FABRICATION OF AIR-HYBRID
ALL TERRAIN VEHICLES
FRONT SUSPENSION SYSTEM

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ABSTRACT

This thesis is about fabricating of Hybrid-air ATV front suspension system. It consists of spring shock absorber and linkage to support the vehicles. Suspension system plays an important role in vehicles. It is to ensure the safety and riding comfort of the passengers during their journey. It is also providing sufficient damping force to overcome the damping of vehicle due to the road condition. The process of fabricating the suspension system is one of the crucial part which will affect the quality and function of the suspension system. The suspension system used for the Air-hybrid ATV suspension system is double wishbone suspension system. The reverse engineering is done to design and fabricate the suspension system. The project is to fabricate the part based of the design given. Most of the part of the suspension system is design to fit the chassis of the Air-hybrid ATV. Thus, the part must follow exactly the dimension of the drawing else they could not fit each other. Part of the suspension system also need to be fitted to the part brought from market and the chassis of the Air-hybrid ATV chassis. Thus, the design refinements are needed to ensure that all the parts of the suspensions system can integrate to each part. It is impossible to fabricate the product as same as the engineering drawing. Therefore, by refining the design, the product can be done as close as the design given. Material preparation and methods chosen for fabricating the part of suspension system will also decide the quality and functionality of the suspension system. Fabricating suspension system of the Air-hybrid ATV suspension system is not easy, but by doing well progress planning and using the right method, the suspension system could be fabricated as close as the design to ensure the quality of the suspension system.
ABSTRAK

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CHAPTER 1

INTRODUCTION

1.1 Background

Front suspension system in a vehicle helps absorb hardness in the road. It is very important to all terrain vehicles because of the road condition it travels. Thus, the fabricating process of all terrain vehicle front suspension system must be very careful to ensure the suspension system works well. It is also to ensure the driver’s safety and comfort of riding the all terrain vehicles.

This project is to fabricate front suspension system of an air-hybrid all terrain vehicle’s front suspension system according to the design given.

1.2 Problem statement

In the progress of fabricating the front suspension system of the Air-hybrid ATV suspension system, it is important to understand Engineering drawing and transform the 3D drawing into a real life product. However, it is difficult to fabricate the product as ideal as the drawing.

Fabricating the Air-hybrid ATV front suspension system involve choosing suitable method to fabricate the product as similar as the design but it is difficult is to make sure the actual product is the same as design. Thus, it is necessary to refine the design according the fabrication process.
1.3 Objectives

The main objectives of this project are:

i. To reverse engineering of double wishbone front suspension unit for ATV motorcycle
ii. To fabricate the working prototype of front suspension unit for ATV motorcycle

1.4 Scopes

The scopes of this project are:

i. Literature review on the selected work scopes
ii. Measurement and reverse engineering of the existing model in 3D format
iii. Preparation of materials and tools
iv. Fabrication of working prototype based on the refined design
v. System integration and operational verification
vi. Final report preparation

1.5 Flow chart

A flowchart is a type of diagram that represents an algorithm or process, showing the steps as boxes of various kinds, and their order by connecting them with arrows. This diagrammatic are presentation solution to a given problem. Process operations are represented in these boxes, and arrows; rather, they are implied by the sequencing of operations. Flowcharts are used in analyzing, designing, documenting or managing a process or program in various fields. Below is the flow chart of this project- Fabricating ATV front suspension system.
START

Literature Review

Planning and Reverse Engineering

Materials and tool preparation

Fabrication

Integration

Final Presentation

Final Report

END

Modification
CHAPTER 2

LITERATURE REVIEW

2.1 All-Terrain Vehicle

An all-terrain vehicle is defined as a motorized off-highway vehicle designed to travel on four low-pressure tires, having a seat designed to be straddled by the operator and handlebars for steering control. ATVs are subdivided into two types as designated by the manufacturer. Type 1 ATVs are intended by the manufacturer for use by a single operator and no passenger. Type 2 ATVs are intended by the manufacturer for use by an operator and a passenger, and are equipped with a designated seating position behind the operator (Jeff Savage, 2004).
2.1.1 Historical Perspective

The table (Table 1.1) below shows the history of ATVs. It records the types of the ATVs build by different manufacturer on different year. This also shows the trends of ATVs.

**Table 1.1: History of ATVs**

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
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<tr>
<td>1970</td>
<td>Honda introduces the first all-terrain vehicle, the three-wheeled US90 with a 7hp engine, for US$595.</td>
</tr>
<tr>
<td>1979</td>
<td>Yamaha introduces its first ATV, the YT125.</td>
</tr>
<tr>
<td>1981</td>
<td>Honda introduces the ATC250R, the first high-performance two-stroke three-wheeler adapted</td>
</tr>
<tr>
<td>1982</td>
<td>Suzuki introduces its first ATVs, including the first four-wheeled ATV, the QuadRunner LT125. It has an odometer, five forward speeds, plus reverse. Honda begins to sell the first ATV designed specifically for utility use, the ATC 200E ‘Big Red’ three-wheeler.</td>
</tr>
<tr>
<td>1984</td>
<td>Yamaha and Honda begin selling four-wheeled ATVs.</td>
</tr>
<tr>
<td>1985</td>
<td>Suzuki introduces the first high-performance, two-stroke four-wheeler, the QuadRacer LT250. Polaris Industries becomes the first North American company to enter the ATV business, introducing snowmobile technology such as automatic transmissions to replace manual gearboxes and floorboards rather than footpegs. Kawasaki offers its first four-wheeled ATV.</td>
</tr>
<tr>
<td>1986</td>
<td>Honda introduces the most successful racing quad in history, the FourTrax 250R two-stroke. The company also debuts the first four-wheel-drive quad, the FourTrax 350 4x4.</td>
</tr>
<tr>
<td>1988</td>
<td>ATV manufacturers agree to stop selling three-wheeled models after the U.S. government raised safety concerns. The industry also launches safety programs to train riders. Honda introduces the FourTrax 300 and FourTrax 300 4x4, which become the most</td>
</tr>
</tbody>
</table>
versatile, most popular ATVs in history selling more than 530,000 units over the next 12 years.

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
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</thead>
<tbody>
<tr>
<td>1992</td>
<td>The last holdout in the high-performance 250cc two-stroke four-wheeler class, the Suzuki QuadRacer, disappears from the showroom floors.</td>
</tr>
<tr>
<td>1996</td>
<td>The first Arctic Cat ATVs go on sale.</td>
</tr>
<tr>
<td>1998</td>
<td>Bombardier of Valcourt, Que. begins selling ATVs.</td>
</tr>
<tr>
<td>Late 1990s to early 2000s</td>
<td>A resurgence of high-performance ATV models return to showroom floors with all-new premium 4-stroke models from virtually every ATV manufacturer.</td>
</tr>
<tr>
<td>2001</td>
<td>Polaris offers a 683cc engine, the largest ever so far in an ATV, on its Sportsman model. It sells for US$7,399.</td>
</tr>
<tr>
<td>2006</td>
<td>Bombardier introduces the fuel-injected 800cc Outlander, a V-twin-powered machine that features class-leading horsepower and torque.</td>
</tr>
<tr>
<td>2008</td>
<td>The displacement wars continue with Arctic Cat taking top honors for the year with their new ThunderCat 1000, twin-cylinder four-stroke sport/utility model</td>
</tr>
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2.1.2 Types of ATVs

ATVs come in many different shapes and sizes. The different types of ATVs are designed and manufactured for different uses including racing, pit-vehicles, recreation, hunting, ranching, military, emergency services and industrial. Just about anything you can think of.

While the most common type of ATV is of the four-wheeled variety, there are also ATVs that come with three, six or even eight wheels. And there are some eco-friendly ATVs hitting the market that run on batteries like the Model One EUV from Barefoot Motors (Edward Abdo, 2012).

Figure 2.1: Earth Utility Vehicle (EUV) Model One Electric Quad by Barefoot Motors

Source: Edward Abdo (2012)
Utility ATVs

Utility ATVs (Figure 2.2) are the most popular type of ATV. This type of ATV typically has short travel suspension, a big motor and more accessories designed for working or hunting.

Utility ATVs are used in industries such as agriculture and ranching where repair work, feeding and other tasks are done. They are also very popular with hunters who traverse rugged terrain, often carrying heavy cargo. Electric ATVs are becoming popular with hunters because they can move more quietly.

You see a lot of Utility ATVs being ridden at recreation spots like desert OHV areas and on private property. Some are bought with every intention of being used as a tool but often see just as much recreation time, which isn’t a bad thing (Edward Abdo 2012).

Figure 2.2: 2012 BRP Outlander 800r EFI 4×4 Utility ATV

Source: Edward Abdo (2012)
Sport ATVs

Sport ATVs (Figure 2.3) are the second most popular type of ATV in the USA. Ranging in size from 250cc on up to 700cc, these All Terrain Vehicles are lightweight, have lots of suspension to handle jumps, bumps and turns. These quads can be highly modified and enhanced with literally thousands of accessories to alter style and performance based on numerous criteria.

Sport ATVs are much quicker than their utility based brethren and extra care goes in to designing them to be as light as possible with very forgiving suspension and responsive engines. Sport quads are used in sanctioned racing because of their speed and suspension advantages over other different types of ATVs (Edward Abdo 2012).

Figure 2.3: Honda TRX 700XX IRS Sport ATV

Source: Edward Abdo (2012)
Side by Sides ATVs

Side by Side ATVs (Figure 2.4) are sometimes referred to as SxS or Rhino’s. They’re like golf carts, only with suspension equal to that of sport quads, with larger, more powerful motors. SxS, with their ability to carry passengers and cargo, their light weight, extreme suspension and short wheel-base, are able to take you and your friends to places you might not have thought possible.

SxS are becoming the most popular of the different types of ATVs in small rural communities. Some towns allow them to be registered on-highway use. They are used as “pit vehicles” at races and other events to provide more versatility in transportation and mobility. Fire and Rescue or military often get them highly modified for specific applications (Edward Abdo, 2012).

Figure 2.4: BRP Can-Am® Maverick™ 1000R

Source: Edward Abdo (2012)
Children's ATVs

Children’s ATVs (Figure 2.5) are smaller than the other different types of ATVs. They usually come between 50cc and 110cc, and in some cases go up to 125cc. They offer little or no suspension, little power and an automatic transmission or no gears at all.

Youth ATVs are geared towards riders with little or no previous riding experience. Children’s ATVs are usually limited to weights that do not exceed around 100 to 150 lbs depending on the make and model (Edward, Abdo 2012).

Figure 2.5: Electric ATV for children

Source: Edward Abdo (2012)
2.2 Suspension system

A suspension system is the system consists of springs, shock absorber and linkages that connect a vehicle to its wheels to allow the vehicle to pass through any road conditions. Suspension system also serves a dual purpose which is contributing to vehicle’s handling and braking. Most of the vehicles suspensions nowadays are passive type which is generally consists of mass, spring and damper. However, both comfort and stability characteristics cannot achieve at the same time, increasing one, decreasing another. Thus, due to the different characteristic of the vehicles, different type of vehicles uses different type of suspension system (Don Knowles, 1994).

Front suspension system

There are two types of front suspension in general use: the independent system & the solid axle system. Independent suspension usually operates through heavy-duty coil springs or torsion bars and direct, doubles acting shock absorbers. In solid axle construction, the axle beam and wheel assemblies are connected to the car by leaf springs and direct or in-direct shock absorber (Don Knowles, 1994).
2.2.1 Historical perspective

**Horse drawn vehicles**

By the early 19th century, most British horse carriages were equipped with springs; wooden springs in the case of light one-horse vehicles to avoid taxation, and steel springs in larger vehicles (Ttti, K K Jain R B Asthana, Bhopal, Jain & Asthana, 2002).

**Automobiles**

a. In 1901 Mors of Paris first fitted an automobile with shock absorbers. With the advantage of a dampened suspension system on his 'Mors Machine', Henri Fournier won the prestigious Paris-to-Berlin race on the 20th of June 1901.

b. In 1920, Leyland Motors used torsion bars in a suspension system.

c. In 1922, independent front suspension was pioneered on the Lancia Lambda and became more common in mass market cars from 1932.
2.2.2 Type of front suspension system

Dependent suspension system

![Dependent suspension system diagram](image)

**Figure 2.6:** Dependent suspension system

Source: Don Knowles (1994)

The dependent front suspension (Figure 2.6) uses a solid axle. This design consists of one steel or aluminum beam extending the width of the vehicle. This beam is held in place by leaf springs (Don Knowles, 1994).

a. Load carrying ability.

b. Use only on heavy trucks and off-road vehicles.
The twin I-beam (Figure 2.7) is one type of independent front suspension. Although it is similar to the solid axle in many ways, it was designed to improve ride and handling (Don Knowles, 1994).

a. Load carrying ability
b. Used to picked up
c. Used on van and four-wheel drive