERTIFICATION OF APPROVAL

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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

Nor Diana

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ABSTRACT

Thickness Measurement System is a method for using risk as a basis for prioritizing and managing the efforts of an inspection program. In an operating plant, a relatively large percentage of the risk is associated with a small percentage of the equipment items. Thickness Measurement System permits the shift of inspection and maintenance resources to provide a higher level of coverage on the high-risk items and an appropriate effort on lower risk equipment. This system provides companies the opportunity to prioritize their equipment for inspection; optimize inspection methods, frequencies and resources; develop specific equipment inspection plans, and enable the implementation of equipment maintenance. This results in improved safety, lower failure risks, fewer forced shutdowns, and reduced operational costs This project work around on how to develop the software so that it can be easily use. This project use Visual Basic.Net for the interface and software implementation and SQL server as database. API RP 580 Risk Base Inspection and API RP 581 RBI Base Resource Document are the reference documents.

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CHAPTER 1

INTRODUCTION

1.1 Background

Thickness Measurement System is a method for using risk as a basis for prioritizing and managing the efforts of an inspection program. In an operating plant, a relatively large percentage of the risk is associated with a small percentage of the equipment items. Thickness Measurement System permits the shift of inspection and maintenance resources to provide a higher level of coverage on the high-risk items and an appropriate effort on lower risk equipment.

It would be interesting to develop software that can achieve inspection objectives in order to improve inspection services of Inspection Company. This project work around developing simple software that can be used to apply inspection method. This software application is clearly preferable to the usual method of treating all equipment equally, regardless of its risk contribution. This system mainly focus on when, what, where and how to manage components of equipment in an oil and gas plant. It calculates main attributes of each component that determines the remaining life of the component. What important is that, in the mean time, this system indirectly highlights important factors in a safety/ health/environment perspective and from economic standpoint.

The application of this system is having an economic impact on Oil and Gas production. When analyzing operational costs incurred, there is a tendency to only consider the visible expenses, such as inspection costs, maintenance costs and management costs, these direct costs only contribute a small fraction to the total cost of operation. A more representative analysis would consider the costs of shutdowns, downtime, lost production, unplanned failures, environmental issues, and regulatory compliance, in addition to the visible expenses.

1.2 Problem Statement

A fundamental consideration for inspection company is what, where, when and how to inspect to assured integrity at affordable cost. Cost is the main thing to be considered. Too little too late means higher risk and high probability of failure which failure is expensive in terms of lost production revenue and the consequential effect of damaged reputation. So the need of inspection is obvious and the reason is diverse.

The basis of plant integrity is to ensure that facilities are correctly designed, operated and well maintained. Plant equipment is exposed to deterioration mechanisms and potential damage throughout their service life. To know with confidence the current condition of plant pressure equipment, we need to inspect the equipment. Moreover, to determine the next inspection date, we need to understand the deterioration mechanisms the equipment will be exposed to and their effects till the next scheduled inspection.

Basically, all the inspections done based on the experiences and in some cases in response to significant failure cases. In general, they did not take full account of failure risks and also of the degradation mechanisms that the equipment is exposed to in operation. As a result, some companies would not do enough inspection and sudden avoidable failures, while others would unnecessarily overspend, resulting in significant waste of resource.

Based on those problems stated above, this system aims at helping the company to schedule and organize their inspection services. This is crucial, since to maintain all the facilities in plant and ensures that it well operated is not an easy task. It will help the company to be alert of the inspection since this system help them maintaining and organizing the inspection works and at the same time reduce the cost of unproductive inspections.

1.3 Objectives

- To determine Corrosion Rate of the equipment
- To determine Remaining Life of the equipment
- To determine the END Life of the equipment
- To generate Thickness Measurement System documentation and record keeping

1.4 Benefits

- Improve the cost effectiveness of inspection and maintenance resources
- Significant savings in terms of increased availability reduced engineering cost and maintenance scheduling.

CHAPTER 2

LITEARURE REVIEW

2.1 Case Study

A) ABS (American Bureau of Shipping) has developed a multi-level risk-based inspection methodology ranging from simplified deterministic approaches using standard design analysis up to sophisticated probabilistic approaches. Each approach has various levels of usefulness ranging from the definition of critical areas for a single inspection campaign up to the generation of an optimized inspection schedule and work scope covering the entire lifecycle of a particular unit. These RBI methodologies have been successfully applied in inspection planning for several FPSO (Floating, Production, Storage and Offloading) installations. The Degradation Assessment case is a risk based method intended to determine both the frequency of inspection as well as the scope. The method identifies the most critical compartments and structures within a compartment using stress and fatigue results generated by ABS SafeHull. **[1]**

B) The first case history considers a North Sea Gas Terminal, with three pipelines and a normal winter gas rate of approximately 45 million Standard cubic meters per day (1.4 BSCF/day) supplying 15-20 % of the current UK demand. The objective of the inspection process applied is to ensure the integrity of the plant, equipment and structures with a view to protecting the personnel and the environment and to ensure that the company is able to safely continue its business. **[2]**

C) The second case history considers a UK Gas field which has an indigenous reservoir of approximately 280 billion cubic feet of gas. It is also used as a mass gas storage site. Results of an inspection performed on the condensate system achieved by the following:

- A reduction of 70% in the level of Ultrasonic Testing.
- An increase in the intervals of internal vessel Inspections, by an average of 20 months.
- Reduction in shutdown days providing additional revenue of $ 225,000 per annum. **[3]**

D) The fourth case history considers an operator with both new and mature North Sea Oil and Gas Fields. Both financial and non financial benefits are being realized, by applying Risk Based Strategies to inspection and maintenance philosophies. The non financial benefits recognized by the operator have demonstrated commitment to the health and safety of the workforce, and commitment to the governing regulations. It is predicted that financial benefits will be realized in 'lifecycle' inspection and maintenance costs. Initially by reducing the number of internal vessel inspections by 50%-60% and then by continuous improvement, through risk based program, it is anticipated that the inspection program will improve, giving a further reduction in costs of 33.3%, as the frequency between intervention periods is increased. **[4]**

From the case studies above, we can see that inspection is crucial nowadays in many oil and gas company. Health and Safety Environment Department take this as a serious matter in doing daily business. It is shown that inspection method is now being applied in most oil and gas plants. This shown that most company takes this as a crucial thing that have to be considered. So, by having this system, company can improve their inspection services in terms of cost and also record keepings where they can manage all the inspection results well.

The application of Inspection is proving to be economically viable, providing both financial and non financial benefits for operators. Inspection strategies have been successful, in reviewing the frequency of interventions and the use of applied inspection techniques, for both planned maintenance and inspection. The adoption of Inspection program allows both new and improved 'alternative' methods of inspection to be applied where suitable. For these strategies to be successful inspection methods available require continual review leading to progressive development utilizing the most effective method of inspection.

CHAPTER 3

PROJECT WORK

3.1 System Development Life Cycle – Waterfall Model (Methodology)

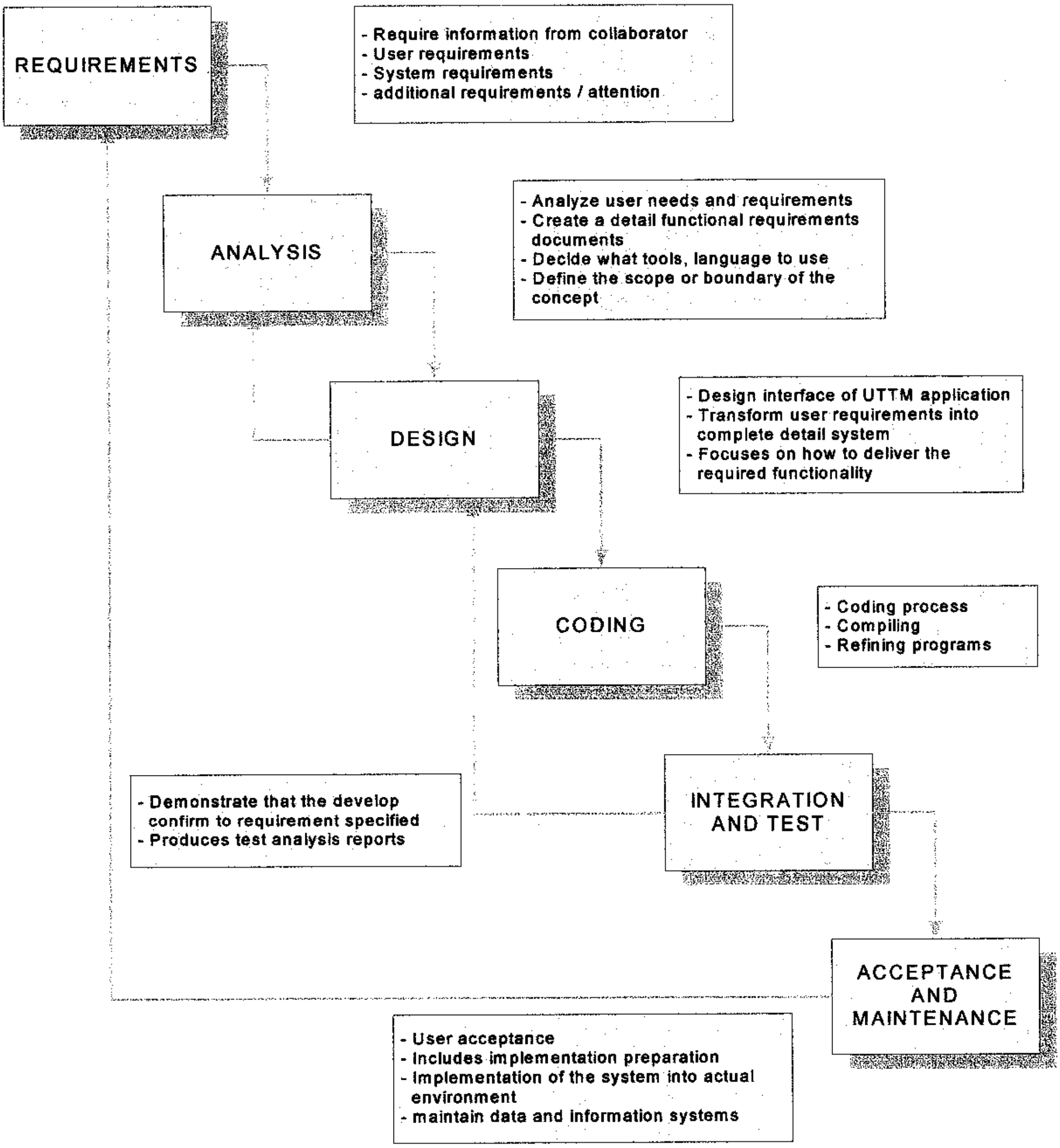

Figure 1: SDLC – Waterfall Model

As to complete the project, System Development Life Cycle (Waterfall Model) method has been chosen as method use in development of the system. This model takes the above objectives and represents them as separate process phases such as requirements, analysis, design, coding, testing as well as acceptance and maintenance. In the ***requirements analysis and definition***, the system's services, constraints and goals are established by consolation with system users. They are then defined in detail and serve as system specification. In ***system and software design***, the system design process partitions the requirements to either hardware or software systems. It establishes overall system architecture. Software design involves identifying and describing the fundamental software system abstractions and their relationships.

During ***implementation and unit testing***, the software design is realized as a set of programs or program units. Unit testing involves verifying that each unit meets its specification. In ***integration and system testing***, the individual program units or program are integrated and tested as a complete system to ensure that the software requirements have been met. After testing, the software system is delivered to the customer. The customer here is inspection company. In ***operation and maintenance***, normally this is the longest life-cycle phase. The system is installed and put into practical use. Maintenance involves correcting errors which were not discovered in earlier stages of the life cycle, improving the implementation of system units and enhancing the system's services as new requirements are discovered. The Waterfall model is widely used by such large software development houses as those employed by the U.S. Department of Defense and NASA, and for many other large project.

3.2 Data Collection Method

The first step in developing this system is collecting all the information and related data from the end user. What they want in the system and how they want the system to be. Besides, all the related information to develop the system is also crucial. In order to collect and gather all those important and related information and data, I have conducted an interview with one of the manager of the particular inspection company.

During the interview, he had gave me the copies of all information needed such as calculation formulas, examples of component and equipment involves, examples of results in tables and graphs and also examples of system they have been using all these while to maintain and organize all the inspection results which is Microsoft Access.

As a complement of the system, interviews of project managers and engineers working in the companies were conducted to understand what type of equipment they inspect, how they inspect and all the inspection services they provided. They also have been asked about current system that has been used in the company. These interviews were focused in three aspects: main problems associated with current system, effectiveness of the current system how would they want the new system to achieve and make their work easier.

The results of these interviews were also used as inputs in the development of the system.

3.3 System Architecture

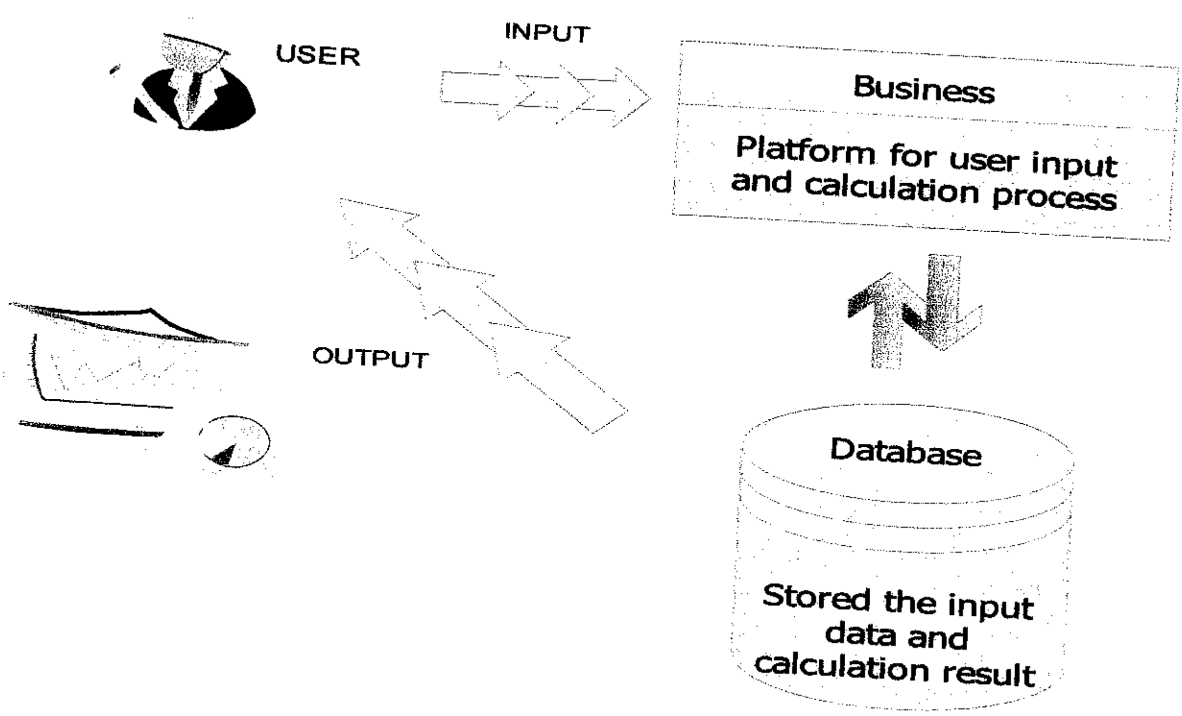

Figure 2: System Architecture

The architecture that has been chosen in order to construct the system is three-tier client server architecture which involves 3 layers of Client, Business and Database. The use of the three tier architecture in this case allows the information transfer between the Business (which is the system) and the database to be optimized. The database provides data management services. It will store all the input data inserted by end user and calculation result. All those input data and results can be retrieved back by the end user. The Client layer is where the users are.

3.4 Flow Chart / System Functionality

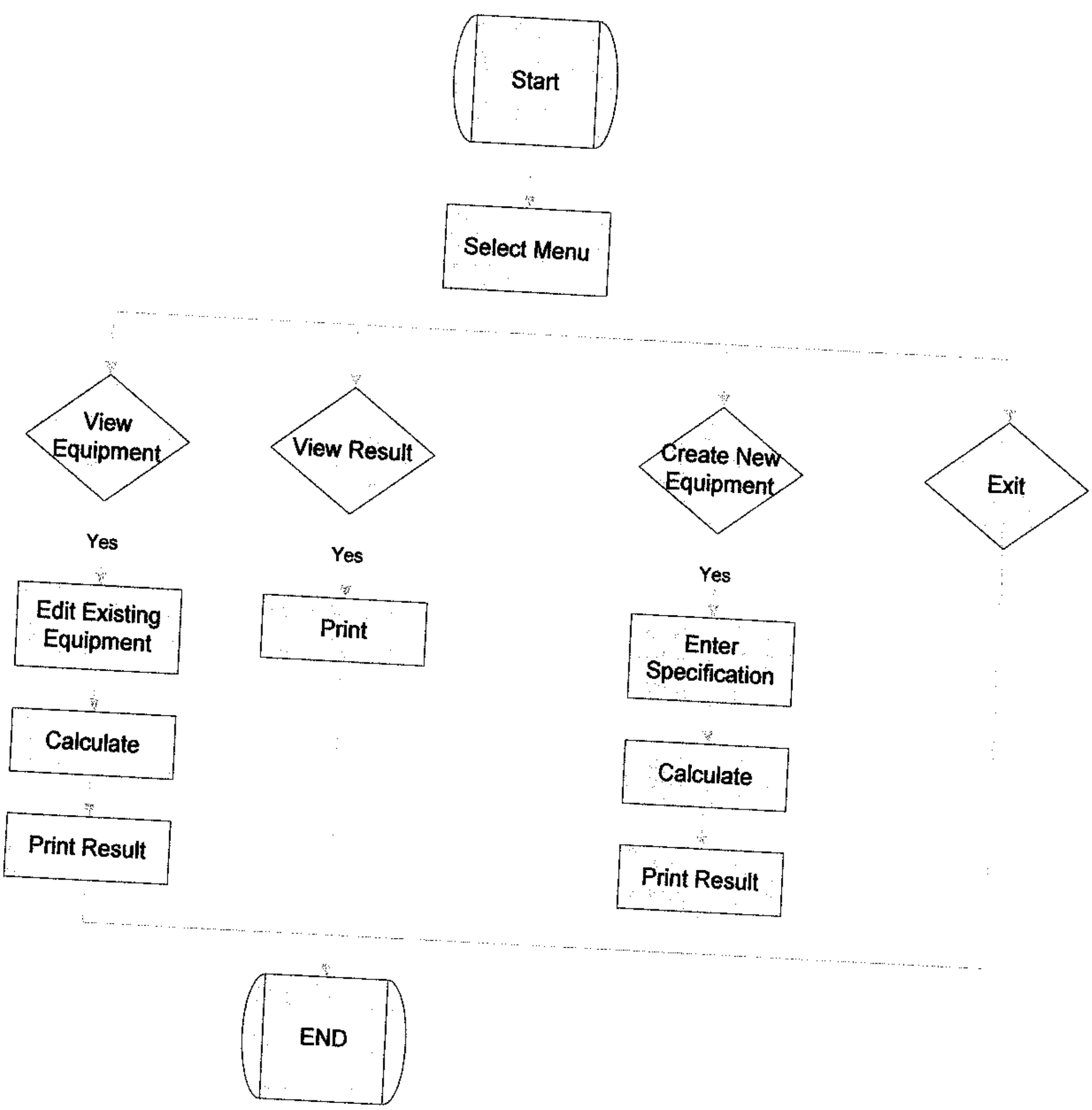

Figure 3: Flow Chart / System Functionality

The flow of the system is:

- User select the menu on the main switchboard
    - View Existing Equipment
    - View Result
    - Create New Equipment
    - Exit
- User enter the specification needed for the calculation process
    - Equipment Specification (name, number, installation date)
    - Component Specification (name, installation date, original thickness, retire thickness)
- User view the result of the measurement
    - Table Result (Remaining Corrosion Allowance, Corrosion Rate, Remaining Life, End of Life)
    - Graph Result (Corrosion Rate, Measurement Date)
- User print the result of the measurement

3.5 Use Case

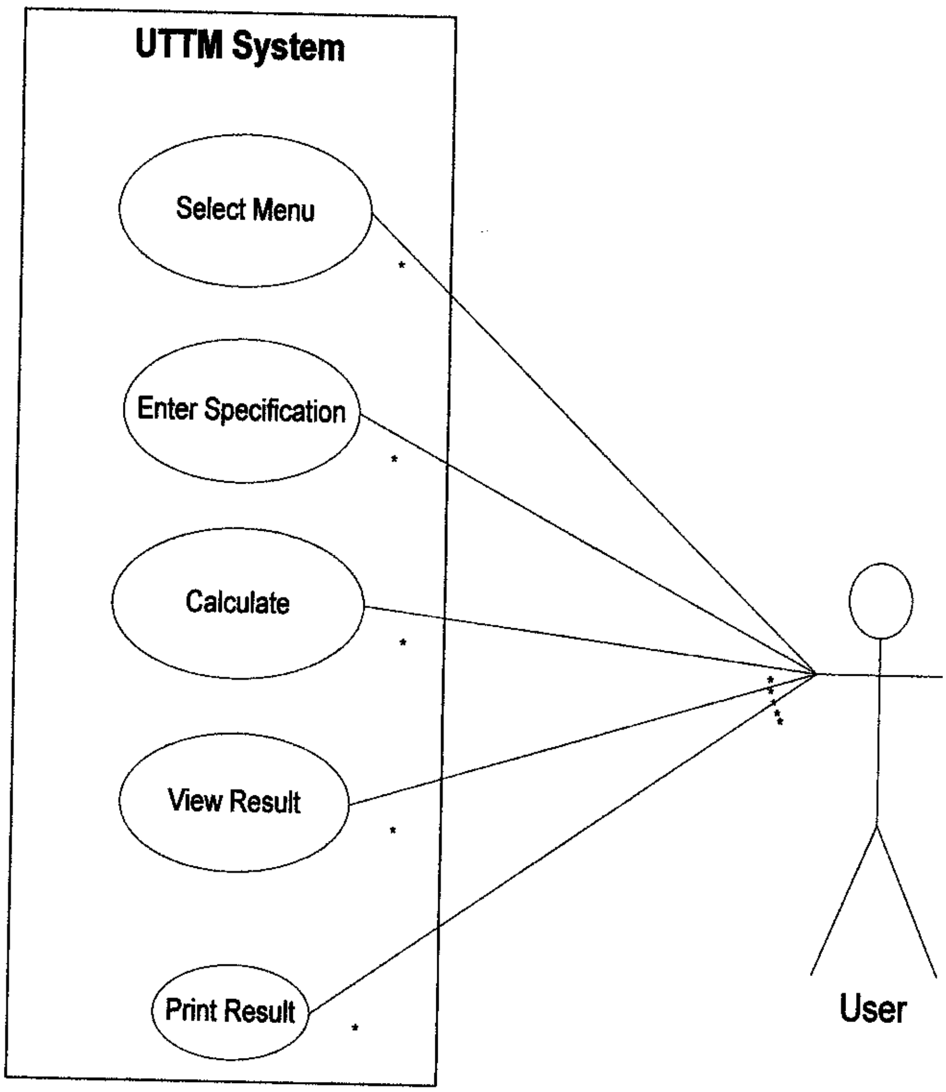

Figure 4: Use Case

Use case diagram were used as it is a simple description of a system's functions form the eye of the users. Use case diagrams are functional diagrams in that they portray the basic functions of the system. It includes what the users can do and how the system should respond to the user's actions.

3.6 Use Case Description

Use case name: Select Menu	**ID:** 1	**Importance Level:** High
Primary actor: User	**Use case type:** Overview, essential	
Stakeholders and interest: User		
Brief description: This use case describes how the user is going to use the system by choosing the menu that are going to determine the path		
Normal flow events: 1. Select menu on the main switchboard • View Equipment • View Result • Create New Equipment		

Use case name: Enter Specification	**ID:** 2	**Importance Level:** High
Primary actor: User	**Use case type:** Overview, essential	
Stakeholders and interest: User		
Brief description: This use case describes how user will get the result by providing the input about the component that wish to be measured		
Normal flow events: 1. Enter the equipment specification (such as equipment name, number and installation date) 2. Enter the component equipment (such as component name, installation date, original thickness and retire thickness)		
Alternate/Exceptional flows: 1. Inspector reenter wrong specification		

Use case name: Calculate	**ID:** 3	**Importance Level:** High
Primary actor: User	**Use case type:** Overview, essential	
Stakeholders and interest: User		
Brief description: This use case describes how the user will get the value of the measured component such as remaining corrosion allowance, remaining life, and end of life and so on.		
Normal flow events: 1. Click the calculate button to generate the result of the measurement		

Use case name: View Result	**ID:** 4	**Importance Level:** High
Primary actor: User	**Use case type:** Overview, essential	
Stakeholders and interest: User		
Brief description: This use case describes how the user will get the and view the result of the measurement		
Normal flow events: 1. The result will be automatically calculate when he user perform the calculate button and the window will display the result both in table and graph.		

Use case name: Print Result	**ID:** 5	**Importance Level:** High
Primary actor: User	**Use case type:** Overview, essential	
Stakeholders and interest: User		
Brief description: This use case describes how user will get the hardcopy of the measurement's result.		
Normal flow events: 1. Click the print button to print the result of the measurement		

3.7 Tools

Software:

- Microsoft Visual Studio (Visual Basic) 2005 (User Interface)
- Microsoft Access (Database)

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Feasibility Study

In many industries there is a strong incentive to maximize their plant and machinery lifetime. This means the plants and machinery may be kept running beyond their original design lifetimes until it is either uneconomical or unsafe to do so. Therefore, risk and reliability analysis has recently become a critical decision tool to optimize maintenance strategy in order to ensure safety and minimize costs.

Recently, the new self-maintenance technology has been developed in order to maintain the safety of aged plants and machines or equipments and to realize how low maintenance cost at high operating rate. In this measurement system, it will focus on calculating process where we call thickness measurement. It will focus on calculating the thickness of each component in the equipment. From the thickness measurement, we can tell the life of each component in the equipment. From the thickness measurement system we can calculate:

- Remaining Corrosion Allowance
- Short Corrosion Rate
- Long Corrosion Rate
- Short Remaining Life
- Long Remaining Life
- End of Life of the equipment

From those value calculated, we can have the estimation of the corrosion rate, the remaining corrosion rate that still be allowed, the remaining life of the component and until when the component is going to be used. From that, the company can predict when they need to do the inspection and change that equipment that reaches their end of life. In the mean time it will reduce engineering cost because it will avoid unnecessary inspection.

4.1.1 Technical Feasibility

In terms of technical feasibility, it is necessary to have a personal computer to install this system and a person to key in the input data and manage the result.

4.1.2 Financial Feasibility

View from a financial perspective, there will be not much cost spend. All they need to spend is to buy the system and hire one person to maintain the system.

4.1.3 Organizational Feasibility

From an organizational perspective, this project has medium risk. The objective of the system is to cut low the inspection cost while operate in high rate is aligned with the company's goal of reducing the inspection cost. The move to new inspection software also aligns with company's goal to operate the inspection service at high rate.

4.2 User Requirement Analysis

To collect information in order to assist the implementation of the system, I have conducted several interviews with the manager, engineer as well as other employees at a respective inspection company. From interviews conducted, the most important information that I have gained is the formula on how to calculate all those components attributes.

Attributes	Formula
Remaining Corrosion Rate	Current Thickness – Retire Thickness
Corrosion Rate	[Current Thickness – Previous Thickness] / [Current Inspection date – Previous Inspection Date]
Remaining Life	Remaining Corrosion Allowance – Corrosion Rate
End of Life	[[[Remaining Corrosion Allowance / Corrosion Rate] * 365.25] + Current Inspection Date]

Figure 5: Formula

Besides the formula, they also gave me lists of component and equipment involved in the oil and gas plant so that I can get a clear view what is exactly being inspected and how all those things looks like.

4.3 System Interface

Below is the example of System Interface that has been developed by the writer. This system contained three main pages which are ***create new equipment, view equipment and view result.***

4.3.1 Create new equipment page

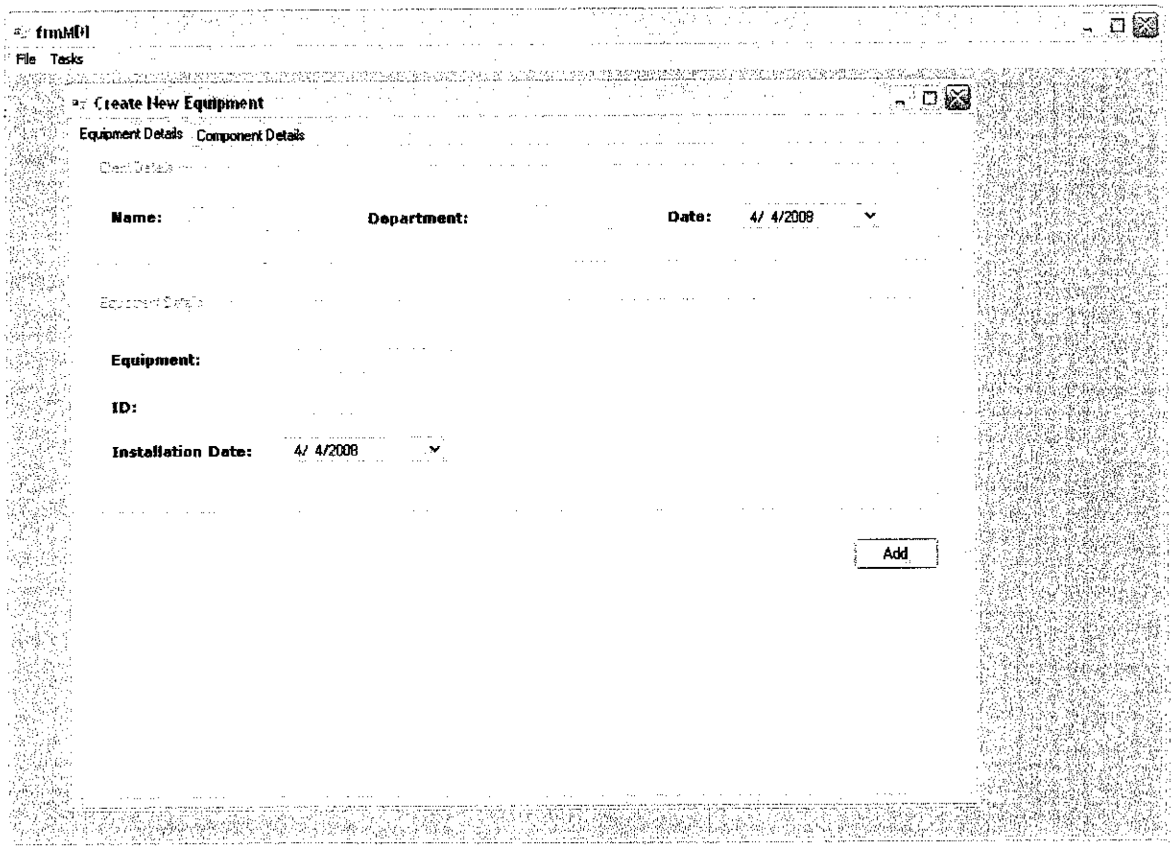

Figure 6: Create new equipment

In this page, user need to key in all the equipment data required and button add will add those data into the database when clicked.

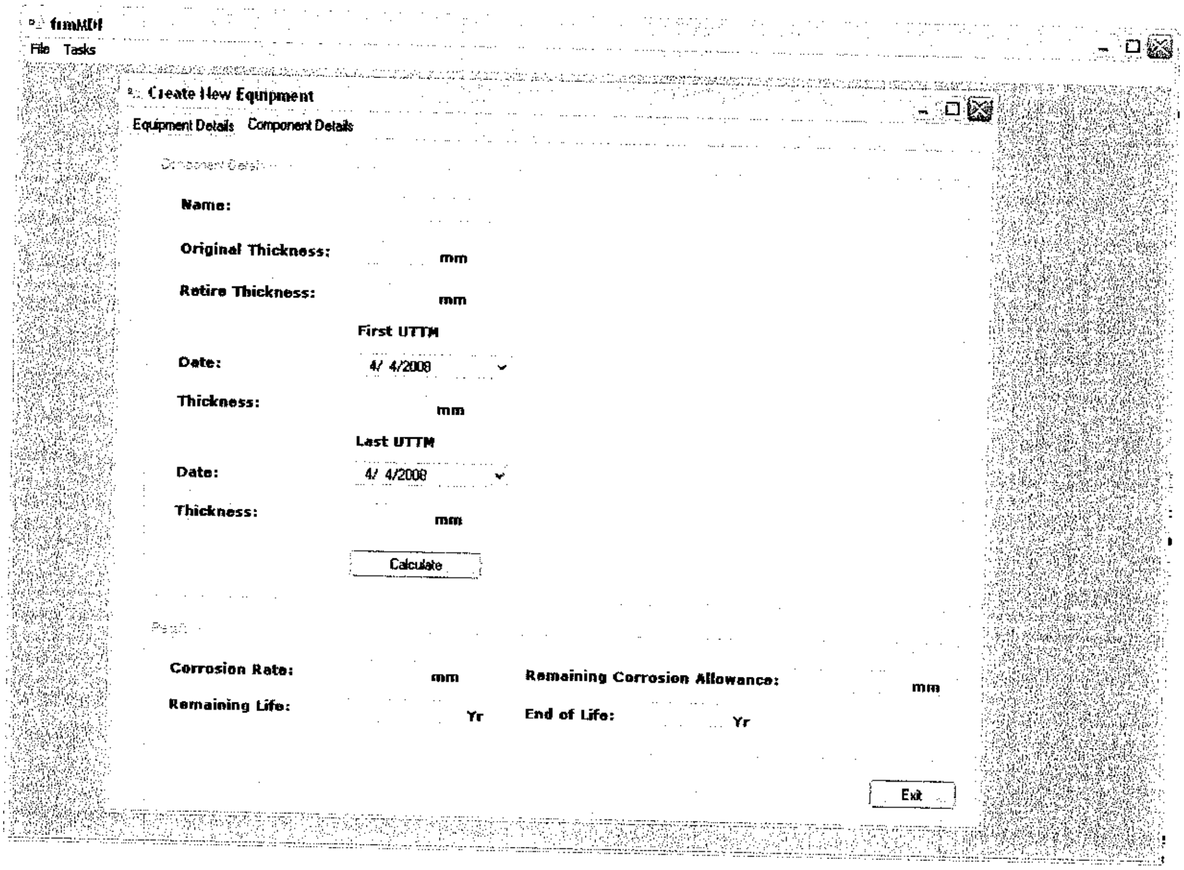

Figure 7: Create new equipment – component details

After completing with the equipment details, user need to key in all the data required in component details page. After inserting all the data required, button calculate will calculate all the attributes which are Corrosion Rate, Remaining Corrosion Allowance, Remaining Life and End Of Life. All those data will be stored in the database once button exit is clicked.

4.3.2 View equipment page

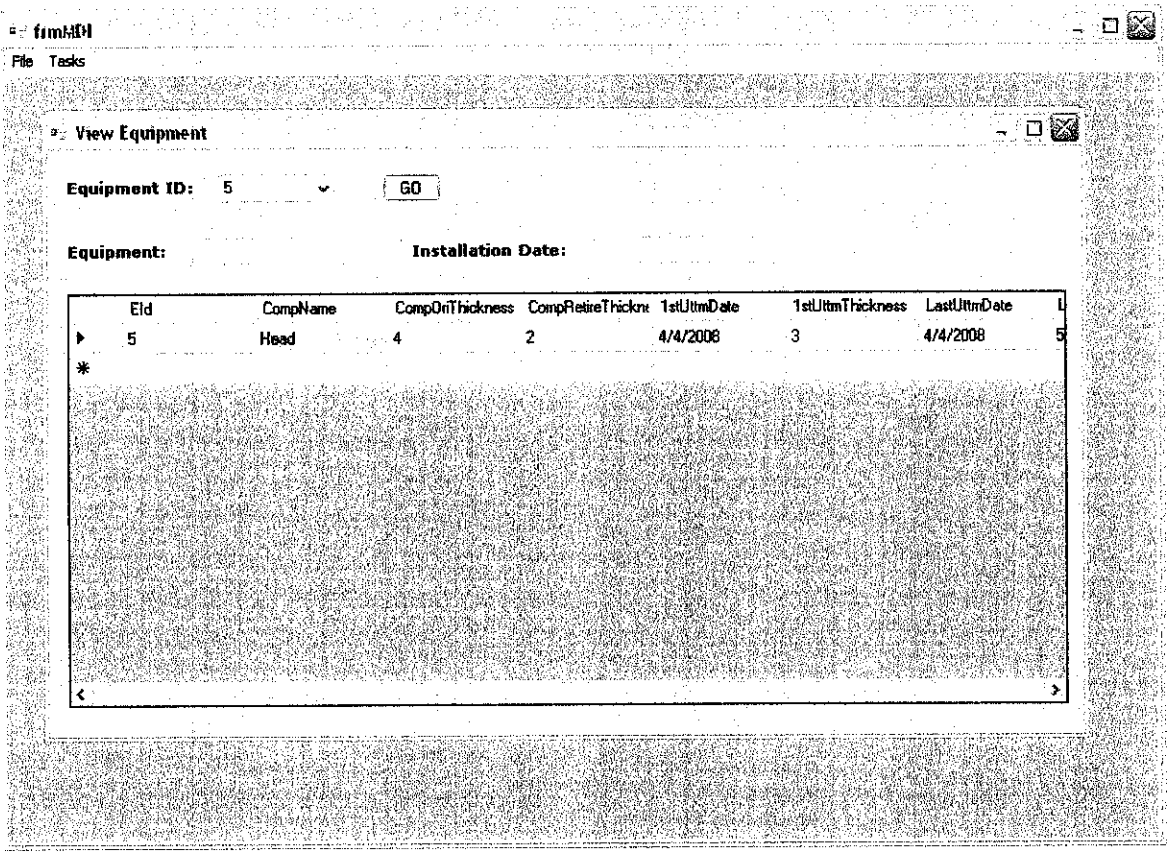

Figure 8: View equipment

In this page, user can retrieved back and view all the inserted and stored just now. All the user need to do is just choose the equipment they want to view by choosing their ID in the combo box provided and click button *GO.* Once the user clicked the button, all the data related to the equipment will be displayed in the text box and data grid provided.

4.3.3 View result page

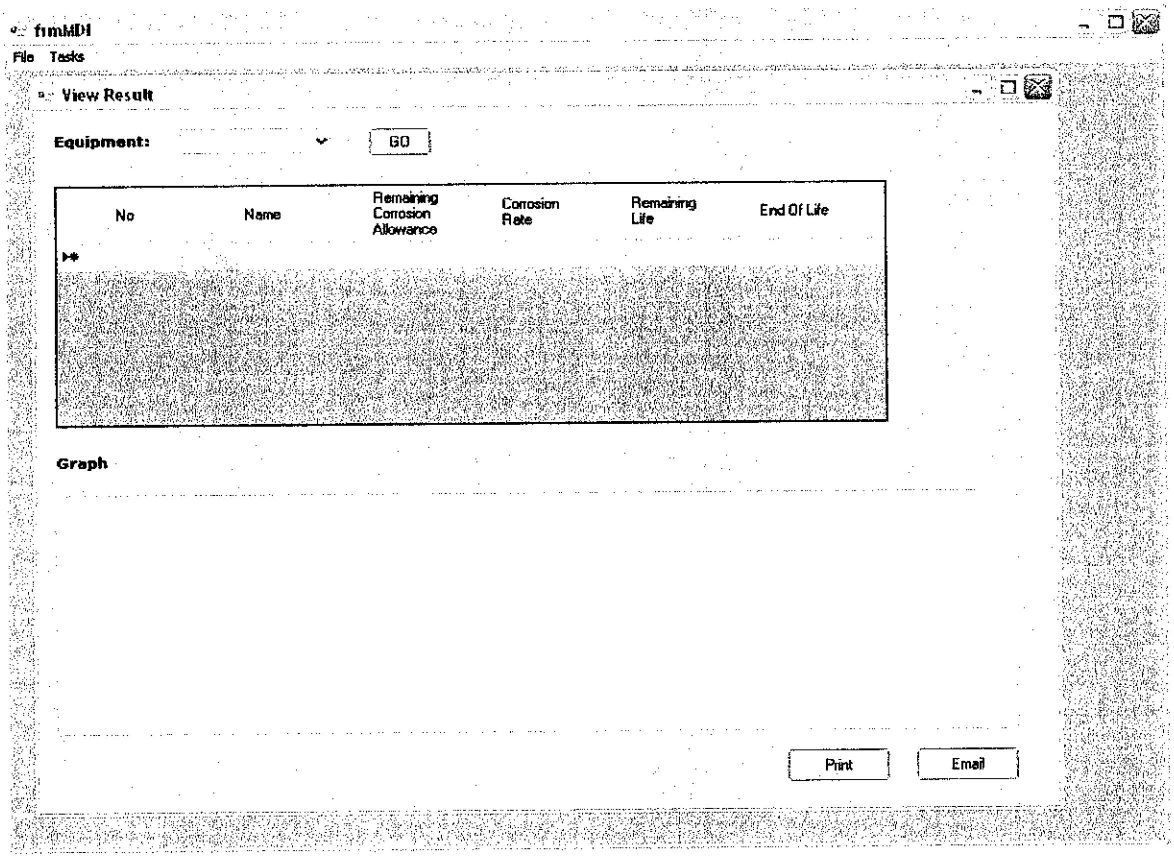

Figure9: View Result

In this page, user can view all the result calculated from the data entry that have been inserted just now. The process is the same as to view equipment. The user need to select an equipment ID provided in the combo box list to view the result of the particular equipment. In this system, the result will be provided in two ways which are in table and also in graph. The graph will portray the thickness vs. year.

4.4 System Output

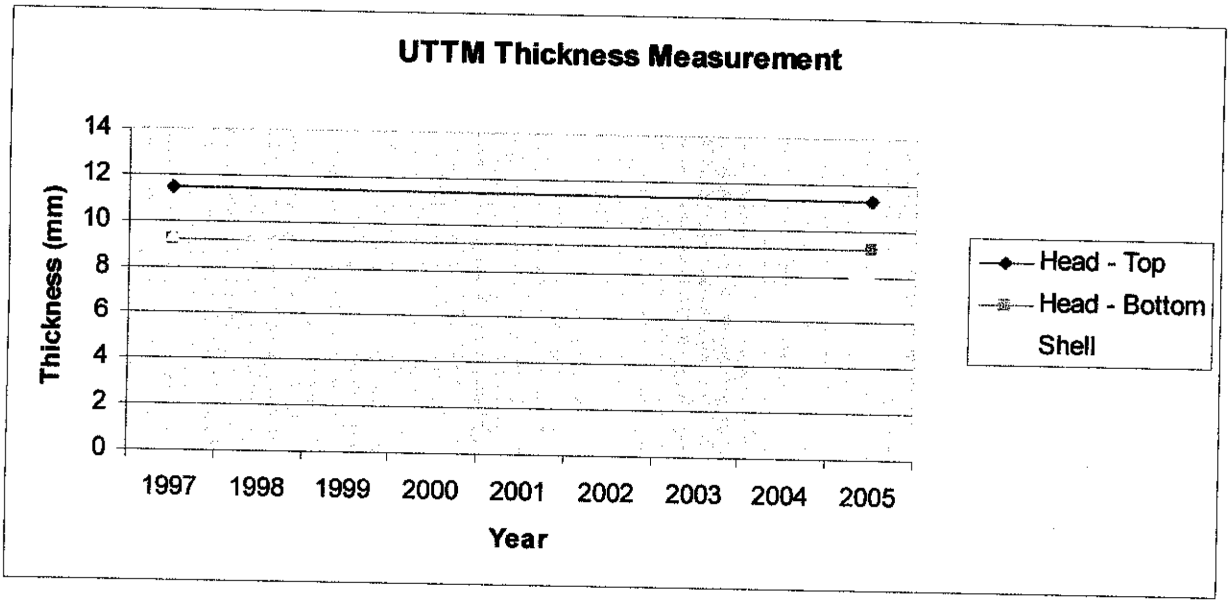

Figure 10: Result in graph

In the graph shown above, we can see that the graph represents thickness versus year of inspection. The graph shows that the thickness of component is decreasing as the year increasing. This means the corrosion of each component will increase by year.

Equipment ID	Equipment Name	Remaining Corrosion Allowance	Corrosion Rate	Remaining Life	End Of Life
1	Head - top	9.51	0.025	508,8	Jun 26,2387
2	Head - Bottom	7.35	0.019	224,3	January 4,3185
3	Shell	7	0.015	381,6	June 15,3056

Figure 11: Result in table

As shown in the table above, the end user can get a clear view of the results by looking at the result table. They can view all the attributes that have been calculated before. After view the result, the user can print or send it directly to the client.

CHAPTER 5

CONCLUSION

This report has described the process and potential advantages and disadvantages of implementing thickness measurement system. Based on the research and requirements gathering for the project, it is possible that the system can be fully implemented. The system is believed to be the additional improvement to the current inspection system.

Nevertheless, there are still a few recommendations and improvements that can be apply to this system. For example in terms of the database. Due to the unfamiliarity to the other database options, the database for this system is Microsoft Access which can be upgraded to SQL server as a database which can guarantee a better server performance. This system also can be improved in terms of the system interface with more graphical and graphs that includes important features.

As the conclusion, this system will help the company to schedule and organize their inspection services. This is crucial, since to maintain all the facilities in plant and ensures that it well operated is not an easy task. It will help the company to be alert of the inspection since this system helps them in maintaining and organizing the inspection works and at the same time reduce the cost of unproductive inspections.

PROJECT TIMELINE

Graphical representation of activities involved in building Risk Based Inspection System

ID	Task Name	Start	Finish	Duration
1	Requirements	8/3/2007	8/31/2007	21d
2	SystemRequirements	8/3/2007	8/17/2007	11d
3	User Requirements	8/20/2007	8/31/2007	10d
4	Analysis	9/3/2007	9/28/2007	20d
5	Analyze user's needs	9/3/2007	9/7/2007	5d
6	Analyze system's needs	9/10/2007	9/14/2007	5d
7	Create a detail functional requirements documents	9/17/2007	9/28/2007	10d
8	Design	10/1/2007	10/19/2007	15d
9	Prototyping: Interface	10/1/2007	10/5/2007	5d
10	Prototyping: System Function	10/8/2007	10/19/2007	10d
11	Testing Prototype	10/22/2007	11/2/2007	10d

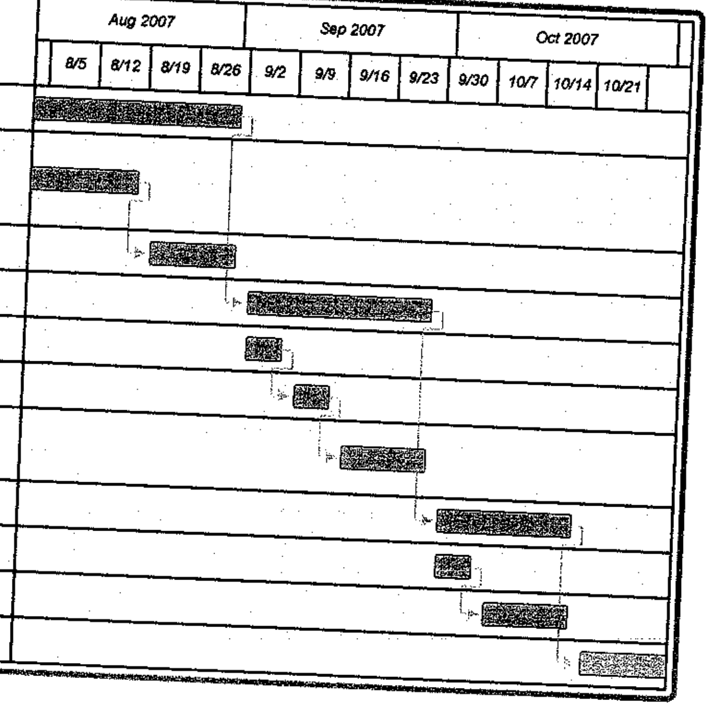

Figure 12: Planning of activities for FYP Part I

ID	Task Name	Start	Finish	Duration
1	Design Interface	1/15/2008	1/28/2008	10d
2	Coding	2/1/2008	2/29/2008	21d
3	Testing	3/3/2008	5/1/2008	44d
4	User Acceptance	5/5/2008	5/30/2008	20d

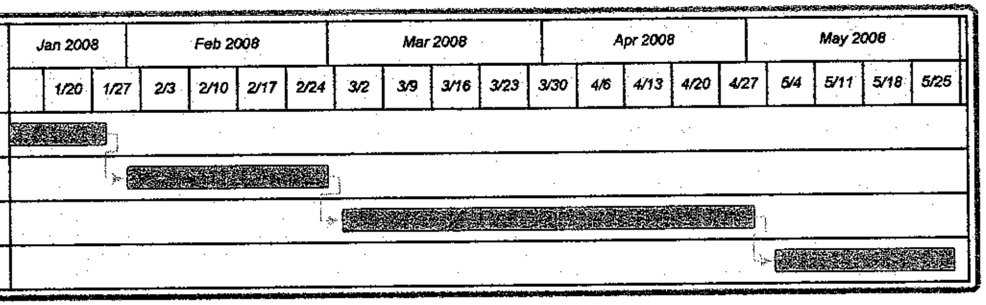

Figure 13: Planning of activities for FYP Part II

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