DFMA ANALYSIS OF A WATER TANK CLEANING ROBOT

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SUPERVISOR DECLARATION

"I hereby declare that I have read this thesis and in my opinion this report sufficient in terms of scope and quality for the award of the degree of
Bachelor of Mechanical Engineering (Design and Innovation)"

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Date : 24 June 2013

DECLARATION

"I hereby declare that the work in this report is my own except for summaries and quotations which have been duly acknowledged"

Signature : _____

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Date : 24 June 2013

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ABSTRACT

This project is a study on water tank cleaning robot. This project completed with the design and the analysis of a Water Tank Cleaning Robot. The conceptual of design selection will be through a House of Quality (HOQ) and weight matrix decision. The robot is designed to clean the water tank. The weight of water tank cleaning robot should be reduced to facilitate the movement of the robots and simplify the process of lifting the robot to put in a water tank. The cost of robot manufacturing must be reduced to allow robots affordable cleaning industry. Next, we will study on the water tank cleaning robot for size of robot, shape of robot, pressure of robot and material of robot. Besides that, this research will be study about design of water tank cleaning robot, function of all components for water tank cleaning robot. Lastly, this research wills analysis the Water Tank Cleaning Robot using DFMA analysis. The results of this analysis will determine whether the next step will be continued or repeat step design. The last step of this research is documentation such as report or paper.

ABSTRAK

Projek ini merupakan satu kajian mengenai robot pembersihan tangki air. Robot ini berfungsi untuk membersihkan tangki di kawasan-kawasan perumahan. Konsep pemilihan rekabentuk akan melalui sebuah rumah yang berkualiti. Robot direka untuk membersihkan tangki air. Kos pembuatan robot mesti dikurangkan untuk membolehkan robot industry pembersihan berpatutan. Seterusnya, kita akan mengkaji robot tangki air pembersihan untuk saiz robot, bentuk robot, tekanan robot danbahan robot. Selainitu, kajian ini akan belajar tentang rekabentuk tangki air pembersihan robot, fungsi semua untuk komponen robot pembersihan tangki air. Akhir sekali, kajian ini akan menganalisis Robot Pembersihan Tangki Air menggunakan DFMA analisis. Keputusan analisis ini akan menentukan samaada langkah seterusnya akan diteruskan atau mengulangi rekabentuk langkah. Langkah terakhir kajian ini adalah dokumentasi seperti laporan.

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LIST OF ABBREVIATION AND SYMBOL

WatClear	=	Water Tank Cleaning Robot
DFMA	=	Design For Manufacturing and Assembly
DFM	=	Design For Manufacturing
DFA	=	Design For Assembly
SAMB	=	Syarikat Air Melaka Berhad
IWK	=	Indah Water Konsortium (IWK) SdnBhd
LNG	=	Liquefied Natural Gas
LPG	=	Liquefied Petroleum Gas
RTC	=	Remote Tank Cleaning
VR	=	Vacuum Robot
MOH	=	Ministry of Health Malaysia
WHO	=	World Health Organization
HFM	=	Hand, Foot and Mouth
in	=	Inch
lbs	=	Pound (mass)
mm	=	Milimeter
Ltd	=	Limited
CAD	=	Computer Aided Design
HOQ	=	House of Quality

CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

Water is a basic necessity for life and it is an element chemical and can exist in liquid, solid or gas. People all over the worldwater use for food, cooking, washing, cleaning process,cultivation and processing of raw materials.Filtered water that is in the dose of chemicals will be stored in a common storage tank known as the clean water tank. Chemical reaction process will continue to occur in the tank to finish and when last treated water was perfect and meets clean water standards set by the Ministry of Health Malaysia (MOH) / World Health Organization (WHO), then it is released to the users with safe.

Water storage tank should be kept clean and safe. This is because water will be used by the public in all groups such as adults, children and the elderly. In2012 Malaysian has many of the problems encountered disease. For example of the disease of hand, foot and mouth (HFM), disease involving the hands, feet and mouth of a patient. This disease affects children 2 weeks to 5 years. It is caused by a virus infection of the enter virus group. Most likely, the cause of this disease is the lack of clean water sources. The main way the virus spreader is taking food and drink contaminated by the stool (fecal-oral route).

1.1 Problem Statement

The cost and time manufacturing needed to be reducing from the Water Tank Cleaning Robot. The water tank cleaning robot use in the water tank storage. The DFMA analysis for the robot need to reduce cost of the robot for of cleaning the water tank cheaper. The cost for make the water tank cleaning robot is so high and not affordable, so the DFMA analysis need to make the robot much more cheaper and affordable to cleaning tank industry.

1.2 OBJECTIVE OF PROJECT

The objective of this research is:

To analyze a Water Tank Cleaning Robot for domestic water tank cleaning purpose using DFMA analysis.

1.3 SCOPE

This report will include:

1. The study is focused on the design of the Water Tank Cleaning Robot is simple and suitableadopted in terrace houses in Malaysia
2. Design of the Water Tank Cleaning Robot
3. Make the DFMA analysis of a Water Tank Cleaning Robot.
4. Redesign of the Water Tank Cleaning Robot
5. Make the DFMA analysis for new design of a Water Tank Cleaning Robot.

CHAPTER 2

LITERATURE REVIEW

2.0 WATER TANK CLEANING ROBOT

WQ Enterprise SdnBhd (2011) defined The Robotic Tank Cleaning function to clean Clear Water Tank, Balancing Tanks, and Cooling Towers without the need to interrup water supply. James Murray described Water Systems have traditionally been limited to two options for cleaning and inspecting a reservoir or storage tank: empty the tank or send in divers. Both methods are costly, labor-intensive and raise personal safety issues. In addition, both options may require taking the tank offline, which can adversely affect the distribution system and result in a potential main break, loss of storage capacity and water quality problems (James Murray, 2010).

2.1 ROBOT FOR THE INSPECTION OF LNG/LPG TANKS

AmithSomanath, Ethan Heller, Cynthia Walker Panas(2007) developed Robot for the Inspection of LNG/LPG Tanks. LNG and LPG in Figure 2.1 are stored in steel alloy tanks at approximately -160C. These tanks need to be periodically inspected for cracks, corrosion and other defects. Currently the inspection process involves sending a human into the emptied tanks with inspection equipment (AmithSomanath, 2007). In order to make the tanks safe for human ingress they need to be warmed for 10-14

days. The cost of this shutdown is about 15 million dollars per day and is still hazardous for the human inspectors (Ethan Heller, 2007).

This project is to develop an inspection robot that can enter the tanks at much lower temperatures thus reducing the maintenance costs and limit the risk to human inspectors. There are many robotic inspection systems out there, but these systems are for external inspection which limits them to the walls and roof of the tank. These systems are not designed for hazardous conditions, thus they would not be suitable for placement into the tank. A new system needs to be designed which can work inside the tank under cryogenic temperatures and hazardous conditions to inspect the floor of the tank (Cynthia Walker Panas, 2007).AmithSomanath, Ethan Heller, Cynthia Walker Panas (2007) develop a mobile robot to inspect these LPG tanks in Figure 2.1.

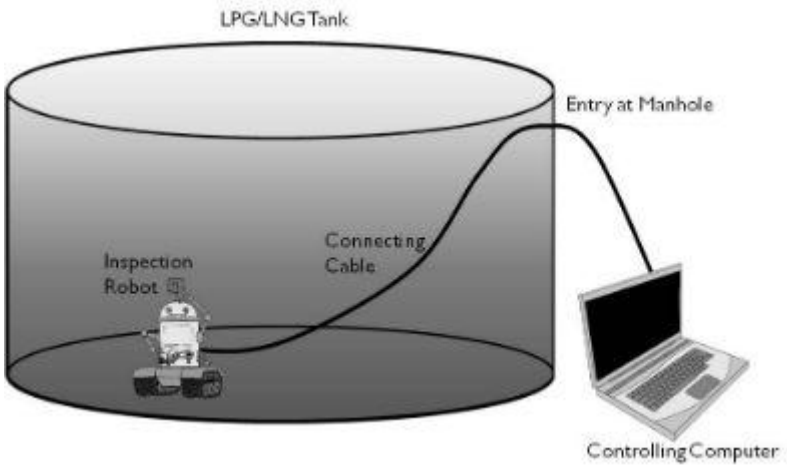

Figure 2.1: Robot for the Inspection of LNG/LPG Tanks (Photograph reprinted from AmithSomanath, Ethan Heller, Cynthia Walker Panas, 2007)

2.2 VR600 CLEANING ROBOT

Giancarlo Rinaldi(2008) developed VR600 Cleaning Robot in Figure 2.2. The underwater missions are providing a hi-tech solution to one of man's most ancient problems - how to secure a constant supply of safe drinking water. In the process, the robot are removing any risk to human life from carrying out operations in a confined space (Giancarlo Rinaldi, 2008).

Figure 2.2: VR600 Cleaning Robot (Photograph reprinted fromGiancarlo Rinaldi, 2008)

Designed with offshore specification components but generally operates in 10m of water. It has recently invested more than £120,000 in new equipment with the hope of expanding its water cleaning in the United States (Giancarlo Rinaldi, 2008).

2.2.1 VR600 Cleaning Robot Specifications

1) Length 750mm (29.5in)
2) Width 600mm (23.6in)
3) Height 450mm (17.75in)
4) Weight 60kg (132lbs)
5) Smallest hatch size it can fit into 600mmx450mm

2.3 REMOTE TANK CLEANING (RTC)

Tank & Pipework Ltd. (2011) developed Remote Tank Cleaning. RTC in Figure 2.3 has been designed and manufactured in the United Kingdom. This leaflet is for guidance only and provides anoutline of the storage tank cleaning service offered (Tank & Pipework Ltd. 2011).

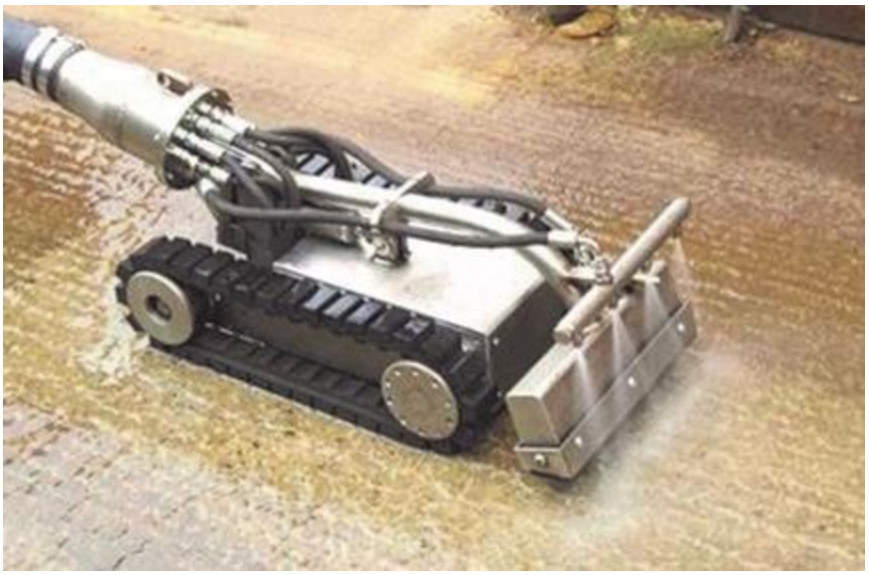

Figure 2.3: Remote Tank Cleaning, RTC. (Photograph reprinted from Tank & Pipework Ltd. 2011)

Tank & Pipework Ltd. (2011) developed RTC in Figure 2.3 have function to cleaning of hazardous storage tanks, particularly thus underground can prove difficult. Compliance with safe working procedures in confined and hazardous locations generally means that there are few choices in selecting specialist contractors and often this can reflect in high costs. The manual cleaning of storage tanks requires compliance with Health & Safety regulations and great care must be exercised at all times. The process is often slow, always dangerous and the consequences of a mistake can prove fatal. Now technology brings a welcomed option to manual cleaning. Our new remotely controlled cleaning robot (RTC) is monitored externally using CCTV imaging to provide industry with a safer option for the cleaning of storage tanks (Tank & Pipework Ltd. 2011).

RTC provides a unique solution. There is no requirement for manned entry into the storage tank and all cleaning operations are controlled safely externally. Multi-directional jets efficiently clean tanks floors and reach side walls to remove sludge and contaminants in the storage tanks. The Remote Tank Cleaning system can use various mediumssuch as high pressure water or use with specialist cleaning solvents in Figure 2.4. Fast, efficient, safe and reliable, RTC removes the risks in storage tank cleaning (Tank & Pipework Ltd. 2011).

Figure 2.4: Operator conductor of the RTC (Photograph reprinted from Tank & Pipework Ltd. 2011)