UNIVERSITY OF TECHNOLOGY – VNU HCM

FACULTY OF AUTOMOTIVE ENGINEERING

Project Report

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Double wishbone suspension

Subject: CAD APPLICATION IN AUTOMOTIVE DESIGN

Class: CC01 Group 4

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ABSTRACT

A suspension system is one of the most critical components of a vehicle, providing the necessary support to the vehicle's weight and controlling its movement over varying terrains. The suspension system's primary function is to ensure that the tires maintain contact with the road surface, which is essential for safe driving, especially at high speeds. A suspension system is responsible for absorbing shocks and vibrations from the road, thereby ensuring that passengers in the vehicle experience a comfortable ride.

One of the most popular types of suspension systems used in modern vehicles is the double wishbone suspension, which is also known as an independent suspension system. The double wishbone suspension system consists of two A-shaped arms or wishbones connected to the wheel hub and the suspension assembly. The arms pivot on ball joints and are attached to the vehicle's body via the shock absorbers and springs.

In this report, we will research the function, operating principle, and structure of double wishbone suspension. From that, we can create a 3D model of the system by using CAD and Solidworks.

CHAPTER 1: SUSPENSION SYSTEM

1.1 Introduction

The suspension system is an essential component in a vehicle's handling, as it helps to keep the tires in contact with the road surface at all times. It serves as a connection between the vehicle and the wheels and is responsible for absorbing shocks and vibrations caused by uneven road surfaces. By doing so, the suspension system provides a smoother and more comfortable ride, while reducing body roll and improving overall stability. It is a crucial component for ensuring the safety and performance of a vehicle and is essential for maintaining proper handling and control while driving.

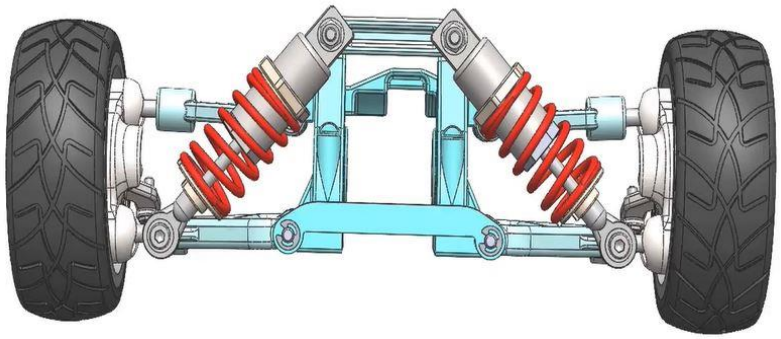

Figure 1.1: General suspension system

1.2 Components

The main components of a suspension system include the springs, shocks, struts, control arms, and sway bars.

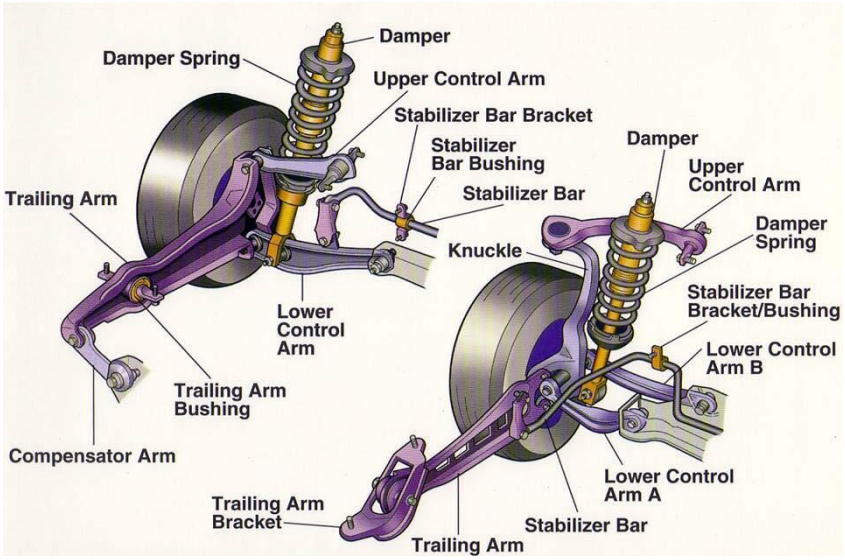

Figure 1.2: Suspension components

- The springs are responsible for supporting the weight of the vehicle and absorbing shocks from the road surface. Several types of springs include coil springs, leaf springs, and torsion bars.
- The shocks (also known as shock absorbers or dampers) control the springs' movement and prevent the vehicle from bouncing excessively. They work by using hydraulic fluid to absorb the energy of the springs as they compress and rebound.
- The struts are similar to shocks but act as a structural part of the suspension system. They are typically used in front-wheel-drive vehicles and are often combined with coil springs to form a single unit.
- The control arms connect the suspension system to the vehicle's frame or body and help control the wheels' movement. They are typically made of steel or aluminum and are attached to the frame or body at one end, and the steering knuckle or wheel hub at the other end.
- The sway bars (also known as stabilizer bars) are responsible for reducing body roll during cornering. They are typically made of steel and are connected to the suspension system at each end, with links that allow for some flexibility.

Together, these components provide a smooth and comfortable ride while ensuring that the vehicle maintains good handling and stability.

1.3 Classification

There are three main classifications of suspension systems

- Dependent
- Semi-independent
- Independent suspension systems

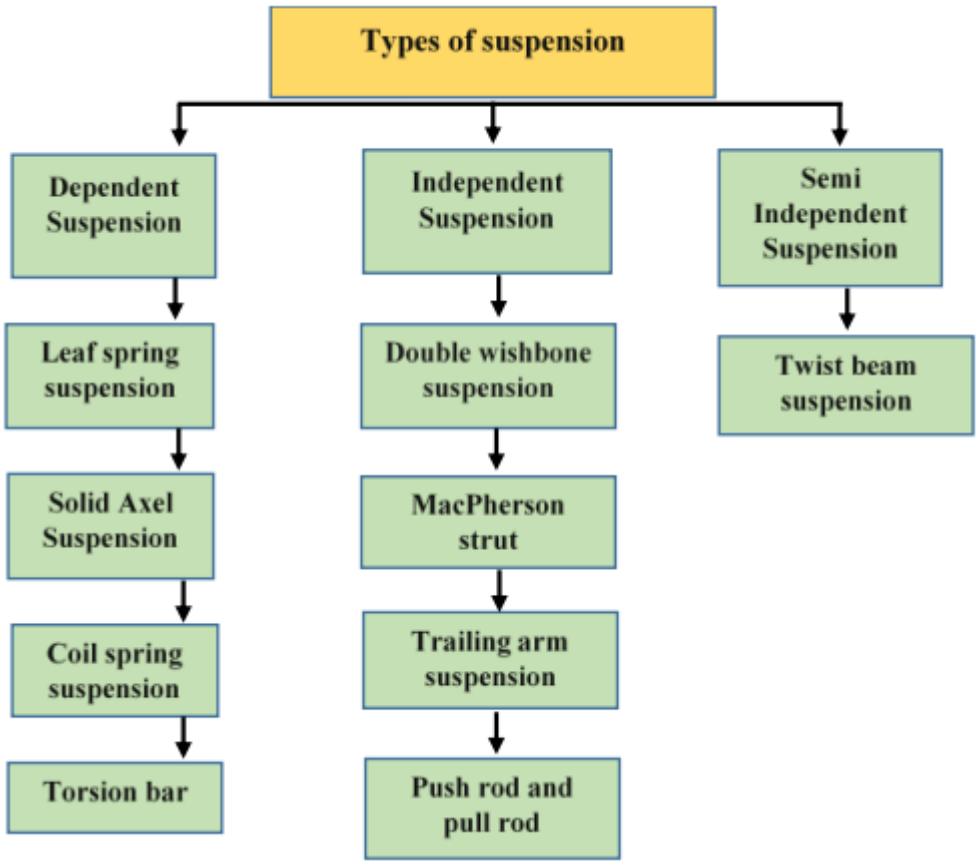

Figure 1.3: Different types of the suspension system[1]

In modern cars, an independent type of suspension is usually seen. It allows each wheel to move independently of the others, providing improved handling and ride quality. There are several types of independent suspension systems used in modern cars, including the MacPherson suspension system, swinging arm suspension system, double wishbone suspension system, and multi-link suspension system.

[1] Research Gate, "Classification of automotive suspension systems", https://www.researchgate.net/figure/Classification-of-automotive-suspension-systems-Adapted-from-9_fig1_358409823

CHAPTER 2: DOUBLE WISHBONE SUSPENSION

2.1 Introduction

Double Wishbone Suspension System is an independent type of suspension system. It means each wheel of the same axle has vertical movement independent of the other. The double wishbone suspension was introduced in the 1930s. French car maker Citroën began using it in their 1934 Rosalie and Traction Avant models. Packard Motor Car Company of Detroit, Michigan, used it on the Packard One-Twenty from 1935 and advertised it as a safety feature[2].

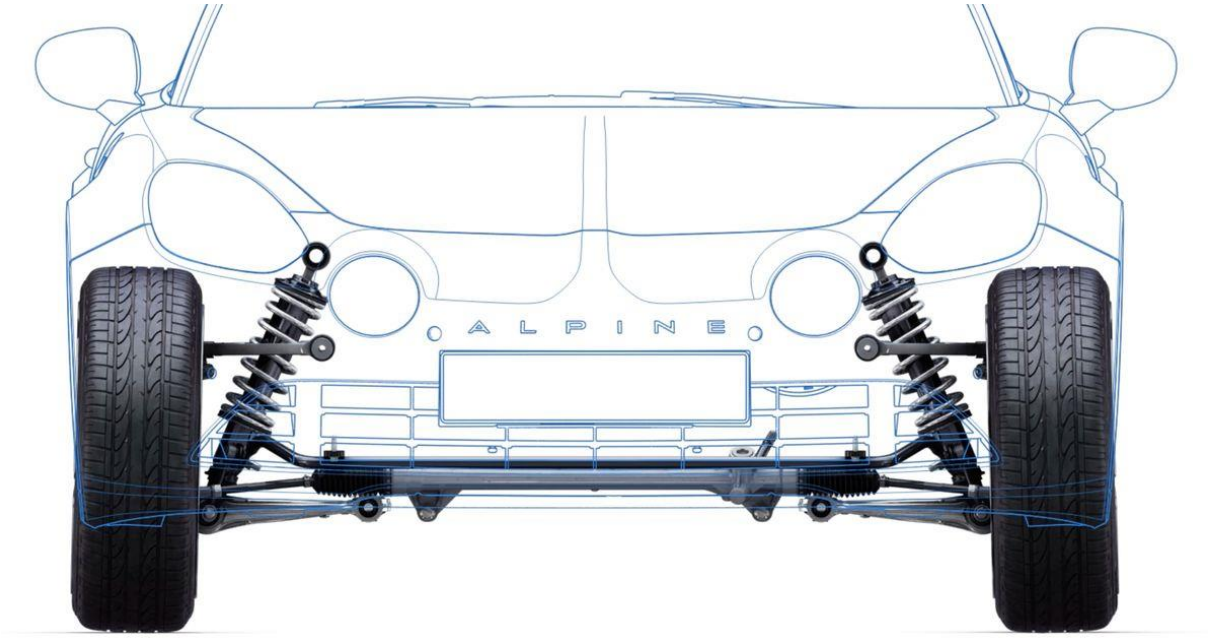

Figure 2.1: General double wishbone suspension

Double wishbone suspension is a popular type of suspension system that is widely used in modern cars. This type of suspension system provides superior handling and stability compared to other suspension systems, making it a popular choice for high-performance and sports cars. Some examples of cars that use double wishbone suspension systems include the Honda Civic Type R, the Mazda MX-5, the Audi A4, and the Porsche 911. Additionally, double wishbone suspension systems are commonly used in motorsports, such as in Formula 1 and other high-performance racing categories.

2.2 Structure and Components

[2] Wikipedia, “Double wishbone suspension”, https://en.wikipedia.org/wiki/Double_wishbone_suspension

A double wishbone suspension is an independent suspension design for automobiles using two (occasionally parallel) wishbone-shaped arms to locate the wheel. Each wishbone or arm has two mounting points to the chassis and one joint at the knuckle. The shock absorber and coil spring mount to the wishbones to control vertical movement. Double wishbone designs allow the engineer to carefully control the motion of the wheel throughout suspension travel, controlling such parameters as camber angle, caster angle, toe pattern, roll center height, scrub radius, scuff, and more.

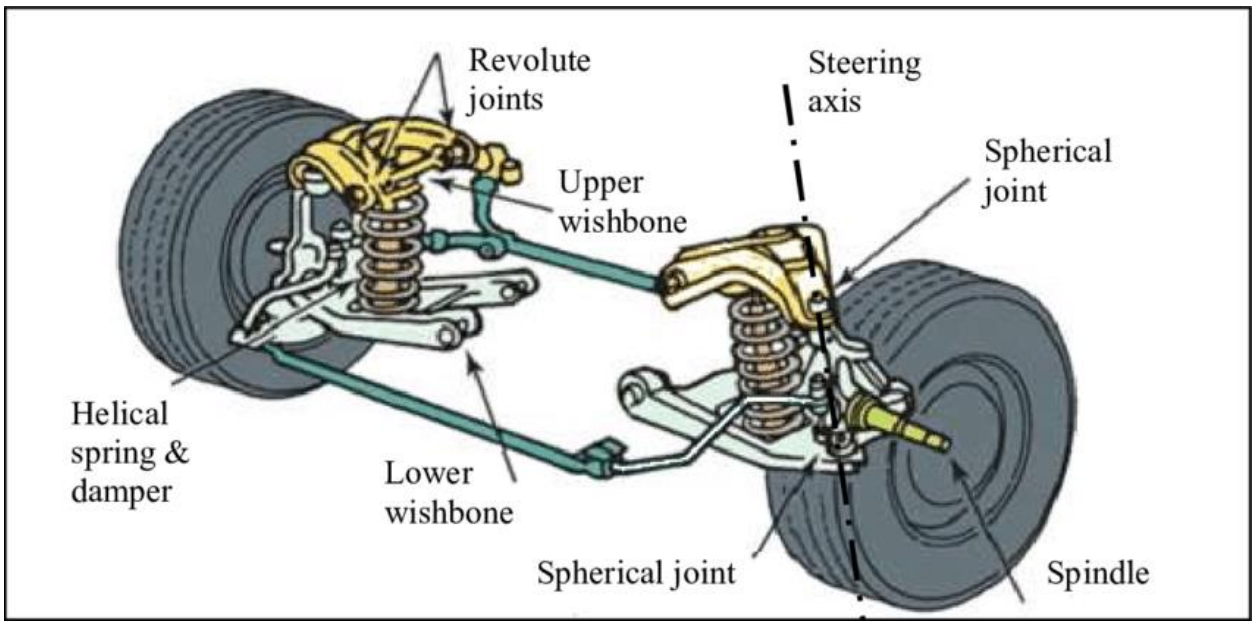

Figure 2.2: Main components of double wishbone suspension

The materials used for the components are shown below:

Component	Material
Spring	Steel
Shock absorber unit	Steel
Chassis Frame	Aluminum
Knuckle	Mild carbon steel
Wishbones	Mild carbon steel

Table 1 : Material Selection

The properties of the selected materials are shown below:

Material	Poisson's Ration	Young's Modulus (Pa)	Density Kg/m^3
Steel	0.28	2.05e+11	7870
Aluminum	0.34	7e+10	2700
Mild Carbon Steel	0.3	2.06e+11	7850

Table 2: Material Properties

2.3 Working

When a vehicle's tires encounter uneven surfaces on the road, the lower arm of the suspension system absorbs the impact and transfers it to the vehicle's frame through the shock absorber. This process is achieved by compressing the spring and damper within the shock absorber, while the upper arm of the suspension system helps to maintain the camber angle of the wheel. The length of the upper wishbone can be adjusted to optimize the handling and ride quality of the vehicle, allowing it to better navigate different road conditions[3].

2.4 Features

2.4.1 Advantages:

1. Better handling: The double wishbone suspension provides better handling and stability compared to other suspension systems. It offers precise control of the wheel and allows for better cornering and maneuverability.
2. Better ride quality: The double wishbone suspension system provides a smoother ride compared to other suspension systems. The independent movement of the two control arms allows the wheel to move up and down independently, resulting in better shock absorption.

[3] Chandan Vrushabhendra, " Double Wishbone suspension system", vol 5 no 1, p1 2019

3. More durable: The double wishbone suspension is more durable compared to other suspension systems. Its design reduces wear and tear, making it less likely to break down.
4. The double-wishbone design allows for optimum adjustability and tire contact.

2.4.2 Disadvantages:

1. Cost: The double wishbone suspension system is more expensive to manufacture and install compared to other suspension systems. There are multiple adjustments and multiple wear points which adds time and cost to repairs
2. More complex: The double wishbone suspension system is more complex compared to other suspension systems. It has more components, which means it is more difficult to diagnose and repair.
3. Space requirement: The double wishbone suspension system requires more space compared to other suspension systems. This means that it may not be suitable for vehicles with limited space or tight engine compartments.

2.5 Simulation Process

2.5.1 CAD:

AutoCAD is a computer-aided design (CAD) software that is used by architects, engineers, and designers to create 2D and 3D models and drawings. It was first released in 1982 by Autodesk and has since become one of the world's most widely used CAD applications. AutoCAD can be used for a variety of design and drafting tasks, including architectural drawings, mechanical engineering designs, electrical and plumbing layouts, and more.

In this report, we use CAD to draw 2D models for the prototype, for example :

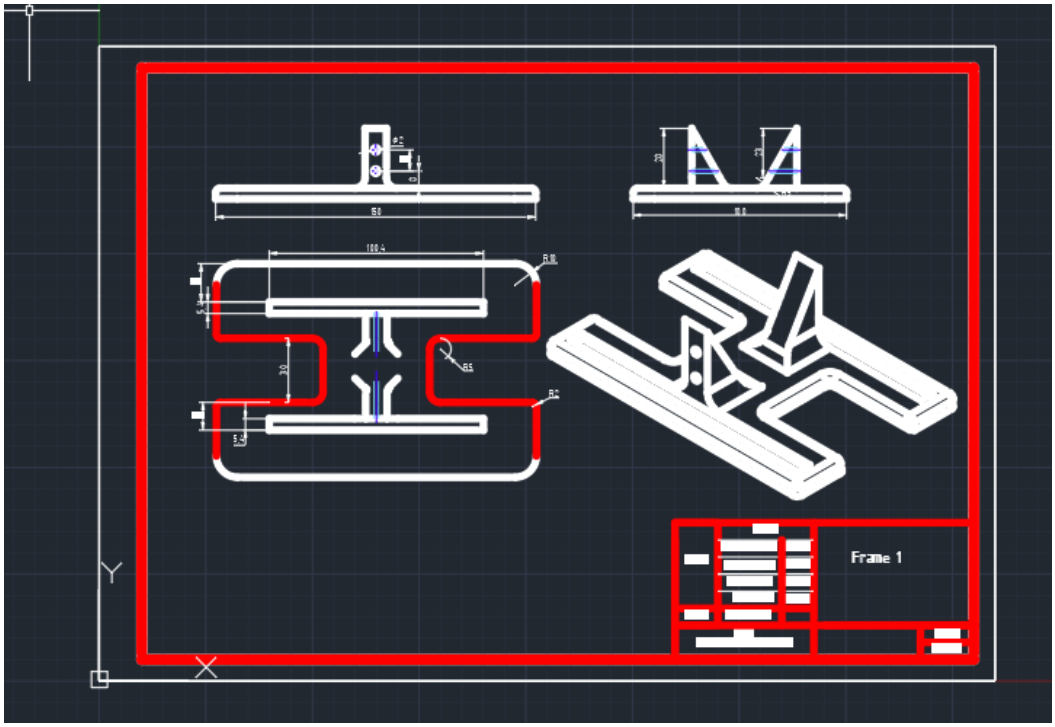

Figure 2.3: Frame

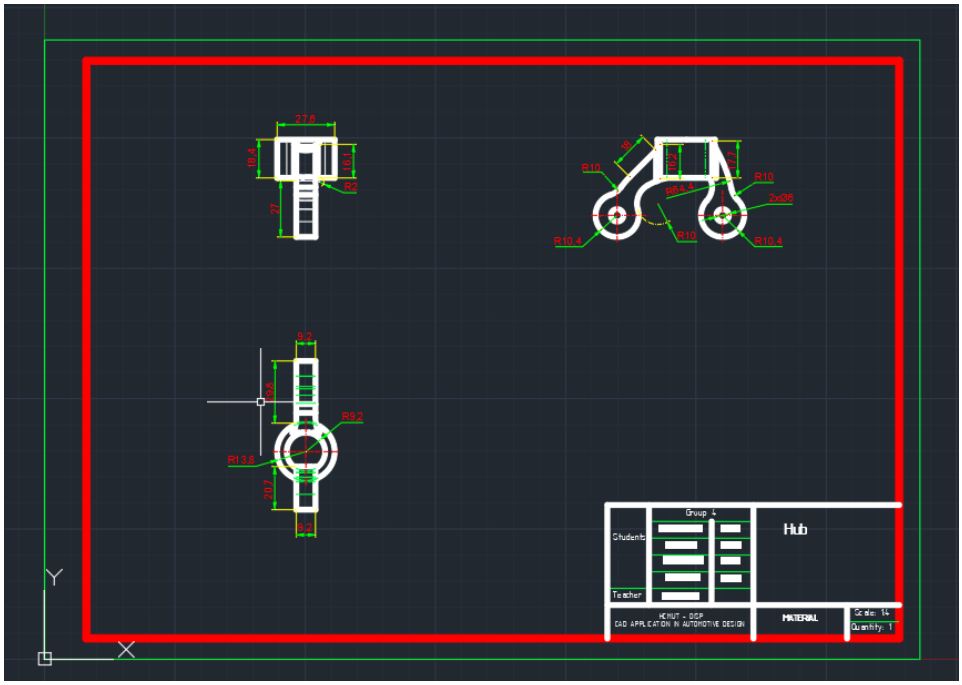

Figure 2.4: Hub

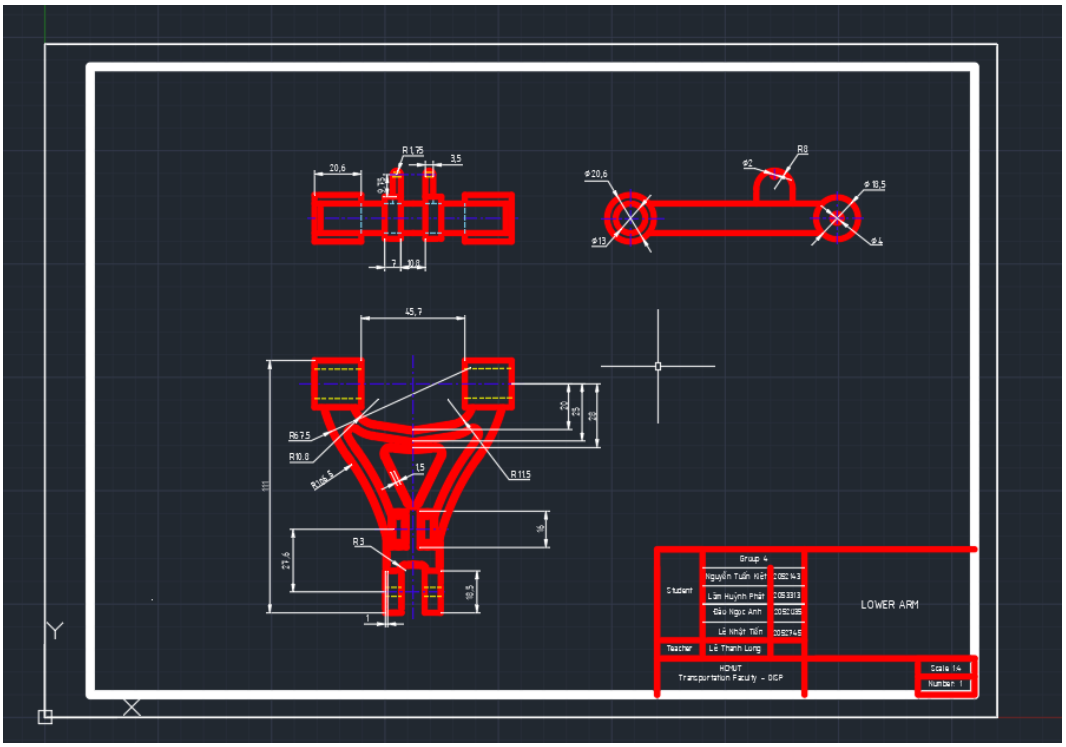

Figure 2.5: Lower arm

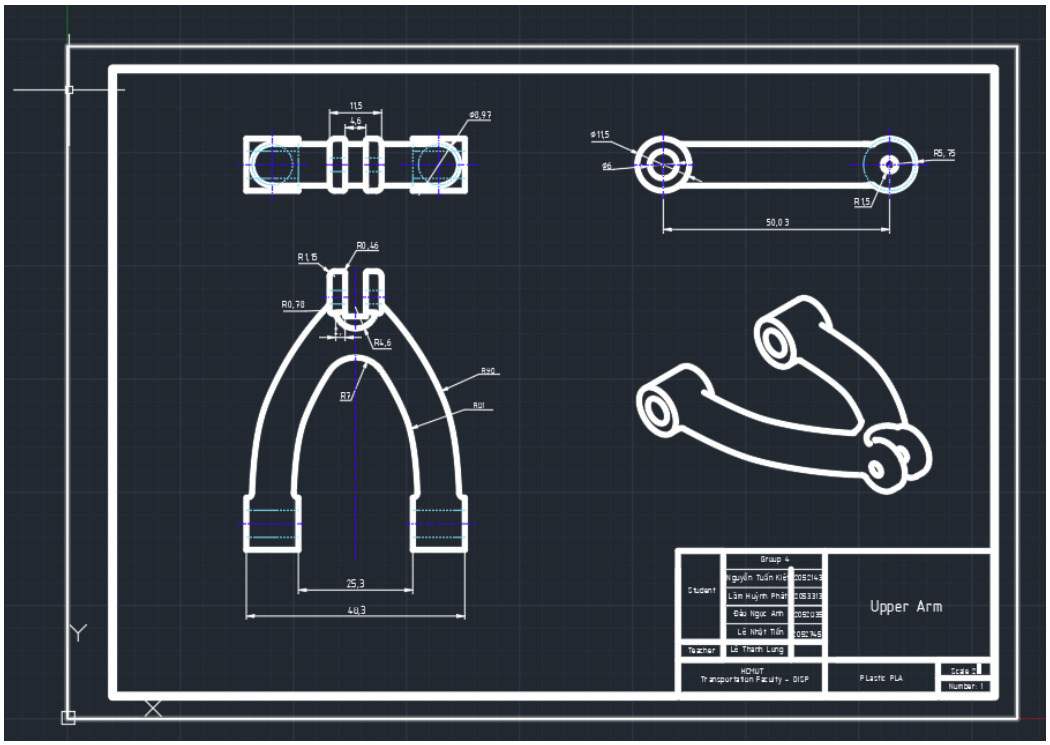

Figure 2.6: Upper arm

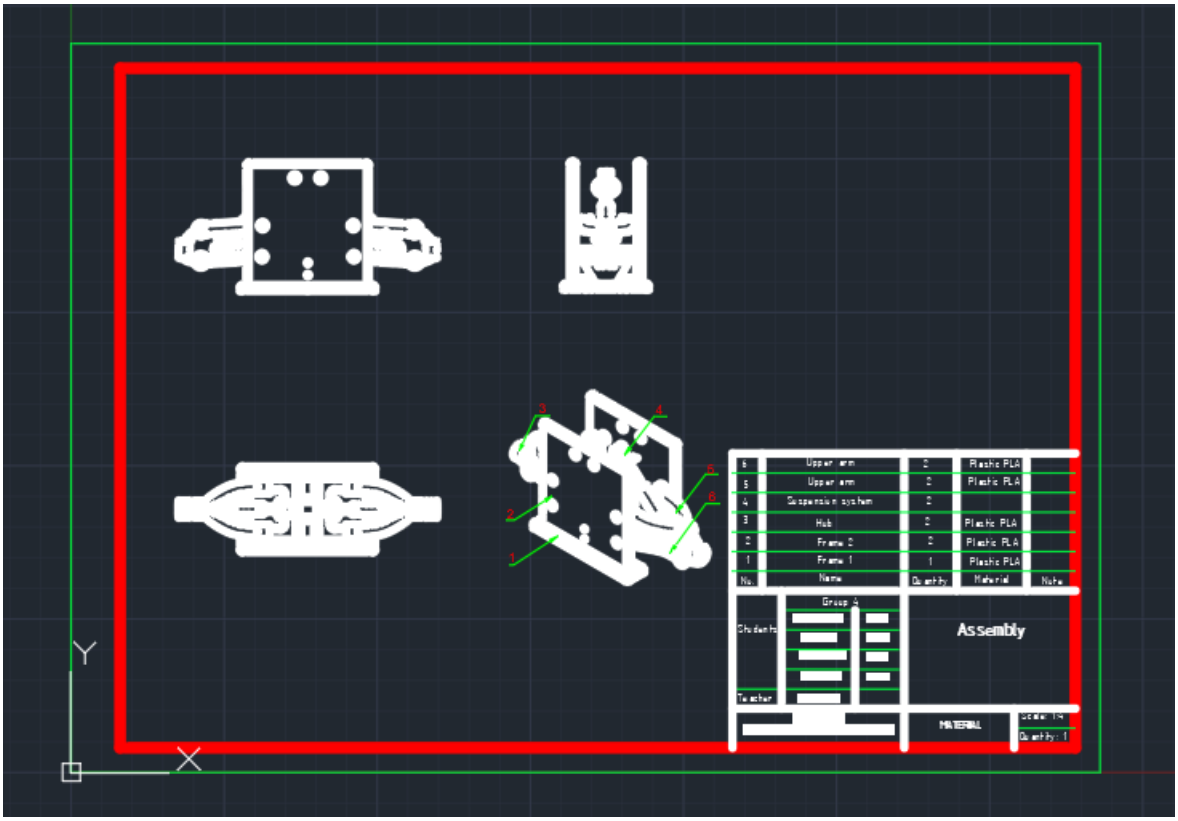

Figure 2.7: Assembly

2.*5.2 Solidwork:*

Solidworks is a 3D CAD software that is used by designers, engineers, and manufacturers to create and design products. It was first released in 1995 by Dassault Systèmes and has since become one of the world's most widely used 3D modeling software. SolidWorks allows users to create 3D models of parts and assemblies, perform simulations and stress tests, and generate 2D drawings and production-ready documentation.

In this report, we use Solidworks to draw 3D models for the prototype, here are some examples:

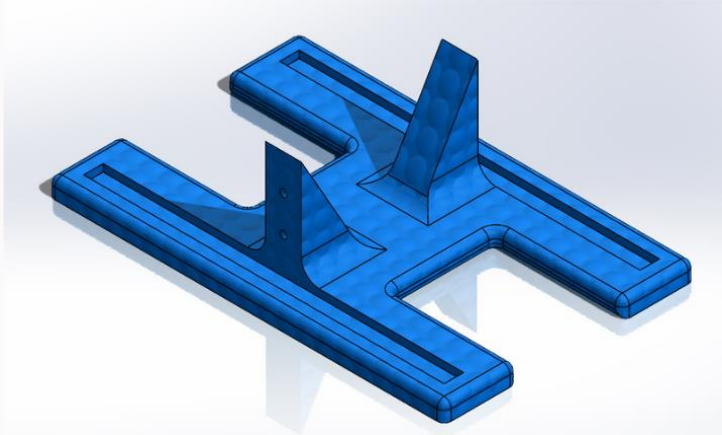

Figure 2.8: *Frame*

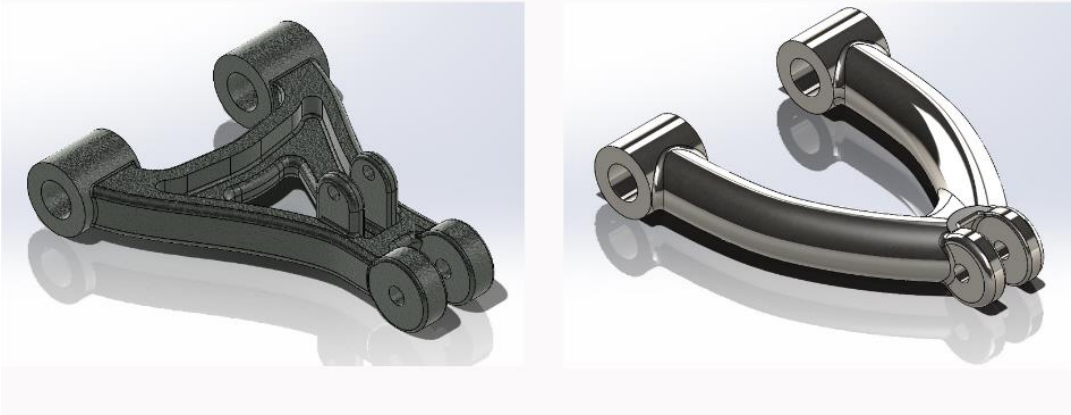

Figure 2.9: The lower and upper arm of the Double wishbone suspension

Figure 2.10: Complete models ready for 3D printing

2.5.3 3D printing process

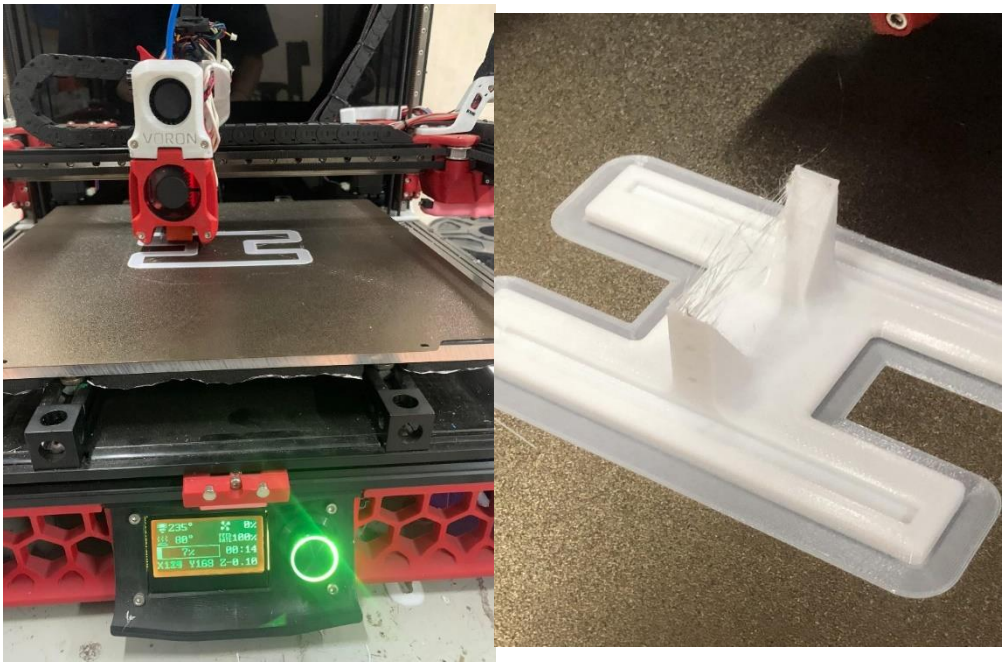

Figure 2.11: Frame models

Figure 2.12: Lower arm and upper arm models

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