



# جامعة الأمير محمد بن فهد PRINCE MOHAMMAD BIN FAHD UNIVERSITY

College of Engineering

Department of Mechanical Engineering

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Senior Design Project Report

**Design and Build One Person Hovercraft**

In partial fulfillment of the requirements for the  
Degree of Bachelor of Science in Mechanical Engineering

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## **Abstract**

The hovercraft is an important vehicle used for many purposes. It can float above any type of ground. Hovercraft is sometimes called Air Cushion Vehicle due to its ability to move by cushion or skirt filled with air and cause the board to hover above the ground, and it moves by the thrust engine forward and fills up the cushion by lift engine.

In this Project, the aim is to design and manufacture one man hovercraft. It can carry around 70 kg with rated speed between 5-10 km/h. Two fans are used for this hovercraft, one of them for thrust and the other one for lift. Each fan has a separate engine to perform the required task. The thrust engine produces up to 10HP at 3600 RPM and the lift engine goes up to 6-7HP at 3000 RPM. The dimensions of the hovercraft are 2.4 meter in length and 1.2 meter in width with 1.00 meter thrust duct diameter. The engine rotation shaft is linked with propeller through hub and pushing. However, the design of the hovercraft applies a horizontal shaft engine and a vertical shaft engine. The horizontal engine is used for thrust and the vertical engine for lift. The hovercraft is provided with rudders to control the direction. The whole engine base of the hovercraft is rectangular in shape, and it can be made of carbon steel or wood. On the other hand, the skirt of the hovercraft is made of PVC Polyester. Finally, our objective is to approach a hovercraft with speed range from 10-15 km/h.

## **Acknowledgment**

At this stage of graduation, we would like to extend our hearts to thank Prince Mohammad Bin Fahad University (PMU) and the distinguished doctors for their efforts and support in our studies. At the same time, we extend our special thanks and appreciation to Dr. Faramarz Djavanroodi and Dr. Nader Sawalihi, for their efforts, continuous guidance, and unparalleled support, are the main ingredients in the accomplishment of our most important graduation project. Their ever-presence and continued mentoring is the constituent of our success. Our project, design, and development of a hovercraft, is unique and required an enormous amount of time and efforts from the concept to design and construction, and needed continued support, cooperation and collaboration from team members and doctors. Every team member, collaborator, and coordinator have put in the maximum during the process and looking forward for a successful project. Finally, we would like to extend our precaution to Mr. Fahad Al-Haidar establishment for their support by using their fabrication workshop.

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### List of Acronyms (Symbols)

<b>Air Cushion Vehicle</b>	A vehicle that floats above any lands such as ice, sand, grass, and water
<b>CAD</b>	Computer Aided Design
<b>Skirt</b>	Full up with air and it is surrounding around the body.
<b>Base of engine</b>	It will carry the engine.
<b>Steering</b>	Control the direction.
<b>Rudders</b>	Change the air flow direction by using steering.
<b>Thrust duct</b>	Design it as a nozzle to increase the flow of air.
<b>Thrust fan</b>	Producing flow air.
<b>BHC</b>	British Hovercraft Corporation
<b>Aerodynamic</b>	Motion of air and gases acting on a body in motion relative to such
<b>Plywood</b>	Sheet of layers manufactured by wood.
<b>HP (Horse Power)</b>	A unit of foot pound second (fps) to express the mechanical energy.
<b>MDF</b>	Medium Density Fiberboard.
<b>RPM</b>	Revolution per minute.
<b>LPR</b>	Low pressure rubber
<b>HPR</b>	High pressure rubber.

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# CHAPTER 1

## INTRODUCTION

### 1.1 PROJECT DEFINITION

### 1.2 PROJECT OBJECTIVES

### 1.3 PROJECT SPECIFICATIONS

## **1.1 Project Definition:**



Figure 1.1 (Example of Hovercraft)

A Hovercraft is a vehicle that floats above any lands such as ice, sand, grass, and water. Hovercraft sometimes called Air Cushion Vehicle due to its ability to move by cushion or skirt filled with air and cause the board to hover above the ground, and by the thrust engine it runs forward and fills up the cushion as shown in figure 1.1. In this project, we intended to build and design our hovercraft which could work in many circumstances as much as the car regarding any land. The concept of the hovercraft is simple, starts with a particular kind of wood that has the property in carrying loads and has some gaps to help wood floats above any land. Underneath the wood, the skirt or cushion takes place, and it functions to create a change in pressure bycatch the air in one area to create the required difference in pressure between inside and outside of the skirt. The mechanical part of our project is the engine and control system which help in maneuvering and monitoring the direction of the hovercraft. The project is helpful and necessary many cases such as military and security in which hovercraft are excellent for off beach protection and rescue. For commercial operation also hovercraft can play a distinct role in guiding the ships to the shore safely and efficiently rather than using small boats which can cost a lot

in maintenance. The best application of the hovercraft comes in situations like flooded areas like what happened in al-Khobar city a few weeks ago. The figure 1.2 explains the simple mechanism of hovercraft.

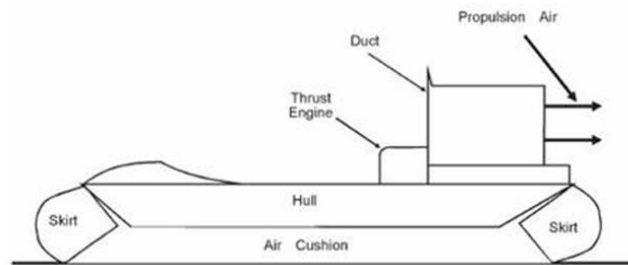


Figure 1.2 (Simple explanation of hovercraft)

### **1.2 Project Objectives:**

The hovercraft project went into different phases and challenges to approach the following objectives:

- I. Prototype a Hovercraft with simple design and can do the required function of movement.
- II. The approach design of hovercraft is to move with a rated speed of 10-15 km/h.
- III. Hovercraft can tolerate with more weight up to 200 kg and runs under intensive operation smoothly.
- IV. Improve the factor of safety for all materials during all operation process.
- V. Propagate new vision for a vehicle can operate in different circumstances.

### **1.3 Project Specifications:**

Our project specifications are mainly:

- I. Design and assemble the parts of the vehicle using CAD.
- II. Construct a vehicle with a dimension of 2.40 m in length and 1.20 in width.
- III. Implementing two engines one for thrust with rated power of 10HP and another one with a rated power of 6-7HP for left.
- IV. Construct the Manual mechanism System to monitor the hovercraft.
- V. Minimize the weight of the hovercraft by select materials like (plywood, foam, MDF, and fiber glass).

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 PROJECT BACKGROUND**

#### **2.2 PREVIOUS WORK**

#### **2.3 COMPARATIVE STUDY**

## **2.1 Project Background:**

The first hovercraft was concocted and protected by the English innovator Christopher Cockerell, in 1952 and figure 2.1 shows the first prototype. A few innovators preceding that date had fabricated or endeavored to manufacture vehicles given the "ground effect" rule (the possibility that catching air between a fast moving vehicle and the ground can give additional lift and decrease drag). These endeavors were of restricted achievement and did not utilize the annular air pad that known today. The initial design for hovercraft was gotten from a British development in the 1950s to 1960s.



Figure 2.1 (First Hovercraft prototype by Christopher Cockerell)

They are presently utilized all through the world as accurate transports in misfortune alleviation, coastguard, military and study applications and also for game or traveler benefit. Large forms have been utilized to transport individuals and vehicles over the English Channel, while others have military applications used to carry tanks, fighters and expensive hardware in antagonistic situations and landscape. Although now a non-exclusive term for the kind of specialty, the name Hovercraft itself was a trademark possessed by Saunders-Roe (later British Hovercraft Corporation (BHC), then Westland), subsequently other producers' utilization of option names to portray the vehicles. [1, 2]

Some hovercraft has two motors with two arrangements of controls for lifting and thrust as figure 2.3 and some hovercrafts do ( lift and thrust ) by one engine as figure 2.2 , the only engine outline parts air lessening the requirement for two motors, to spare weight and disentangle operation. Left and right bearing are overseen by steering to control rudders into the back of the fan channel get together. Some hovercraft have a high focus of gravity and can be hard to guide around corners; like a car like which lowers center of gravity that helps cornering.[3]

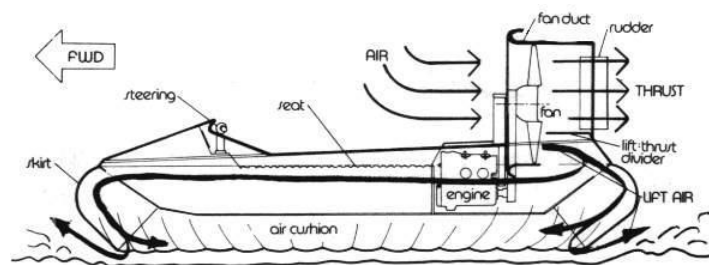


Figure 2.2 (One Engine Hovercraft)

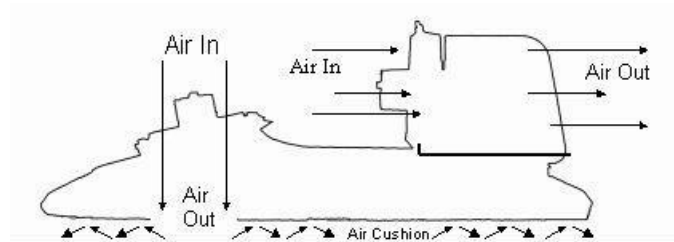


Figure 2.3 (Two Engines Hovercraft)

## 2.2 Previous Work:

A **hovercraft**, otherwise called an air-cushion vehicle or ACV, is a specialty equipped for going over land, water, mud, ice, and different surfaces. Hovercrafts are half vessels worked by a pilot as a flying machine as opposed to a chief as a marine vessel. A hovercraft is a land and water capable vehicle that is bolstered by a pad of marginally

pressurized air. Although regularly observed as a secretive, even unusual method of transportation, it is reasonably straightforward. To see how hovercraft functions, it is important to understand that the progression is more firmly identified with airship than to boats and automobiles. As an individual from a group of air pad vehicles (ACVs) or Ground Effect Machines, which incorporates wing-in-ground-impact or ram wings, surface impact ships, sidewall hovercraft ship and surface skimmers, hovercraft are the land and water capable individuals from the air pad vehicle family. They are the most novel among vehicles that are bolstered by pressurized air. Allude to the delineation underneath as presented that how precisely hovercraft functions.

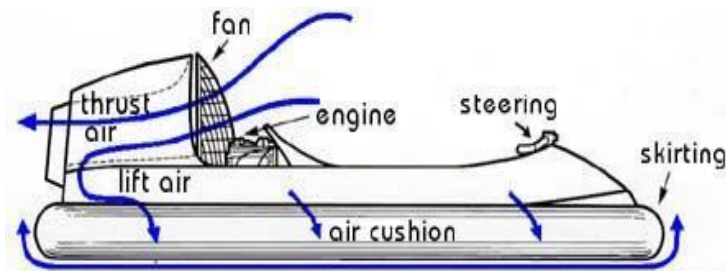


Figure 2.4 (Distribution of Air Along the hovercraft)

As in (figure 2.4); Hovercraft glides on a pad of air that has been constrained under the specialty by a fan. This causes the hovercraft to rise or lift. The measure of lift can run from 6" to 108" (152mm to 2,743mm) contingent upon the extent of hovercraft. The measure of aggregate weight that a hovercraft can raise is equivalent to pad weight duplicated by the zone of the hovercraft. To make the specialty work all the more effectively, it is important to restrict the pad air from getting away, so the air is contained by the utilization of what is known as a hovercraft skirt. Formed from texture, which allows a thick cushion or clearance of obstacles, hovercraft skirts shift in style extending

from packs to cells to isolate fingered areas called fragments.

Once "lifted" or "on the cushion," push must be made to propel the hovercraft. With many specialties, this is produced by a different motor from the one used to make the lift, yet with a few, a similar motor is utilized for both. The fan-produced air stream is the part, so that piece of the air is coordinated under the body for lift, while a significant portion of it is utilized for pushed. Since the hovercraft has lift and push, it must be controlled securely. This is accomplished using an arrangement of rudders behind the fan, controlled by handlebars in advance. Directing can likewise be controlled by the utilization of body weight dislodging, an aptitude which is accomplished after practice. Hovercraft utilizes blowers to deliver a large volume of air underneath the frame that is somewhat above air weight. The weight distinction between the higher pressure air underneath the frame and lower weight encompassing air above it produces lift, which causes the body to skim over the running surface. For dependability reasons, the air is commonly blown through openings or gaps around the outside of a slots or holes giving most hovercraft a trademark adjusted rectangle shape. Often this pad is contained inside an adaptable "skirt," which permits the vehicle to go over little checks without harm.

Small hovercraft has a developing part to play in pursuit and protect business and military operations around the globe. Hovercraft can be a down to earth recommendation for operations in zones out of reach to different vehicles including solidified water, mud pads, intertidal regions, shallow streams and overflowed inland regions.

Hovercraft has at least one separate motor (some hovercraft, for example, the SR-N6, have one motor with a drive split through a gearbox). One motor drives the fan (the impeller) which is in charge of lifting the vehicle by compelling air under the hovercraft.

The air in this manner must exit all through the "skirt," lifting the art over the territory on which the craft resides. At least one extra motor is utilized to give push keeping in mind the end goal to drive the specialty in the fancied course. Some hovercraft use ducting to permit one engine to perform both errands, by guiding a portion of the air to the skirt, whatever remains of the air going out of the back to push craft forwards.[4]

Hover work of Parry Sound planned to improve the situation of the hovercraft rudder, which utilizes a hybrid and skirt outline that consolidates the best of routine hovercraft innovations. The Air Rider Hovercraft is proposed to defeat a portion of the shortcomings of the two most basic hovercraft plans. The air pad of a hovercraft is delivered by an adaptable elastic or plastic skirt that hangs down from the structure. The skirt should be sufficiently flexible to hold noticeable all around, yet sufficiently adaptable to permit the art to arrange rugged landscape, waves, and low impediments. This settles on the selection of skirts somewhat of a bargain, with the two primary options showing unmistakable qualities and shortcomings. The first is loop skirt, which, as the name suggests, encloses the hull of the craft. The compressor lift fan blows air under the body where the circle catches it, shaping a cushion and lifting the craft. It's an effective plan. The loop skirt is great at making and keeping up the air pad, yet on water, it makes for an incredibly rough ride with heaps of shower and drag. As per Hover work, Air-Rider hovercraft split the contrast between the two skirts by method for a loop/segment hybrid design. The sides and stern are secured by a loop skirt, and the bow has a fragmented skirt. This eliminates the splash and slamming as the fragmented bow respects approaching waves, while the circuit gives greater security and to a lesser degree an inclination to catch. Hover-works says that the plan likewise improves the Air-Rider

much then either customary outline at arranging stony stream beds or waterway rapids.

[5]

Sir John Thornycroft was a British architect who in the 1870s started to test his hypothesis that delay a ship's structure could be diminished if a ship had a plenum chamber, basically an empty box, open at the base. He imagined that if the chamber could be pumped brimming with air, the ship would skim over the water and move quicker because there would be less resistance. He wasn't able to prove that how to keep the "air pad" from getting away from under the craft. Cockerell throws away the plenum load guideline, guessing rather that if he could pump air under the vessel through a limited space that circled it, the air would stream toward the vessel's middle, in this manner shaping an outer blind that would trap the rise of air under the hull. Cockerell trusted this framework, which got to be distinctly known as a peripheral jet, would permit the boat to hover. He petitioned for a patent in late 1955, and the following year shaped Hovercraft Ltd. In 1959, he propelled the principal down to earth air pad vehicle, the SR-N1. It had an elastic skirt that contained the air pad over harsh terrains or water. This model crossed the English Channel in June 1959. It had a top speed of 10 mph and couldn't arrange rushes of more than 18 inches or land hindrances higher than a foot. [6]

### **2.3 Comparative Study:**

1/ Indiana State University's Society of Manufacturing Engineers (SME) and Society of Automotive Engineer (SAE) have teamed up to build a hovercraft. The students hope to enter a few races in the fall of 2004.[7] With encouragement from Chris Fitzgerald, founder of the World Hovercraft Organization and president of Neoteric Hovercraft, Inc., in Terre Haute, the ISU team has spent long hours planning, designing and building their hovercraft from a material kit purchased from Universal Hovercraft in Harvard, Ill. The materials package the ISU team is using consists of plywood, foam, fiberglass, epoxy, contact cement, PVC-coated nylon, a propeller, an aluminum hub, a ten horsepower Tecumseh engine, and screws and pulleys.

The purchase of the kit was made possible by a donation of \$1,060 from the local parent chapter of SME 275. The local chapter 275 has been a big supporter of the ISU student chapter 089.

A team of 15 ISU students began working on the Hovercraft project in January 2004.

“A lot of SME guys are graduating, and we wanted to do something before we were gone,” Dave Oelschlager, a senior from Columbia City, Ind., said.

The students downloaded a set of hovercraft blueprints from [www.DiscoverHover.org](http://www.DiscoverHover.org), the website of the World Hovercraft Organization's International School Hovercraft Program, which provides hovercraft plans and instructions at no charge to students, schools and youth organizations. The ISU team then began a redesign of the original blueprints.

According to Oelschlager, who is heavily involved in the project, the redesigning of the

blueprints took well over 70 hours of volunteer work. Through the use of AutoCAD and Pro-E, junior high and high school students can easily understand the new blueprints.

Rob Wilson, Neoteric Hovercraft's Technical Director in Australia, is currently reviewing the new plans for accuracy.

"ISU is playing a key role in taking the Discover-Hover Build-a-Hovercraft School Project to schools and students throughout the world by creating a prototype project for the program and improving the original plans," said the marketing director for Neoteric Hovercraft and the World Hovercraft Organization.

James Smallwood, chairperson and professor of manufacturing/construction technology and Mike Hayden, professor of industrial/mechanical technology, serve as advisers to the students.

"When an organization does a project like this, it gives students additional real-life, problem-solving skills," Smallwood said. "They are not only doing the work; they are managing a project. We've learned that all else being equal, a manager who has experience in the technology behind a project is a better manager than one who does not have that experience, we're preparing managers."

Hovercraft operate by floating on a cushion of air over land, water, ice, and mud.

"They're very environmentally friendly, with little impact," Herring continued. "A hovercraft can be flown over a nest of bird's eggs without harming them."



Figure 2.5 (Hovercraft of another student's project) [8]

The photo was taken at the end of spring semester, 2004. Students were able to get the craft running around Campus, but it still needs to be painted and fine-tuned. [8]

2/ a hovercraft, as known by the world today, is a type of an air-cushion vehicle (ACV) with the capability of traveling on both lands and water. It had been in use for over half a century and gone through various modifications since then, to apply its unique features to modern day transportation needs.

We, a team of 2nd year engineering undergraduates of the University of Moratuwa, Department of Mechanical Engineering, would like to inaugurate this transportation technology to Sri Lanka by proposing a project to design and build a single passenger hovercraft.

The designing and adding modifications to the hovercraft will be carried out in such a way that it will best suit the transportation needs and topography of Sri Lanka.

The project will be conducted under the supervision of,

- Dr. Palitha Dasanayake (Head of Department – Mechanical Engineering)
- Dr. Nirosch Jayaweera (Senior lecturer)
- Mr. Sasiranga De Silva (Lecturer)

As engineering undergraduates of DOME UoM, Our goal is to conduct a study on Hovercraft technology and ultimately design and manufacture a cost effective working model, using the knowledge and skills of the finest undergraduate talent in the island and the facilities of our very own country.

Objectives:

- To design and build a hovercraft to be presented to the exhibitions.
- To analyze the potential capabilities of designing and building hovercrafts locally and to assess the advantages of such a conveyance to Sri Lanka.
- To identify potential research areas related to hovercraft technology and implement upon completion of the project.
- To introduce an energy-efficient way of travelling and search for other utilities of implementing this technology.
- To understand the applications of basic engineering principles learnt as a mechanical engineering student and to improve professional and teamwork skills.
- To get hands on experience with various manufacturing methods and engineering tools.

- **Why a Hovercraft?**

The Hovercraft is internationally renowned for its ability to travel on diverse terrains. As a vehicle which can be effectively deployed on land, water, ice and marsh areas, the Hovercraft is a real masterpiece of engineering technology. They are now used throughout the world as specialized transports in disaster relief, coastguard, military and survey applications as well as for sport or passenger service. Although it holds high potential to provide efficient solutions to many transport problems on the island, the concept of the Hovercraft is still new to Sri Lanka. The design and development of the hovercraft will be carried out in such a way that it best adapts and addresses the applications unique to our country.

- **What will be different in our project?**

- Constructing CAD model for our material selection.
- Assembly drawing are given in manufacturing steps.
- Publicize the concept of hovercraft in Saudi Arabia.
- Good exercise to understand all the theoretical studies we have done in our mechanical engineering bachelor degree program and put them into practical use.



**CHAPTER 3**  
**SYSTEM DESIGN**



**3.1 DESIGN CONSTRAINTS**



**3.2 DESIGN METHODOLOGY**



**3.3 PRODECT SUBSYSTEMS AND  
COMPONENTS**



**3.4 IMPLEMENTATION**

### **3.1 Design Constraints:**

The hovercraft is a vehicle that is used in land, water, river, snow, ice...etc. The most important for the hovercraft is the designing to have the successful result. You need your CAD drawing to be applied to help your hovercraft structure. Before the designing process of hovercraft began, the following points should be consider in designing of hovercraft:-

- The engine, horse power, torque, and rpm.
- The full size and weight of hovercraft body.
- Thrust duct design.
- The material for the hovercraft.
- The air channel to the skirt.
- The maximum load for hovercraft.

These are some of the important factors which one needs to consider for designing a hovercraft. Material selection is very important. The CAD drawing should be exactly correct and near to reality to help you make your hovercraft successfully. The sizing and measuring for (height, weight, length) are essential to run-up your assembly in SOLIDWORKS program. Also, we can test the properties of materials in the lab. When the length, for example, is not accurate with the weight of the engines and total body which been designing, this might affect the balance of the hovercraft. Our hovercraft project recommended design specification shown in (Table 3.1):

(Table 3.1 Recommended Design Specifications)

**Metric**

<b>Capacity</b>	1 person
<b>Payload</b>	up to 130 kg
<b>Speed</b>	15-20 km/h
<b>Length</b>	2.26 m
<b>Width</b>	1.21 m
<b>Empty weight</b>	45 - 60 kg
<b>Thrust Engine</b>	10 HP horizontal shaft (under 30 kg)
<b>Lift Engine</b>	6 HP vertical shaft (15 kg)
<b>Construction Method</b>	Foam, Plywood and PVC polyester
<b>Construction Time</b>	150 - 170 hours

The payload is the lifting capacity of the hovercraft. There are two sorts of payload, the ground weight lift ability, and the on-water weight lift capacity. Hovercraft for the most part lift half more weight when beginning ashore, a few providers fudge their on-water ability, so it doesn't depend on the number of seats the hovercraft have. We must check the on-water lift capacity on the off chance that you plan to go over and stop or need, to begin with, water. At the point when hovercraft begin on water, the hovercraft makes a weight wave known as the Hump – now and then difficult to get over and get to be distinctly airborne. We can delineate the protuberance by pushing a bit of paper on a work area while binding it with another discovered the paper curves up like a wave. Getting over mound is harder to do in shallow water.

The feasibility of utilizing hovercraft for marine protection has less fluid resistance comparing with (i.e. ships and pontoons). So, the organization can easily perform their job by reaching the enemy as an example. The Improvement of coastal safeguard effectiveness will in the long run. The quantity of security units that should be sent to keep up seaside resistance and the capacity to move arrive based landscape alongside maritime floors. In fact, we trust that hovercraft are the most reasonable specialties to be utilized for sea protection and in whatever another area. It won't just enhance resistance and security in the local, however, will decrease the expenses on marine defense having an effect on the overall defense budget. The hovercraft is useful for island areas. Many of the islands are difficult to reach by aircraft because of the small size of the area. It is not far away from the cities, so the hovercraft is one of the appropriate solutions for transportation.



Figure 3.1 (Using a Hovercraft for RESCUE)

Using the hovercraft for rescuing people from ship sinking or helps people for emergency cases as in figure 3.1. So, the hovercraft can take the forces or any other helpers quickly to that islands because it does not need for the port construction. The military used the hovercraft to coach those people who try to use the sea border to escape from country or Smuggling of contraband into the country. One of the most used and it is an official for hovercraft. It has used to explore for unexploded bombs. The hovercraft is more safely than the boat in many areas that have stones which can damage the fan used in the boat. In the other hand, hovercraft does not have the fan as the boat. The fan is on the top which cannot touch the floor. The hovercraft is more safety to use it in many areas that any other vehicles cannot go. Also, the bottom of the hovercraft is not made of carbon steel or material that can be corroded. It is made by PVC polyester which is under all of the hovercraft with fewer prices than other material. If any problem happened with the skirt as damage. It can be easily fixed or changed because as it is not expensive.

### **3.2 Design Methodology:**

Before the designing process of hovercraft began, we determined the most important principles to structure our hovercraft. We consider the following points as criteria guidance:

- Availability of materials.
- Good performance.
- Economical.

The performance of hovercraft is depend on the material selection and function for each part. Materials and parts were selected based on their availability and easy to use in repair and maintenance when facing problem. The main principle governing process was the guide line to achieve our aim for successful project. The most important factor is minimize the friction between the hovercraft structure and the ground. On other hand, material cost played a large factor on hovercraft designing. After that, we determined the type and specifications of the hovercraft designing based on factors below (Table 3.2):

(Table 3.2 Specifications based on Factors)

<b><u>Factors</u></b>	<b><u>Factor Priority</u></b>	<b><u>Description</u></b>
<b>Lift</b>	High	Minimize friction between hovercraft and floor
<b>Lift skirt</b>	Essential	Generate air cushion in the skirt
<b>Speed control</b>	Essential	

<b>Limit speed</b>	Optional	
<b>Low weight</b>	High	
<b>Low cost</b>	High	
<b>Durability</b>	High	Must be able with stand impacts

By applying the previous principles and factors, we expecting to have a successful project has been designed to perform the required functions.

Starting with the engine, we checked the previous researches and studies in addition to home hovercraft manufacturer. We reached to the fact that all hovercraft of the same size can be designed with one or two engines for both functions (thrust and lift), use a horizontal shaft engine with 10HP gasoline engine with 3600 rpm for thrust and a vertical shaft engine with 6-7HP gasoline engine with 3000 rpm for lift. By using SolidWorks program, we were able to apply our design using real dimensions. That afforded valuable information of how the hovercraft will be. Also, it enabled manufacture team to correctly create all necessary pieces so that we were able to avoid unnecessary engine vibrations that result from wrong measurements of the pushing that connects shafts to the engine. On the hand, we used rubber sheet between the engine and engine base to minimize the vibration.

Moreover, through the team's efforts to looking for most suitable building materials, we found that one manufacturer was able to contract wood thickness, supporting it with a high-density foam board which provided a lighter weight. The team was able to find that type of waterproof foam boards that effectively was used for isolation purposes. The team

checked the chemical properties of the material obtained to adjust measurements and calculations of weights and durability. On the other hand, the material used for the skirt was the hardest challenge of the project. However, the team, through written communications, reached valuable chemical properties of PVC polyester, the material used for skirt building which is also used for tent manufacture.

Thrust duct is the most critical part of a hovercraft. It was important to learn about past experiments of thrust duct designs. Thus, the strategy used for designing thrust duct is to use nozzle shaped like wooden boards. The design was completed through SolidWorks program. It depended on using foam spray with a wooden object then it is arranged in the figure attached.

Through searching the designs and functions of mechanism in the previous hovercraft, we gained valuable information on the mechanism of hovercraft. Thrust air increases in power because of the nozzle-shaped thrust duct. Air produced is divided into two divisions; one is used for motion of a craft while the other division of air is compressed and pushed through a duct under the craft to lift it with the help of the skirt.

We start calculate the thrust air produced by the propeller:

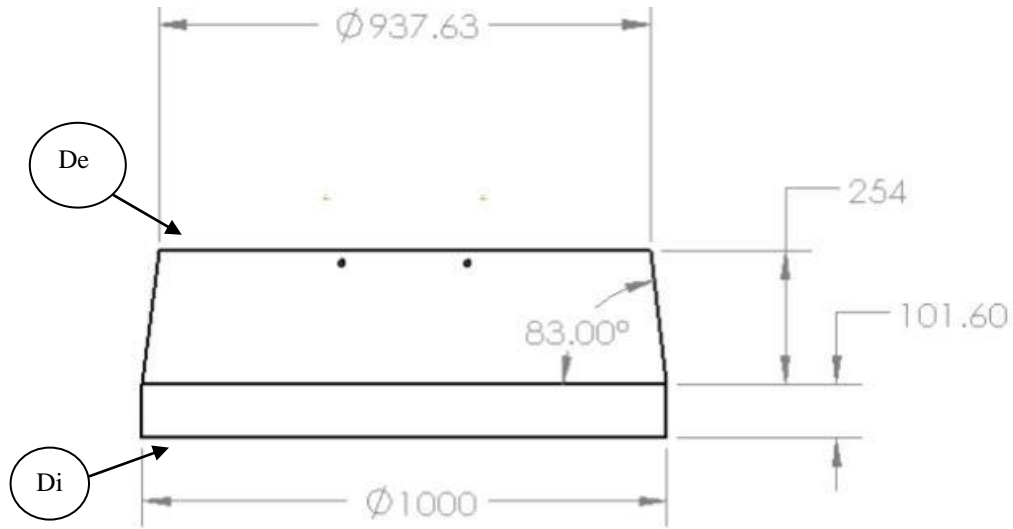


Figure 3.2 (The sketch of thrust duct, the dimension in mm)

-Di: The diameter of thrust duct where the air get in.

-De: The diameter of thrust duct where the air get out.

-Re: The exit radius of thrust duct.

$$Di = 1.00 \text{ m} \quad , \quad De = 0.935 \text{ cm} \quad , \quad Re = \frac{1}{2}De = \frac{1}{2}(0.935) = 0.4675 \text{ m}$$

Thrust Calculation:

$$F\Delta t = \Delta \vec{p} \quad , \quad \vec{p} = m\vec{V}$$

$$F = \frac{m}{\Delta t} (Vf - Vi), Vi = 0, Vf = Vavg$$

$$F = \dot{m} (Vavg)$$

$$F = \rho \dot{V} (Vavg) \dots\dots\dots \text{Equation(3.1)}$$

Where:

$\vec{p}$  : Linear Momentum

V avg: Average Measurement Velocity

$\rho$  : Density of Air = 1.03

$\dot{V}$  : Volume flow Rate

Also needed calculation to get the thrust calculation:

➤ Volume rate ( $\dot{V}$ ) = Vavg \* A .....Equation(3.2)

The volume rate it will be calculated in table 3.3 after calculate the area of the exit for duct.

Where:

Vavg: measurement Velocity.

A: Area of the exit for thrust

➤ Area of the exit thrust air:-

$A = \pi R e^2$  .....Equation(3.3)

$A = \pi(0.4675)^2$   $= 0.687 m^2$

Where:

A: Area of the exit for thrust

Re: The exit radius of thrust duct

(Table 3.3 Volume Rate and Percent of Error)

RPM	Measurement		$\dot{V}$	Measurement ( $\dot{V}$ )	%error
	$V_{avg}$	$V_{avg} * A$			
		(m <sup>3</sup> )/s	cfm		
<u>1770</u>	<u>17</u>	17 * 0.687=	11.679	24746.4	<u>24900</u> 0.62%
<u>2370</u>	<u>25</u>	25 * 0.687=	17.175	36391.8	<u>36000</u> 1.09 %
<u>2700</u>	<u>27</u>	27 * 0.687=	18.549	39303.1	<u>38000</u> 3.43%

Table (3.3) is calculating the volume rate by multiply the measurement velocity by the area of the exit duct. Also it shown the error between the measurement Volume rate and calculated Volume rate.

We can use equation(3.1) to calculate the thrust force that comes out of the duct and the calculation shown in table (3.4):

(Table 3.4 Thrust duct Calculation)

RPM	$\dot{V}$	$V_{avg}$	Fthrust (N)
1770	11.679	17	217.415
2370	17.175	25	470.166
2700	18.549	27	548.401

Here we start to calculate the needed power of the lift engine:

Work(kw) = Cushion Pressure (pa) \* Volume rate of cushion( $\frac{m^3}{s}$ ) .....Equation(3.4)

We start with needed data to end up with all needed for calculation.

#First needed is the Cushion Pressure in (pa):

Length = 2.4 m , Width = 1.2 m , Gross Mass = 200 kg

➤ Cushion Pressure (pa) =  $\frac{\text{Gross weight (N)}}{\text{Cushion Area}}$  .....Equation(3.5)

○ Gross weight (N) = mg .....Equation(3.6)

Gross weight (N) = 200 \* 9.81 = 1962 N

○ Cushion Area = Length \* Width .....Equation(3.7)

Cushion Area = 2.4 \* 1.2 = 2.88 m<sup>2</sup>

Cushion pressure: the pressure comes out from the base of hovercraft.

Gross weight: the total weight of hovercraft including the person.

Cushion area: the total area of hovercraft which is length multiply by width.

After calculating the gross weight and cushion area we can use them in equation(3.5) to calculate the cushion pressure:

➤ Cushion Pressure (pa) =  $\frac{1962}{2.88} = 681.25$  pa

#Second needed is the Volume rate of cushion in ( $\frac{m^3}{s}$ ):

➤ Volume rate of cushion( $\frac{m^3}{s}$ )

= Total Hover Gap Area \* Velocity of Air( $\frac{m^3}{s}$ ) .....Equation(3.8)

○ Total Hover Gap Area = Lift Parameter \* Airgap.....Equation(3.9)

Total hover gap area: is the total area that the air comes out under the hovercraft.

- Lift Parameter = (2 \* Legth) + (2 \* Width) .....Equation(3.10)

$$= (2 * 2.4) + (2 * 1.2) = \boxed{7.2 \text{ m}}$$

The lift parameter means the total parameter of the hovercraft which added all sides of hovercraft.

- Airgap: is the space between the hovercraft and the ground which

is =  $\boxed{0.008 \text{ m}}$

Now we can calculate the total hove gap area from equation(3.8):

- Total Hover Gap Area = 7.2 m \* 0.008m = 0.576m<sup>2</sup>

Table 3.5 is calculating the Velocity of Air ( $\frac{\text{m}^3}{\text{s}}$ ):

We need to calculate our  $\alpha$  to know what is our velocity of air on the fixed table that can helps to know how much velocity of air you need:

$$\alpha = \frac{\text{Gross Mass (kg)}}{\text{Cushion Area}} \dots\dots\dots\text{Equation(3.11)}$$

Our  $\alpha = \frac{200}{2.88} = 69.444$

(Table 3.5 Velocity of Air )

---

$\alpha$

Minimum $\times 10^{-6}$	Maximum $\times 10^{-6}$	Velocity of Air (m/s)
0	8.787	0
8.787	43.933	14.265

43.933	57.992	17.556
<u>57.992</u>	<u>79.080</u>	<u>20.300</u>
79.080	96.654	22.494
<u>96.654</u>	<u>114.227</u>	<u>24.689</u>
114.227	131.801	26.700
<u>131.801</u>	<u>149.374</u>	<u>28.529</u>

➤ Volume rate of cushion ( $\frac{m^3}{s}$ ) = Total Hover Gap Area \* Velocity of Air ( $\frac{m^3}{s}$ ) =  
 $0.0576 * 20.300 = 1.1693 (\frac{m^3}{s})$

To convert the (Volume rate of cushion) from ( $\frac{m^3}{s}$ ) to (cfm)

use the following equation:-

Volume rate of cushion (cfm) = Volume rate of cushion ( $\frac{m^3}{s}$ ) \* 2118.88

Work = [ Cushion Pressure (pa) \* Volume rate of Cushion ] .....Equation(3.12)

To get the work in (kw), You need to multiply the answer by ( $10^{-3}$ )

Also, you need divided it by the Coefficient fraction of fan which is = (0.593)

Work(kw) = [ 681.25 (pa) \* 1.1693 ( $\frac{m^3}{s}$ ) ] \*  $\frac{10^{-3}}{0.593}$  = 1.343 kw

To get the work in Horse power, multiply the answer by 1.341:

Work(HP) = Work(kw) \* 1.341 = 1.343 kw \* 1.341 = 1.801 HP

### 3.3 Product Subsystems and Components:

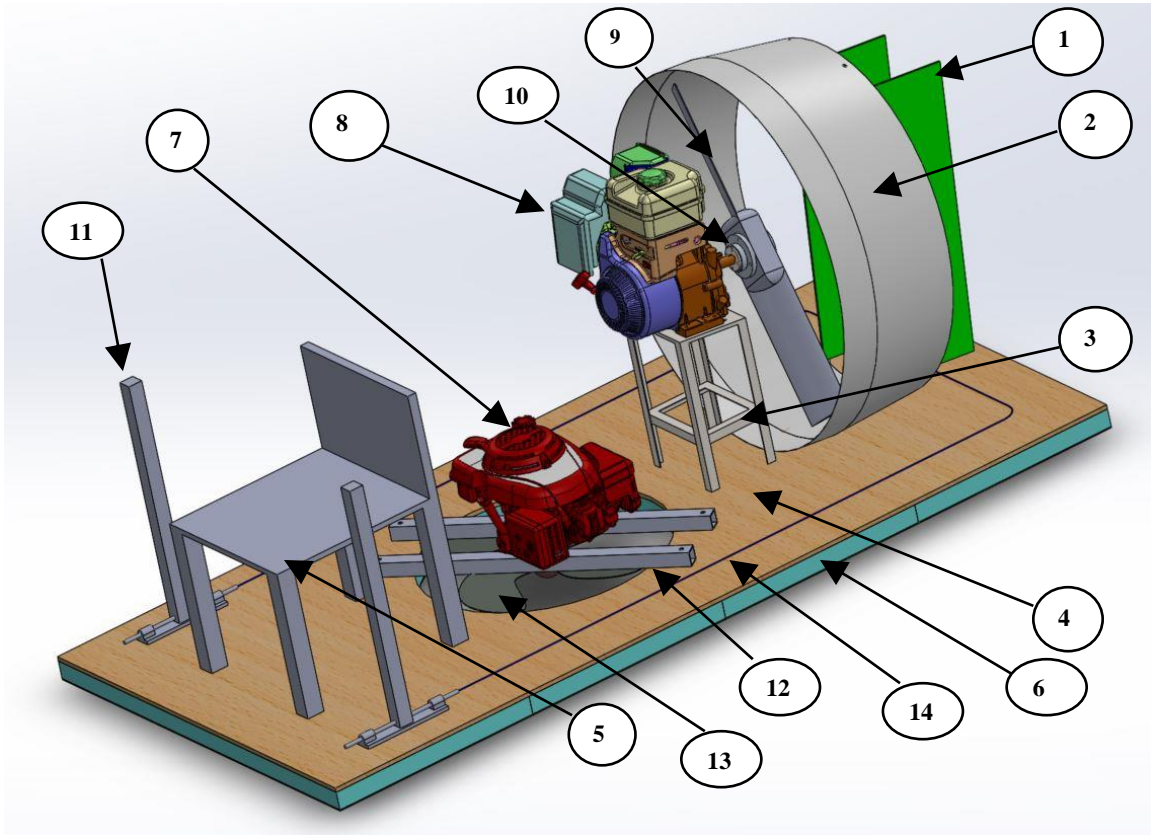


Figure 3.3 (Components of Hovercraft)

Table 3.6 will explain each part in Figure 3.2

(Table 3.6 Components of Hovercraft)

ITEM NO	PARTS	MATERIAL
1	Rudder	Wood
2	Thrust duct	Steel sheet
3	Engine base	Steel
4	Bored	wood

5	Hover seat	wood
6	Bored	foam
7	Lift Engine	steel
8	Thrust engine	steel
9	Propeller	Wood
10	Bushing	Steel
11	Control stick	Carbon Steel
12	Rectangular Profile	Carbon Steel
13	Lift fan	Wood + fiberglass
14	Wire	Copper
15	Hovercraft supports	Wood

\*Item number 15 is shown in figure 3.4

- Hovercraft is a self-driven vehicle, dynamically supported by a self-generated cushion of slow moving, high-pressure air which is ejected against the surface below and contained within a flexible skirt such that is totally amphibious and has some ability to travel over less than perfect surfaces. The momentum of the hovercraft is not derived from contact with the water or the ground.
- Skirt is the device that grants air cushion to be maintained. The skirt is fixed in the craft perimeter holds and keep enough air mass and pressure beneath the hull granting it to be away from the surface, it must be flexible, contour surface irregularities, waves and be water and air proof, and have high resistance to ripping as we see in figure (3.4).



Figure 3.4 (Skirt of Hovercraft)

- Propeller Hovercraft also use air to move forward. Many hovercraft use an engine with an airplane-type propeller or multi-blade axial fan to push air behind the hovercraft, creating forward thrust. Often, a circular enclosure called a thrust duct is built around the propeller.
- Lift fan – it is a part that use to produce the air for lift system.
- Rudder – as we see in figure (3.5) the rudder acts as steerable wheels on a car. The direction of rudder I the primary control of the hovercraft direction by moving opposite direction of the deflecting the air hitting the rudders. Rudder generally made from wood for easy parts to find and meet the required function in the hovercraft system. It normally has about 30-45 degree maximum range of movement either side of their normal direction. Rudders are usually located at the rear of the craft.

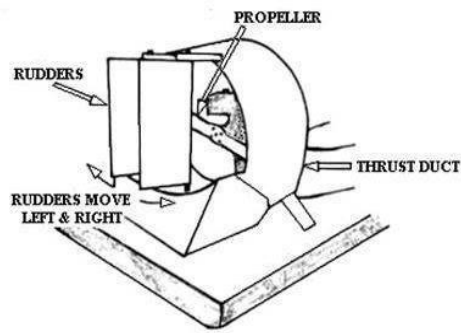


Figure 3.5 (Propeller, Rudders and Thrust duct)

- A Thrust duct – is a propulsion arrangement whereby a mechanical fan, which is a type of propeller, is mounted within a cylindrical shroud or duct. The duct reduces losses in thrust from the tips of the props, and varying the cross-section of the duct allows the designer to advantageously affect the velocity and pressure of the airflow according to Bernoulli's Principle. The thrust duct made from the wood type MDF and was selected biased in the strength and the ability of knockout bay nails without affecting the properties functions in the system process.
- Engine base – is the part carrying the engine of the hovercraft at the basic of the plywood.
- Bored – The main structure which is all load placed on and attached to the cork and against the water.
- Hover seat – It's a comfortable set for the hovercraft driver to control the hovercraft movement and direction.
- Bored foam – It's the main important part protect the hovercraft in the underneath and used to supporting the hovercraft basement during lifting due to high pressure or forcing forward due to backward air blow which is a result of the hovercraft movement over the water or land. It also has high resistance to water and heat.

- Thrust engine – it has a main shaft which is mounted a compressor and a turbine. It's connected to the thrust system. The engine was selected due to less weight comparing other engine and more power as provide 10 HP at 3600 RPM.
- Lift engine – it is a vertical shaft engine with 6 – 7 HP at 3000 RPM.
- Bushing – it is the main parts connected the engine shaft with the propeller. It has been storage to tolerate the maximum torsion load between the two parts.

### **3.4 Implementation:**

After defining the specification of each part on the hovercraft, we comes to the assembly and implementation of the part to get the final shape as shown in figure below. First thing is the base plate, we are going to use wood called plywood with thickness of 9 mm. the wood required support so we are going to add plate of cork what's significant in this cork is that its high density to help in floating of the wood then we are going to use fiberglass coating to prevent the water form attach the wood. Then we are going to use the steel to make the engine base which going to be attached by super glow and some pins to keep it stuck into the base plate and performs it functions. In addition, we are going to add two rods of steel attached to the base plate in order to help balancing the hovercraft after get started to avoid rapid movement at start up. The below figure 3.6 shows and exploded view of the hovercraft assembled before the implementation.

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	Foam Board 125x60x6	Construction Foam	4
2	Wooden Board 1215x2440	12mm thick	1
3	Wooden Board 1215x2440	3mm thick	1
4	Wooden frame Bottom		2
5	Thrust Duct		1
6	engine support		1
7	MOTOR BRIGGS PARTE		1
8	broing h1		1
9	Flange		1
10	CAP		1
11	New Propeller	Horizontal	1
12	rectangular profile	Horizontal	1
13	Propeller (1)	Vertical	1
14	Chair		1
15	control stick		2
16	Wire		2
17	Rudder shaft		2
18	Rudder		2
19	Vertical Engine		1

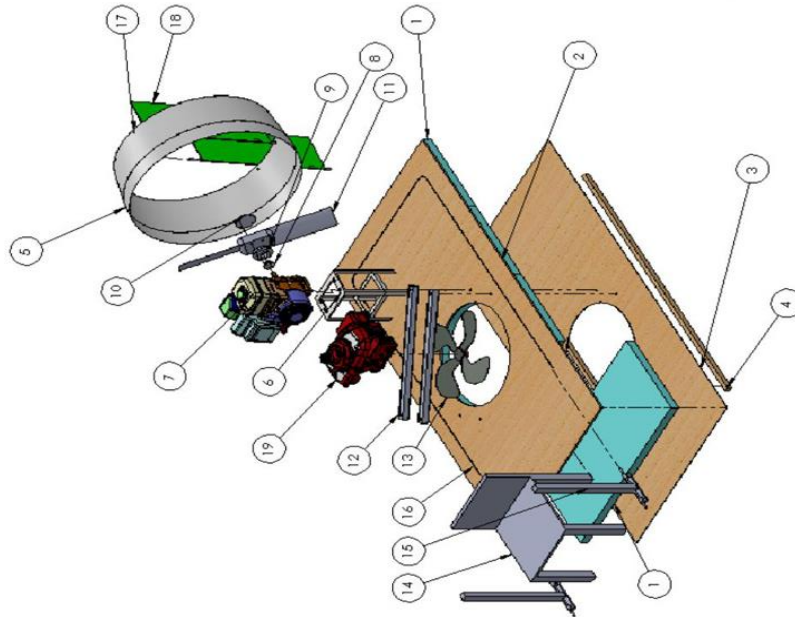




Figure 3.6 (Exploded View SolidWorks)

Spontaneously, after that we will attach the engine to the engine base and the fan to the engine. The fan made of wood and it has been submerged into fiberglass solution to help in increasing the density of the wood and close any gaps between the wood and the pin and the bushing. Then we are going to attach the skirt made of PVC plaster in which it can surround the air under the base plate. The attachment mechanism is by using the

super glow and some pins to prevent the air from escape under the base plate. The nozzle we made of steel sheet and it going to be attached into the base plate by super glow and pins. Finally the direction blades with a thickness of 6 mm will be mounted in a joints at the exit of the nozzle using screws and pins and controlled by thin wire by the driver. Finally the passenger seat will be made of plywood type of wood with thickness of 9 mm same as the base wood, then it will be mounted into the base palate by using super glow and some pins to hold. The below Table 3.7 illustrate the process of making and assemble the major parts of building the hovercraft.

Table 3.7 (process of making and assemble the major parts of building the hovercraft)

<b>Process</b>	<b>Explanation</b>
	<p>Carpentry work for the base of the Hovercraft.</p>
	<p>Manufacturing of the duct by applying the rolling process.</p>



Connect the propeller with the engine shaft  
by flange and boring.



Manufacturing of the base of the engine  
and assemble the engine on it.



Fit the propeller and the engine with thrust  
duct.



	<p>Apply the rudder system to control the direction air generated by the propeller.</p>
	<p>Cut the base in order to mount the lift fan and apply the lift engine in it.</p>

Table 3.7 (process of making and assemble the major parts of building the hovercraft)

# **CHAPTER 4**

## **SYSTEM TESTING AND ANALYSIS**

### **4.1 SUBSYSTEM 1**

### **4.2 SUBSYSTEM 2**

### **4.3 OVERALL RESULTS, ANALYSIS AND DISCUSSION**

#### 4.1 Theoretical thrust calculation:

In order to design a good hovercraft we start implement the main equations to have a good background about the hovercraft. We start our study by conduct a testing and theoretical calculations in order to be aware of the outcome of the project. We focused on apply the following equations in order to have a clear picture about the outcome. We conduct our meeting at Abqaiq, Eastern Province, Kingdom of Saudi Arabia.

The equations we used as follow:

$$\begin{aligned}
 F\Delta t &= \Delta \vec{p} , \quad \vec{p} = m\vec{V} \\
 F &= \frac{m}{\Delta t} (V_f - V_i), V_i = 0, V_f = V_{avg} \\
 F &= \dot{m} (V_{avg}) \\
 \mathbf{F} &= \rho \dot{V} (V_{avg})
 \end{aligned}
 \tag{Equation 4.1}$$

(Table 4.1 Thrust duct Calculation)

RPM	$\dot{V}$	Vavg	Fthrust (N)
1770	11.679	17	217.415
2370	17.175	25	470.166
2700	18.549	27	548.401

#### Discussion:

This table above explain the volume flow rate in different RPM and calculate the thrust force produced by the engine.

## 4.2 Actual thrust calculation:

The aim of the test is to show how effect our design for the thrust and how we can run smoothly. To achieve a good result, we started conduct some meetings at the workshop nearby Dammam, Eastern Province, Kingdom of Saudi Arabia. We used some tools we purchase from outside of the kingdom, these devices are as shown in Figure 4.1:



Figure 4.1 (Measurement Tools)

Devices that uses in the project:

Vibrometer: to measure the acceleration, Velocity and Displacement of vibration.

Tachometer: measuring the RPM.

Laser gun: measuring the temperature.

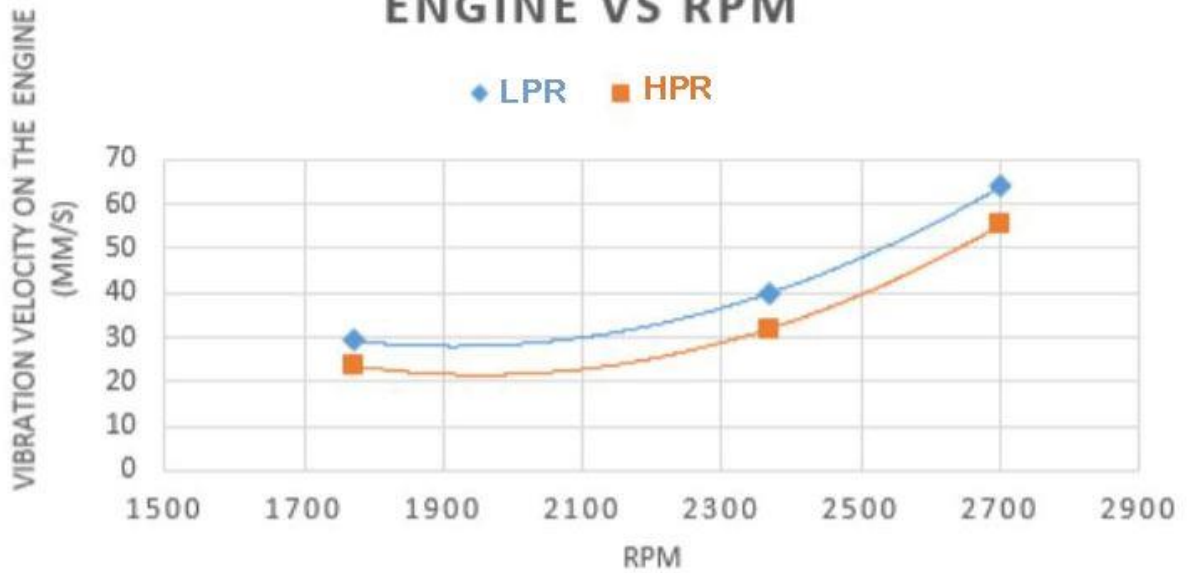
Digital Anemometer: to measure the velocity of the air and the air flow.

### **4.3 Overall Results, Analysis and Discussion:**

For minimizing the vibration, we used different type of rubber depends on its properties.

In results, we found that the rubber with high pressure can consume the vibration more than the low pressure rubber. The following charts explain the difference. Also it proves our results.

## VIBRIATION VELOCITY ON THE ENGINE VS RPM



## VIBRIATION VELOCITY ON THE BASE OF ENGINE VS RPM

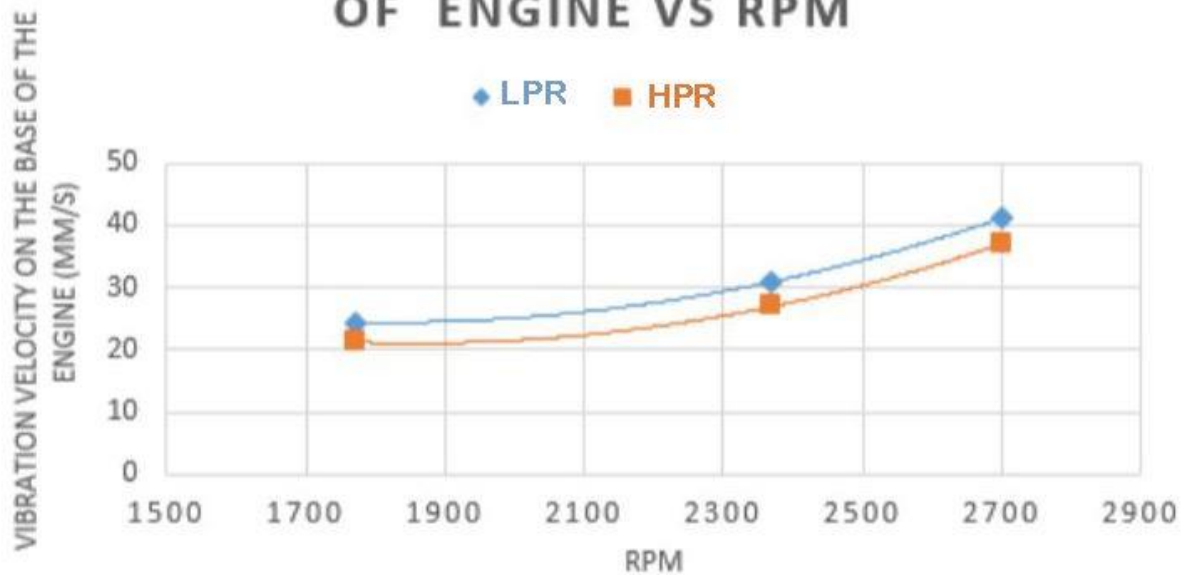
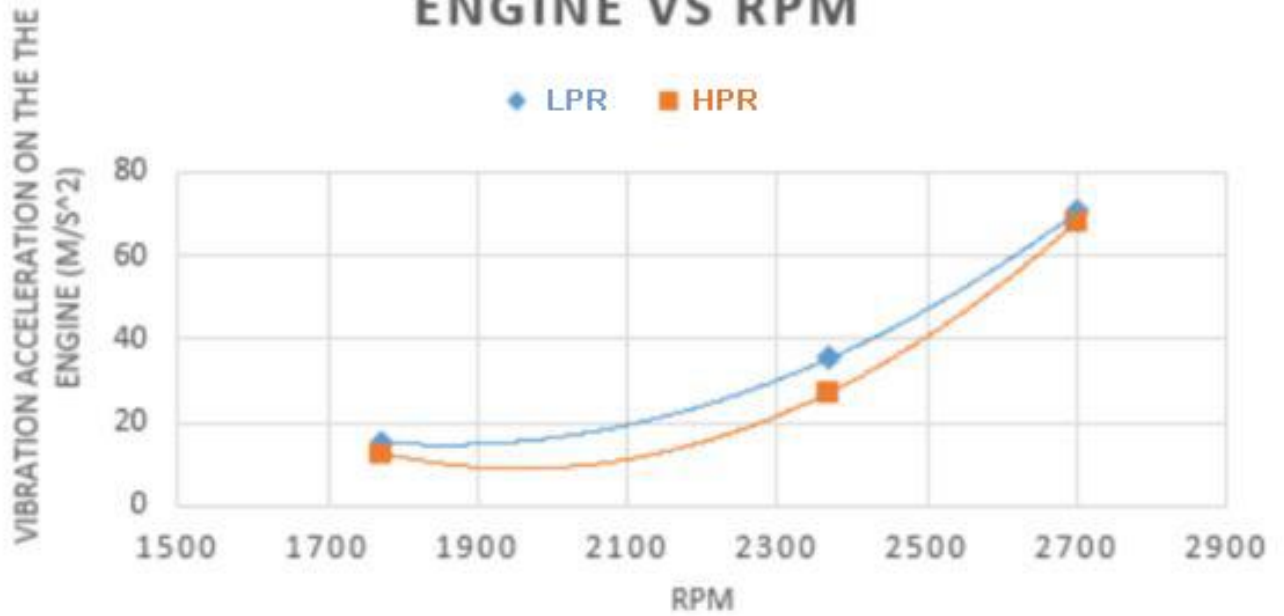


Figure 4.2 (Vibration velocity of the engine and base of the engine)

## VIBRIATION ACCELERATION ON THE ENGINE VS RPM



## VIBRIATION ACCELERATION ON THE BASE OF THE ENGINE VS RPM

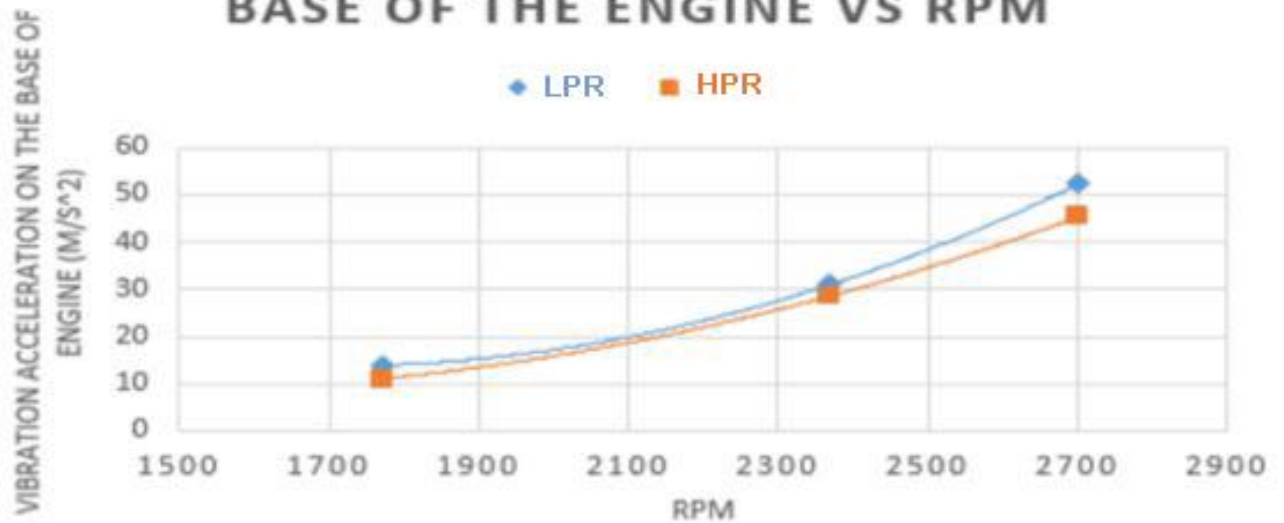
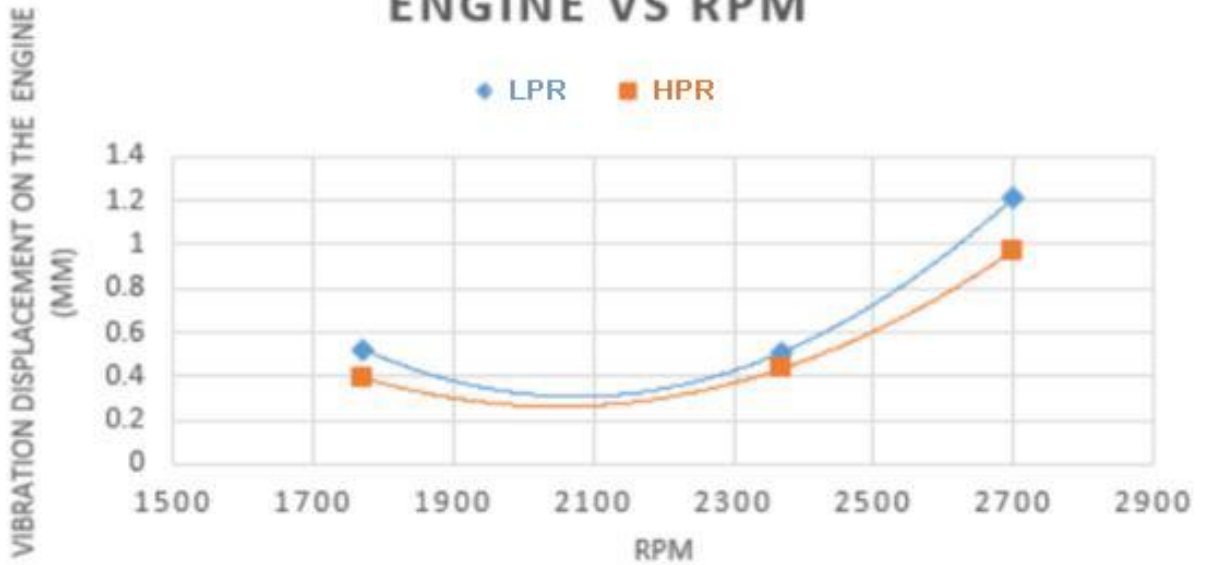


Figure 4.3 (Vibration acceleration of the engine and base of the engine)

## VIBRIATION DISPLACEMENT ON THE ENGINE VS RPM



## VIBRIATION DISPLACEMENT ON THE BASE OF THE ENGINE VS RPM

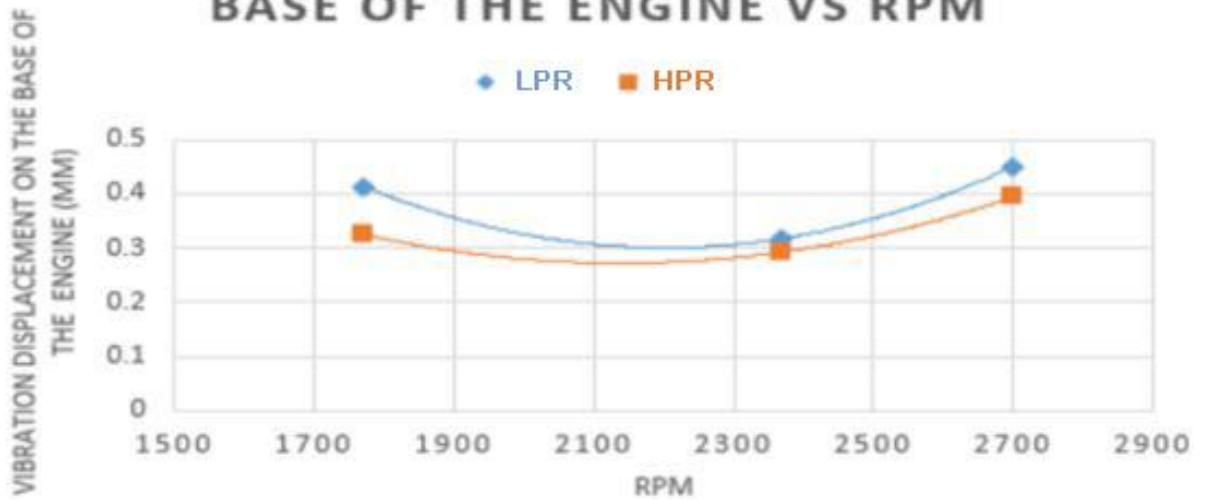


Figure 4.4 (Vibration displacement of the engine and base of the engine)

Table 4.2 (Actual testing result using the proper equipment at 1770 RPM)

<b>RPM</b>	<b>1770</b>
<b>Outside temperature C°</b>	<b>36</b>
<b>Humidity (%)</b>	<b>20</b>
<b>Wind speed (Km/h)</b>	<b>22</b>
<b>Air flow (cfm)</b>	<b>24900</b>
<b>Area of flow (m<sup>2</sup>)</b>	<b>0.687</b>
<b>Vibration velocity on the base of the engine (mm/s)</b>	<b>24.5</b>
<b>Vibration velocity on the thrust duct (mm/s)</b>	<b>45.5</b>
<b>Vibration velocity on the engine (mm/s)</b>	<b>29</b>
<b>Vibration acceleration on the base of the engine (m/s<sup>2</sup>)</b>	<b>13.9</b>
<b>Vibration acceleration on the thrust duct (m/s<sup>2</sup>)</b>	<b>11.9</b>
<b>Vibration acceleration on the engine (m/s<sup>2</sup>)</b>	<b>15.3</b>
<b>Vibration displacement on the base of the engine (mm)</b>	<b>0.414</b>
<b>Vibration displacement on the thrust duct (mm)</b>	<b>1.413</b>
<b>Vibration displacement on the engine (mm)</b>	<b>0.523</b>
<b>Air velocity (m/s)</b>	<b>17</b>

Table 4.3 (Actual testing result using the proper equipment at 2370 RPM)

RPM	2370
<b>Outside temperature C°</b>	<b>36</b>
<b>Humidity (%)</b>	<b>20</b>
<b>Wind speed (Km/h)</b>	<b>22</b>
<b>Air flow (cfm)</b>	<b>36000</b>
<b>Area of flow (m<sup>2</sup>)</b>	<b>0.687</b>
<b>Vibration velocity on the base of the engine (mm/s)</b>	<b>19</b>
<b>Vibration velocity on the thrust duct (mm/s)</b>	<b>29</b>
<b>Vibration velocity on the engine (mm/s)</b>	<b>35</b>
<b>Vibration acceleration on the base of the engine (m/s<sup>2</sup>)</b>	<b>31</b>
<b>Vibration acceleration on the thrust duct (m/s<sup>2</sup>)</b>	<b>26</b>
<b>Vibration acceleration on the engine (m/s<sup>2</sup>)</b>	<b>35.4</b>
<b>Vibration displacement on the base of the engine (mm)</b>	<b>0.318</b>
<b>Vibration displacement on the thrust duct (mm)</b>	<b>0.7</b>
<b>Vibration displacement on the engine (mm)</b>	<b>0.51</b>
<b>Air velocity (m/s)</b>	<b>25</b>

Table 4.4 (Actual testing result using the proper equipment at 2700 RPM)

RPM	2700
<b>Outside temperature C°</b>	<b>37</b>
<b>Humidity (%)</b>	<b>20</b>
<b>Wind speed (Km/h)</b>	<b>22</b>
<b>Air flow (cfm)</b>	<b>38000</b>
<b>Area of flow (m<sup>2</sup>)</b>	<b>0.687</b>
<b>Vibration velocity on the base of the engine (mm/s)</b>	<b>41.2</b>
<b>Vibration velocity on the thrust duct (mm/s)</b>	<b>49.5</b>
<b>Vibration velocity on the engine (mm/s)</b>	<b>63.8</b>
<b>Vibration acceleration on the base of the engine (m/s<sup>2</sup>)</b>	<b>52.2</b>
<b>Vibration acceleration on the thrust duct (m/s<sup>2</sup>)</b>	<b>44.6</b>
<b>Vibration acceleration on the engine (m/s<sup>2</sup>)</b>	<b>70.4</b>
<b>Vibration displacement on the base of the engine (mm)</b>	<b>0.451</b>
<b>Vibration displacement on the thrust duct (mm)</b>	<b>0.501</b>
<b>Vibration displacement on the engine (mm)</b>	<b>1.214</b>
<b>Air velocity (m/s)</b>	<b>27</b>

### **Discussion**

The above table's shows significant increase on the main parameters of the hovercraft. By increasing the RPM speed of the engine the values of the vibration showing increase, in order to avoid that we go into the process of finding High Pressure Rubber (HPR) it will do the job of reducing the vibration and stable the Engine.

## **CHAPTER 5**

### **PROJECT MANAGMENT**

#### **5.1 PROJECT PLAN**

#### **5.2 CONTRIBUTION OF TEAM MEMBERS**

#### **5.3 PROJECT EXECUTION MONITORING**

#### **5.4 CHALLENGES AND DECISION MAKING**

#### **5.5 PROJECT BILL OF MATERIALS AND BUDGET**

### **5.1 Project Plan:**

We are as one team but to be run with the time for the course. Our leader suggest to divide the team to two groups as field work group and writing and research group. Every group was working by all member advices. every group was exchange the ideas and information to support other group and work as team in the same time. This management was successful to finish the project which is not simple project for students. The team found Mr.Fahad Hussain Al-haidar who has a work shop located in Dammam to be our major sponsor for our project. He make the workshop to be able for the team in any time to work and finish the project.

In table 5.1 will explain time work for each task.

(Table 5.1 Project's time frame)

	<b>Task</b>	<b>Start Date</b>	<b>Finish date</b>	<b>Resources</b>
<b>1</b>	Introduction	02/19/2017	03/03/2017	Research, Books, Journals, Hovercraft websites, documentaries
		7		Previous work,
<b>2</b>	Literature Review	02/19/2017	03/03/2017	journals, undergruading projects
		7		
<b>3</b>	System Design	03/04/2017	03/08/2017	CAD (Solidwork) , Hovercraft websites, plog builders
		7		

<b>4</b>	System manufacturing and assembly	03/09/201	04/13/2017	
		7		
<b>5</b>	System Testing and Analysis	04/15/201	04/20/2017	Digital laser grip thermometer, peak-meter for wind speed and volume of air, digital photo laser tachometer to measure RPM, vibration sensor meter, Solidwork
		7		
<b>6</b>	Project Management	04/20/201	04/27/2017	Leader of the team
		7		
<b>7</b>	Project Analysis	04/27/201	05/05/2017	
		7		
<b>8</b>	Conclusions and Future Recommendations	05/10/201	05/15/17	Depends on our project
		7		
<b>9</b>	Field Work	03/25/17	End of April	Suppliries, research team workshop, CAD drawing, literature review, solidwork calculation,

(Table 5.2 Work Plan)

<b>Work Plan</b>
<b>Phase 1</b>
<b>Reviewing, researching and finding materials suppliers.</b>
<b>Phase 2</b>
<b>CAD drawing, simple calculation and choosing material.</b>
<b>Phase 3</b>
<b>Project's assembly .</b>
<b>Phase 4</b>
<b>Results and analysis.</b>

Table 5.2 explains the work plan and the project steps. We follow these phases to manage the work and time.

### **5.2 Contribution of Team Member:**

All the members were effective, shared ideas, exchange ideas and opinions. Every member try to attempt to work in all sections but because of the pressure of the Semester and the division member to two groups we work as below table 5.2 to show exact work for each member:

(Table 5.3 Task Distribution)

#	Task	Team member assigned
1	Researching and Writing the project report	Saud Al-Shamsi, Abdullah Al-Zahrani, Mishal Al-Othman, Abdullah Al-Muraisel
2	Group project allocation	Abdullah Al-Muraisel
3	Gantt Chart	Abdullah Al-Muraisel, Mishal Al-Othman
4	Introduction & project objective (report)	Mishal Al-Othman
5	Literature review (report)	Saud Al-Shamsi
6	System Design (report)	Abdullah Al-Zhrani, Abdullah Al-Muraisel, Mishal Al-Othman, Saud Al-Shamsi
7	Project Management	Saud Al-Shamsi, Abdullah Al-Muraisel
8	Project analysis	, Mishal Al-Othman
9	Meet Dr.ROODI biweekly	All members
10	CAD-drawing	Abdullah Al-Muraisel, Mahdi Al-Marzoug, Mishal Al-Othman
11	Design and build engine base	Abdullah Al-Muraisl,

		Hussain Al-Haidr, Mahdi Al-Marzoug
12	Design and build lift thrust divider system	Abdullah Al-Muraisl, Hussain Al-Haidr, Mahdi Al-Marzoug
13	Choosing material	Abdullah Al-Muraisl
14	Applying and choosing fan system	Abdullah Al-Muraisl
15	Manufacturing Hovercraft Base	Abdullah Al-Muraisl, Hussain Al-Haidr, Mahdi Al-Marzoug
16	Manufacturing Thrust Duct	Abdullah Al-Muraisl, Hussain Al-Haidr, Mahdi Al-Marzoug
17	Choosing and applying the engine	Abdullah Al-Muraisl
18	Measurement and Testing	Abdullah Al-Muraisl, Mahdi Al-Marzoug, Saud Al-Shamsi, Hussain Al-Haidr
19	Applying the air fan to the shaft of the engine	Abdullah Al-Muraisl, Hussain Al-Haidr, Mahdi Al-Marzoug, Saud Al- Shamsi

20	Manufacturing Rudders	Abdullah Al-Muraisl, Hussain Al-Haidr, Mahdi Al-Marzoug
21	Applying the skirt around the hovercraft	Abdullah Al-Muraisl, Hussain Al-Haidr, Mahdi Al-Marzoug
22	Applying fiberglass coating	Abdullah Al-Muraisl, Hussain Al-Haidr, Mahdi Al-Marzoug

The above table 5.3 explains all the tasks and every member that work on the task.

### **5.3 Project Execution Monitoring:**

The team meet twice every week to discuss the updated progress. The leader for management the meeting is Mr. Abdullah Al-Zahrani. He is an employee and night student and other members goes with his available time. All meeting was to review the previous work and planning for next part. All meetings was a helpful for each member because every member try to exchange his own idea with others. Field group and writing group were try to work smoothly together not just focusing on their part. Every group support the other. When we face any problem, we try our best solution to ask our advisor about it. The advisor was successful to help us to work as engineers and find the solution by ourselves.

#### **5.4 Challenges and Decision Making:**

The group were suffering with the time of the meeting. One of the members is an employee and he faced many problems to manage his time between his work, classes, and project meetings. The leader tried hard to manage the meeting to be at noon to be flexible for all members. On the other hand, there is another member living outside of our meetings. Also, this member faced a hard situations. We solve this problem to make some of the meetings by an application that is meet all of us together online. Our group did not faced any cooperating problems. The members were divided the work and made the plan early which is in the beginning of the semester. Every member was supporting the other in any needs that happened for the project.

The main problem was the availability of workshop. It takes too much time to find a place that we can make our field work. After spending too much time, Mr.Fahad Al-Haidar heard about our project which he is father for one of the members. He contacts with the leader to ask about all needs for the project and he tell the leader that some equipments that the group need it is available in his workshop. Also the materials and components that the group looking for is not that much easy to find it. Some of the members were looking for the materials and components, others were try to chose the materials by reading and researching to give the correct choosing.

We used a material to manufacture the thrust duct which was not the material that going with our project. The material was too soft and after finishing the thrust by this material, we see that is not stable because it is a thick material. It does not give us a unique circle that can handle a fiber glass coating. Another problem is when we try to make a hole in the fan for the nails. It was too difficult to make it uniform holes and we were scared

from any damaging might happened for the fan. During the wilding work for the thrust, we burn a small area from the wood base. This happened because, we do not have that much skills for wilding work.

### **5.5 Project Bill of Materials and Budget:**

(Table 5.4 Project Budget)

<u>Cost Analysis</u>	<u>Sponsor</u>	<u>Group Payment</u>	<u>Cost (SR)</u>
<u>Horizontal Shaft Engine</u>	600	2200	2800
<u>Design and Build Engine</u>	200	-	200
<u>Base</u>			
<u>Design and Manufacture</u>	200	-	200
<u>Lift Thrust Divider System</u>			
<u>Plywood</u>	150	-	150
<u>4 Polystyrene Foam Sheets</u>	-	60	15 each = 60
<u>Thrust Duct</u>	600	-	600
<u>Fan</u>	-	1300	1300
<u>Skirt</u>	-	150	150
<u>Rudders and Control System</u>	250	-	250
<u>Fiber Glass Coating</u>	1000	1150	2150
<u>Fabrication</u>	✓	=	=
<u>Total</u>	<b><u>3000</u></b>	<b><u>4860</u></b>	<b><u>7860 SR</u></b>

As a team with this big project we found a sponsor for our project. The above table 5.4 shows the total payment of the sponsor and the members.

## **CHAPTER 6**

### **PROJECT ANALYSIS**

#### **6.1 LIFE-LONG LEARNING**

#### **6.2 IMPACT OF ENGINEERING SOLUTION**

#### **6.3 CONTEMPORART ISSUES ADDRESSED**

### **6.1 Life-long Learning:**

This experience we had as a team during this project helped us to compute our skills and knowledge gained through our undergrad study. It shows how we can work as teams and how we solve any difficulty we might face. What makes our implementation of the competencies special is that we had a project required a lot of teamwork, leadership, and technical communication skills a lot compare with other projects. Time and cost management also plays a significant factor as well, because this type of project required a lot of testing, calculation and required to figure out the necessary equipment with high quality and ensure its functionality and efficiency within the cost. With all that, we as the team successfully done this iconic project within the time and cost limitations. Also in this project, we went to some journals and other expertise on the web that related to this type of project, and we get to know some ideas and ways on manufacturing. One great example of this is the rudder; many kinds and mechanisms could be implemented plus the engine type we figure out that there are many kinds of drivers in the market we can control the speed and RPM, but others run fixed by the manufacturer. Furthermore, we had a chance to look into some similar project been done in other university students worldwide and try to make some difference in material selection and to design as well. When it comes to calculation, we started doing it by using SolidWorks program to achieve the necessary calculation in the professional and iconic way.

### **6.2 Impact of Engineering Solutions:**

When it come to the impacts that our project achieve, we can divide this achievement into three categories: society, environment, and economy we will talk in details.

### **6.2.1 Society:**

Hovercraft consider one of the efficient ways of transportation. It easy to handle and control besides that, it easy to maintained and don't require too much work to fix. Hovercraft plays a significant role in rescue people in a harsh situation like what happened in the eastern province of the Kingdom on 16<sup>th</sup> of February 2017 the civil defense uses it in reaching the area gets blocked due to flooded roads and tunnels. Additional uses of the hovercraft in situations like wars. Armies worldwide use it to transport their equipment and armed forces. Also, it could be utilized by the marine people to guide and towing heavy ships to the shore and vice versa.

### **6.2.2 Environment:**

We can consider the hovercraft environment-friendly comparing with other vehicles used in many situations nowadays. When it comes to the advantages, the less friction between the hovercraft lead to less fuel burnt to move, and less friction on the surface means less disturbance to the environment. According to "Hovercraft technology: Economics and Application 1989 by J.R. Amyot" the hovercraft has to very low pressure "footprint" and he mentions that average human exerts pressure on the ground is around 25lbs.per square inch when walking. Comparing with hovercraft that exerts a pressure of 1/3lb.per square inch regardless of its speed. With all that we can see that the hovercraft are saving the green land and reduce the assumption of destroying it.

### **6.2.3 Economy:**

Saudi Arabia and GCC countries consider one of the biggest countries worldwide in depending on oil and gas. Moreover, by removing the subsidization from the oil and gas products steadily offering oil to your V8 car will be much difficult. By using the

hovercraft for the nearby areas instead of your V8 car, it will make a big difference, and it will save your budget at the end.

### **6.3 Contemporary Issues Addressed:**

Before start talk about the issues that are facing our GCC countries and Saudi Arabia, we will describe some of the difficulties we faced during this project. It starts by leaking for sources and information between the student and the real world outside the campus. There is no good infrastructure, in other words; we spend a couple of days just looking for any company or workshop just to manufacture our parts and assemble them together. Also, we suffered a lot because there is some part you cannot manufacture in the kingdom and we do not have any solution except ordering it from outside. When it come to the GCC countries and Saudi Arabia, there are some real steps taken to accomplish self-sustainability in areas regarding manufacturing and development. Moreover, with Saudi Arabia's vision 2030 there are going to be big and significant change many aspects and support of youth from the beginning of their academic career until they become very professionals and supporting the developing of our country.

# **CHAPTER 7 CONCLUSIONS AND FUTURE RECOMMENDATION**

## **7.1 COCLUSIONS**

## **7.2 FUTURE RECOMMANADATIONS**

## **7.1 Conclusions**

In consolation, we as a team went into the process of designing and manufacturing of one person hovercraft. Hovercraft is a vehicle which can float in any lands also it is known by Air Cushion Vehicle due to its ability to move by cushion or skirt filled with air. The concept of the hovercraft is simple, starts with a particular kind of wood that has the property in carrying loads attached to a skirt in order to surround the air which leads to developing pressure under the hovercraft. The ducting system or “thrust duct” we used a thin sheet of steel to create the thrust probably. When it comes to the power system, it runs with a motor connected with the propeller made of wood which generates the thrust required for both thrust and lifts. Also, we went into the process of designing the rudder system which used in steer and directs the thrust air generated by the motor in the required direction. After manufacturing parts has been done, we start measuring the vibration, temperature, generated air and distance travelled by the vehicle.

During this period we spend on this project, we get to know a lot of things that are essential and required to accomplish a successful project. It starts with time management, time plays a big role in this project. Due to the lack of places that supply the required materials for duct and the base, we manage the time between team members to avoid any losing of time and finish the work within the time. Also we get to know how to assemble multiple part together. It was very difficult process but we did it and preformed the required checks to insure that fit within the standards of the hovercraft. We learned about vibration and how we can minimize it on the hovercraft. Besides that, we get to know the importance of minimizing the weight which is a major part in any design of vehicles.

## **7.2 Future Recommendations**

As a team, we come up with recommendations that lead to have a faster and more durable hovercraft which give better results.

- 1- Try to reduce vibration generated by the motor by using some materials to absorb the vibration impacts.
- 2- For fast hovercraft, we recommend to use two engines, one horizontal shaft for thrust and one vertical shaft for the lift to increase the power which leads to more powerful hovercraft which can handle more weight and sliding easily on surfaces.
- 3- Use Carbon-Fibre or Fiberglas for all body of the hovercraft to minimize the total weight but it is costly.

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## **APPENDIX - A PROGRESS REPORTS**

**# REPORT 1**

**# REPORT 2**

**# REPORT 3**

**# REPORT 4**

	<b>SDP – WEEKLY MEETING REPORT</b>
	<b>Department of Electrical Engineering</b> <b>Prince Mohammad bin Fahd University</b>

<b>SEMESTER:</b>	Spring Semester	<b>ACADEMIC YEAR:</b>	2016-2017
<b>PROJECT TITLE</b>	One Person Hovercraft		
<b>SUPERVISOR S</b>	Dr. Faramarz Djavanrood & Dr. Nader Sawalhi		

**Month 1: February**

<b>ID Number</b>	<b>Member Name</b>
201100546	Abdullah Al-Muraisel
201302079	Meshal Othman
201000170	Abdullah AlZahrani
201300297	Hussain ALHaider
201201060	Mahdi ALmarzoug
201100333	Saud Al-Shamsi

**List the tasks conducted this month and the team member assigned to conduct these tasks**

<b>#</b>	<b>Task description</b>	<b>Team member assigned</b>	<b>Progress 0-100%</b>	<b>Delivery proof</b>
<b>1</b>	Studying the market	Abdullah Al-Muraisel	100%	----
<b>2</b>	Review the Project with supervisors	Abdullah Al-Muraisel	100%	----
<b>3</b>	Gantt chart + CAD drawings	Abdullah Al-Muraisel	100%	----
<b>4</b>	Acknowledgement & Introduction	Abdullah Al-Muraisel , Abdullah AlZahrani	100%	----
<b>5</b>	literature review	Saud Al-Shamsi	100%	----

**List the tasks planned for the month of March and the team member/s assigned to conduct these tasks**

<b>#</b>	<b>Task description</b>	<b>Team member/s assigned</b>
<b>1</b>	Complete the other chapters required	Meshal & Saud & Abdullah Al-Muraisel
<b>2</b>	Purchasing the duct materials	Abdullah Al-Muraisel
<b>3</b>	Purchasing the base material (Wood)	Abdullah Al-Muraisel
<b>4</b>	Starting the carpentry work	Abdullah Al-Muraisel
<b>6</b>	Purchasing the Engine	Hussain , Abdullah Al-Muraisel ,

7	Order the Propeller From USA	Abdullah Al-Muraisel
8	fabrication of control system (rudders)	Mahdi

- To be Filled by Project Supervisor and team leader:
- Please have your supervisor fill according to the criteria shown below

**Outcome f:**  
An understanding of professional and ethical responsibility.

Criteria	None (1)	Low (2)	Moderate (3)	High (4)
f1. Demonstrate an understanding of engineering professional and ethical standards in dealing with public safety and interest	Fails to Demonstrate an understanding of engineering professional and ethical standards in dealing with public safety and interest	Shows limited and less than adequate understanding of engineering professional and ethical standards in dealing with public safety and interest	Demonstrates satisfactory understanding of engineering professional and ethical standards in dealing with public safety and interest	Understands appropriately and accurately the engineering professional and ethical standards in dealing with public safety and interest

**Outcome d:**  
An ability to function on multidisciplinary teams.

Criteria	None (1)	Low (2)	Moderate (3)	High (4)
----------	----------	---------	--------------	----------

d1. Ability to develop team work plans and allocate resources and tasks	Fails to develop team work plans and allocate resources and tasks	Shows limited and less than adequate ability to develop team work plans and allocate resources and tasks	Demonstrates satisfactory ability to develop team work plans and allocate resources and tasks	Understands and applies proper and accurate team work plans and allocate resources and tasks
d2. Ability to participate and function effectively in team work projects	Fails to participate and function effectively in team work projects	Shows limited and less than adequate ability to participate and function effectively in team work projects	Demonstrates satisfactory ability to participate and function effectively in team work projects	Understands and participates properly and function effectively in team work projects
d3. Ability to communicate effectively with team members	Fails to communicate effectively with team members	Shows limited and less than adequate ability to communicate effectively with team members	Demonstrates satisfactory ability to communicate effectively with team members	3. Understands and communicates properly and effectively with team members


Indicate the extent to which you agree with the above statement, using a scale of 1-4

(1=None; 2=Low; 3=Moderate; 4=High)

#	Name	Criteria (d1)	Criteria (d2)	Criteria (d3)	Criteria (f1)
1	Abdullah Al-Muraisel	4	4	4	4
2	Meshal Othman	4	4	4	4
3	Abdullah AlZahrani	4	4	4	4
4	Hussain ALHaider	4	4	4	4
5	Mahdi ALmarzoug	4	4	4	4
6	Saud Al-Shamsi	4	4	4	4

**Comments on individual members**

Name	Comments
Abdullah Al-Muraisel	**No Comment**
Meshal Othman	**No Comment**
Abdullah AlZahrani	**No Comment**
Hussain ALHaider	**No Comment**
Mahdi ALmarzoug	**No Comment**
Saud Al-Shamsi	**No Comment**

	<b>SDP – WEEKLY MEETING REPORT</b>
	<b>Department of Electrical Engineering</b> <b>Prince Mohammad bin Fahd University</b>

<b>SEMESTER:</b>	Spring Semester	<b>ACADEMIC YEAR:</b>	2016-2017
<b>PROJECT TITLE</b>	One Person Hovercraft		
<b>SUPERVISOR S</b>	Dr. Faramarz Djavanrood & Dr. Nader Sawalhi		

**Month 2: March**

ID Number	Member Name
201100546	Abdullah Al-Muraisel
201302079	Meshal Othman
201000170	Abdullah AlZahrani
201300297	Hussain ALHaider
201201060	Mahdi ALmarzoug
201100333	Saud Al-Shamsi

**List the tasks conducted this month and the team member assigned to conduct these tasks**

#	Task description	Team member assigned	Progress 0-100%	Delivery proof
1	Report chapters 3 &4	Meshal&Saud&Abdullah AlZahrani	100%	Report Attached
2	Purchasing the duct materials + base material (Wood) + Order the Propeller From USA	Abdullah Al-Muraisel &Mahdi&Hussain	100%	Photo Attached
3	Purchasing the Engine	Hussain	100%	----
4	Purchasing the safety equipments	Mahdi	100%	Photo Attached
5	Discussion meeting before the assembly work	All Members	100%	Photo Attached

**List the tasks planned for the month of April and the team member/s assigned to conduct these tasks**

#	Task description	Team member/s assigned
1	Starting the carpentry work (shifted from march)	All Members
2	Figure out a place starts the assembly	Hussain
3	Ordering the measurement equipment from USA	Abdullah Al-Muraisel
4	Find the wilding and machining shops	Hussain & Mahdi
6	Finding sponsors for the project	Hussain

- To be Filled by Project Supervisor and team leader:
- Please have your supervisor fill according to the criteria shown below

**Outcome f:**  
An understanding of professional and ethical responsibility.

Criteria	None (1)	Low (2)	Moderate (3)	High (4)
f1. Demonstrate an understanding of engineering professional and ethical standards in dealing with public safety and interest	Fails to Demonstrate an understanding of engineering professional and ethical standards in dealing with public safety and interest	Shows limited and less than adequate understanding of engineering professional and ethical standards in dealing with public safety and interest	Demonstrates satisfactory understanding of engineering professional and ethical standards in dealing with public safety and interest	Understands appropriately and accurately the engineering professional and ethical standards in dealing with public safety and interest

**Outcome d:**  
An ability to function on multidisciplinary teams.

Criteria	None (1)	Low (2)	Moderate (3)	High (4)
d1. Ability to develop team work plans and	Fails to develop team work plans and allocate	Shows limited and less than adequate ability to	Demonstrates satisfactory ability to	Understands and applies proper and accurate team work

allocate resources and tasks	resources and tasks	develop team work plans and allocate resources and tasks	develop team work plans and allocate resources and tasks	plans and allocate resources and tasks
d2. Ability to participate and function effectively in team work projects	Fails to participate and function effectively in team work projects	Shows limited and less than adequate ability to participate and function effectively in team work projects	Demonstrates satisfactory ability to participate and function effectively in team work projects	Understands and participates properly and function effectively in team work projects
d3. Ability to communicate effectively with team members	Fails to communicate effectively with team members	Shows limited and less than adequate ability to communicate effectively with team members	Demonstrates satisfactory ability to communicate effectively with team members	3. Understands and communicates properly and effectively with team members

Indicate the extent to which you agree with the above statement, using a scale of 1-4

(1=None; 2=Low; 3=Moderate; 4=High)

#	Name	Criteria (d1)	Criteria (d2)	Criteria (d3)	Criteria (f1)
1	Abdullah Al-Muraisel	4	4	4	4
2	Meshal Othman	4	4	4	4
3	Abdullah AlZahrani	4	4	4	4
4	Hussain ALHaider	4	4	4	4
5	Mahdi ALmarzoug	4	4	4	4
6	Saud Al-Shamsi	4	4	4	4

**Comments on individual members**

Name	Comments
Abdullah Al-Muraisel	**No Comment**
Meshal Othman	**No Comment**
Abdullah AlZahrani	**No Comment**
Hussain ALHaider	**No Comment**
Mahdi ALmarzoug	**No Comment**
Saud Al-Shamsi	**No Comment**

	<b>SDP – WEEKLY MEETING REPORT</b>
	<b>Department of Electrical Engineering</b> <b>Prince Mohammad bin Fahd University</b>

<b>SEMESTER:</b>	Spring Semester	<b>ACADEMIC YEAR:</b>	2016-2017
<b>PROJECT TITLE</b>	One Person Hovercraft		
<b>SUPERVISORS</b>	Dr. Faramarz Djavanrood & Dr. Nader Sawalhi		

### Month 3: April

ID Number	Member Name
201100546	Abdullah Al-Muraisel
201302079	Meshal Othman
201000170	Abdullah AlZahrani
201300297	Hussain ALHaider
201201060	Mahdi ALmarzoug
201100333	Saud Al-Shamsi

**List the tasks conducted this month and the team member assigned to conduct these tasks**

<b>#</b>	<b>Task description</b>	<b>Team member assigned</b>	<b>Progress 0-100%</b>	<b>Delivery proof</b>
1	Carpentry work	All Members	100%	Report Attached
2	Start wilding and machining at location	All Members	100%	Photo Attached
3	Prepare the Mid Presentation	All Members	100%	PPT Attached
4	Finding places for skirt	Hussain & Mahdi	100%	Photo Attached
5	Review feedbacks For the presentation & reports	All Members	100%	Photo Attached

**List the tasks planned for the month of May and the team member/s assigned to conduct these tasks**

<b>#</b>	<b>Task description</b>	<b>Team member/s assigned</b>
1	Fiberglass Coating	Abdullah Al-Muraisel & Hussain & Mahdi
2	Complete chapters 6 & 7	Meshal & Saud & Abdullah AlZahrani
3	Doing the testing and collect Data	All Members
4	Implement the skirt to the hovercraft	All Members
6	Review the data and finalize the project	All Members

- To be Filled by Project Supervisor and team leader:
- Please have your supervisor fill according to the criteria shown below

**Outcome f:**  
An understanding of professional and ethical responsibility.

Criteria	None (1)	Low (2)	Moderate (3)	High (4)
f1. Demonstrate an understanding of engineering professional and ethical standards in dealing with public safety and interest	Fails to Demonstrate an understanding of engineering professional and ethical standards in dealing with public safety and interest	Shows limited and less than adequate understanding of engineering professional and ethical standards in dealing with public safety and interest	Demonstrates satisfactory understanding of engineering professional and ethical standards in dealing with public safety and interest	Understands appropriately and accurately the engineering professional and ethical standards in dealing with public safety and interest

**Outcome d:**  
An ability to function on multidisciplinary teams.

Criteria	None (1)	Low (2)	Moderate (3)	High (4)
d1. Ability to develop team work plans and	Fails to develop team work plans and allocate	Shows limited and less than adequate ability to	Demonstrates satisfactory ability to	Understands and applies proper and accurate team work

allocate resources and tasks	resources and tasks	develop team work plans and allocate resources and tasks	develop team work plans and allocate resources and tasks	plans and allocate resources and tasks
d2. Ability to participate and function effectively in team work projects	Fails to participate and function effectively in team work projects	Shows limited and less than adequate ability to participate and function effectively in team work projects	Demonstrates satisfactory ability to participate and function effectively in team work projects	Understands and participates properly and function effectively in team work projects
d3. Ability to communicate effectively with team members	Fails to communicate effectively with team members	Shows limited and less than adequate ability to communicate effectively with team members	Demonstrates satisfactory ability to communicate effectively with team members	3. Understands and communicates properly and effectively with team members


Indicate the extent to which you agree with the above statement, using a scale of 1-4

(1=None; 2=Low; 3=Moderate; 4=High)

#	Name	Criteria (d1)	Criteria (d2)	Criteria (d3)	Criteria (f1)
1	Abdullah Al-Muraisel	4	4	4	4
2	Meshal Othman	4	4	4	4
3	Abdullah AlZahrani	4	4	4	4
4	Hussain ALHaider	4	4	4	4
5	Mahdi ALmarzoug	4	4	4	4
6	Saud Al-Shamsi	4	4	4	4

**Comments on individual members**

Name	Comments
Abdullah Al-Muraisel	**No Comment**
Meshal Othman	**No Comment**
Abdullah AlZahrani	**No Comment**
Hussain ALHaider	**No Comment**
Mahdi ALmarzoug	**No Comment**
Saud Al-Shamsi	**No Comment**

	<b>SDP – WEEKLY MEETING REPORT</b>
	<b>Department of Electrical Engineering</b> <b>Prince Mohammad bin Fahd University</b>

<b>SEMESTER:</b>	Spring Semester	<b>ACADEMIC YEAR:</b>	2016-2017
<b>PROJECT TITLE</b>	One Person Hovercraft		
<b>SUPERVISOR S</b>	Dr. Faramarz Djavanrood & Dr. Nader Sawalhi		

**Month 4: May**

ID Number	Member Name
201100546	Abdullah Al-Muraisel
201302079	Meshal Othman
201000170	Abdullah AlZahrani
201300297	Hussain ALHaider
201201060	Mahdi ALmarzoug
201100333	Saud Al-Shamsi

List the tasks conducted this month and the team member assigned to conduct these tasks

#	Task description	Team member assigned	Progress 0-100%	Delivery proof
1	Fiberglass Coating	Abdullah Al-Muraisel & Husain & Mahdi	100%	Photo Attached
2	Complete chapters 6 & 7	Meshal & Saud	100%	Report Attached
3	Doing the testing and collect Data	Abdullah Al-Muraisel , Saud , Mahdi , Mahdi	90%	Report Attached
4	Implement the skirt to the hovercraft	Husain , Mahdi	100%	Photo Attached
5	Review feedbacks For the Final presentation & reports	Abdullah Al-Muraisel , Saud	75%	-----

- To be Filled by Project Supervisor and team leader:

- Please have your supervisor fill according to the criteria shown below

<b>Outcome f:</b>				
An understanding of professional and ethical responsibility.				
Criteria	None (1)	Low (2)	Moderate (3)	High (4)
f1. Demonstrate an understanding of engineering professional and	Fails to Demonstrate an understanding of engineering professional and	Shows limited and less than adequate understanding of engineering	Demonstrates satisfactory an understanding of	Understands appropriately and accurately the engineering professional and ethical standards in

ethical standards in dealing with public safety and interest	ethical standards in dealing with public safety and interest	professional and ethical standards in dealing with public safety and interest	engineering professional and ethical standards in dealing with public safety and interest	dealing with public safety and interest
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**Outcome d:**

An ability to function on multidisciplinary teams.

<b>Criteria</b>	<b>None (1)</b>	<b>Low (2)</b>	<b>Moderate (3)</b>	<b>High (4)</b>
d1. Ability to develop team work plans and allocate resources and tasks	Fails to develop team work plans and allocate resources and tasks	Shows limited and less than adequate ability to develop team work plans and allocate resources and tasks	Demonstrates satisfactory ability to develop team work plans and allocate resources and tasks	Understands and applies proper and accurate team work plans and allocate resources and tasks
d2. Ability to participate and function effectively in team work	Fails to participate and function effectively in team work	Shows limited and less than adequate ability to participate and function	Demonstrates satisfactory ability to participate and function	Understands and participates properly and function effectively in team work

projects	projects	effectively in team work projects	effectively in team work projects	projects
d3. Ability to communicate effectively with team members	Fails to communicate effectively with team members	Shows limited and less than adequate ability to communicate effectively with team members	Demonstrates satisfactory ability to communicate effectively with team members	3. Understands and communicates properly and effectively with team members

**Indicate the extent to which you agree with the above statement, using a scale of 1-4**

**(1=None; 2=Low; 3=Moderate; 4=High)**

#	Name	Criteria (d1)	Criteria (d2)	Criteria (d3)	Criteria (f1)
1	Abdullah Al-Muraisel	4	4	4	4
2	Meshal Othman	4	4	4	4
3	Abdullah AlZahrani	4	4	4	4
4	Hussain ALHaider	4	4	4	4
5	Mahdi ALmarzoug	4	4	4	4
6	Saud Al-Shamsi	4	4	4	4

### Comments on individual members

Name	Comments
Abdullah Al-Muraisel	**No Comment**
Meshal Othman	**No Comment**
Abdullah AlZahrani	**No Comment**
Hussain ALHaider	**No Comment**
Mahdi ALmarzoug	**No Comment**
Saud Al-Shamsi	**No Comment**

**APPENDIX - B**  
**BILL OF MATERIALS**







































**APPENDIX - E**  
**OPERATIOB MANUEL**

Start up the Hovercraft:

1. Before starts the vehicle check out the surroundings and run it in places that are clear.
2. Check the general condition of the hovercraft (skirt and rudder)
3. Use the safety goggles and earbuds for protection.
4. Check the oil levels in both engines before start's them.
5. Check the rudder system and joint lubrication,
6. Run the thrust engine. Don't increase the RPM Suddenly.
7. Run the lift engine. Don't increase the RPM Suddenly.
8. Drive Safe!

Shut down the Hovercraft:

- 1- First turn off the lift engine, wait until the hovercraft landed on ground.
- 2- Turn off the thrust engine.