

Prototype Design and Research Collection

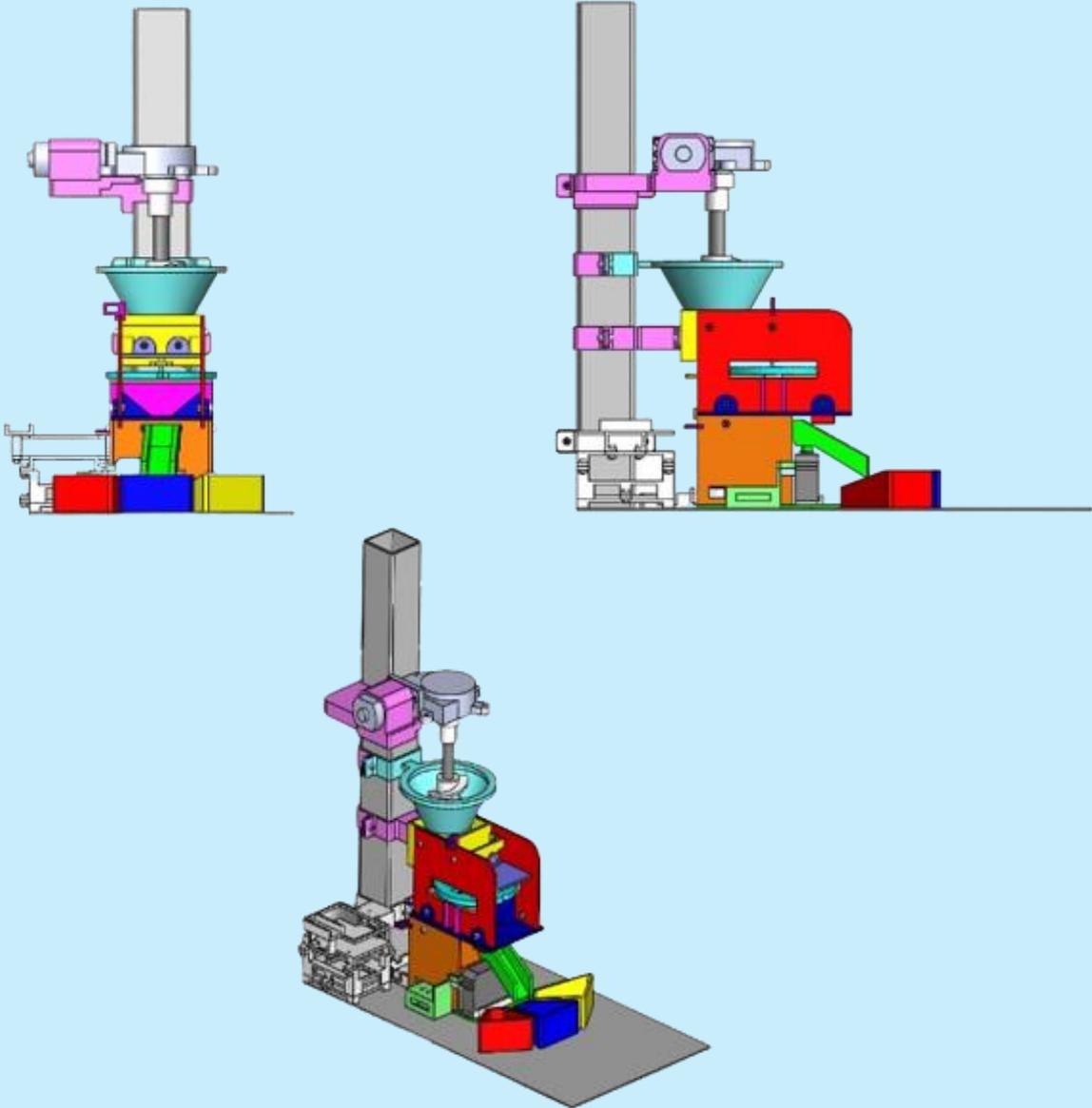
Series 1



Universiti Teknologi MARA
Pasar Gudang Campus

Prototype Design and Research Collection

Series 1



AHMAD NAJMIE RUSLI

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FOREWORD

This digital book on Prototype Design and Research Collection Series 1 (PDRC Series 1), is designed as a comprehensive reference for mechanical engineering students. The designs featured in this collection undergo an extensive analysis process, incorporating both prototype development and research to ensure a thorough understanding of design principles. Each project is carefully analysed before the prototype fabrication with detailed summaries of the project description and design parameters. The design and research products presented in this series cover a wide range of tools and equipment for various applications including household, workshop and entrepreneurial purposes.

This collection aims to foster innovation by offering students valuable insights into both the technical and research aspects of product design. It is hoped that this book will inspire future engineers and designers to approach product development with a deeper understanding of the design and research processes.

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CHAPTER 13

Structural Design and Fabrication of a Go-Kart Front Suspension

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ABSTRACT

The suspension system is an essential component of an automotive vehicle, ensuring proper functionality and performance. It absorbs shocks from rough terrains while maintaining handling stability by keeping all tyres in contact with the road. This project focuses on developing a functional front suspension for a go-kart. The most suitable suspension type will be selected and integrated into the go-kart's frame. An informed decision will be made through mock-ups and testing of different suspension types. Ultimately, this research and development process will enhance the go-kart's overall performance.

Keywords: Design, Fabrication, Front Suspension

1 INTRODUCTION

The suspension is a mechanical system that connects the wheels to the vehicle's frame, allowing relative motion between them. It is designed to support the weight of the vehicle and its passengers by evenly distributing it across all wheels. Additionally, it absorbs and dampens shocks and vibrations caused by uneven road surfaces, maintains tyre contact with the road, and controls body roll, pitch, and yaw to enhance stability and handling. The suspension system also improves ride comfort by isolating the cabin from road noise and disturbances as in Figure 1.

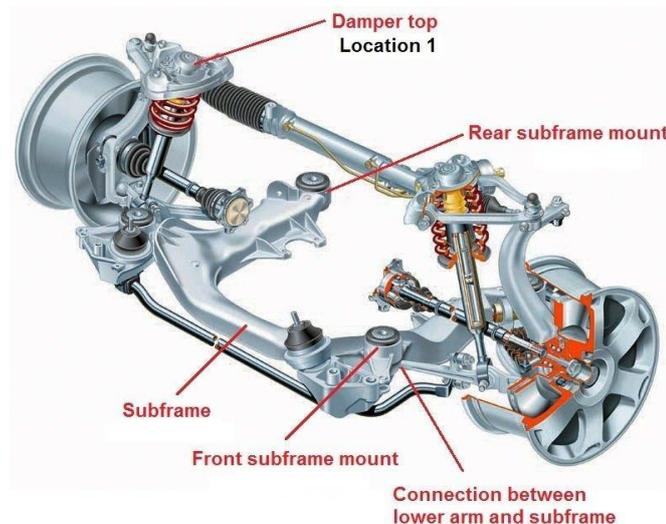


Fig. 1: Multilink Suspension

A suspension system consists of multiple components working together to fulfil its function. For example, springs store and release energy when compressed or extended while supporting the vehicle's weight. Dampers, also known as shock absorbers, dissipate the energy stored in the springs to minimize excessive oscillations and bouncing. Control arms or wishbones connect the wheels and the frame, enabling controlled vertical and horizontal movement.

Over the years, various suspension innovations have been developed, ranging from rigid axle to active suspension. Rigid axle suspension consists of a solid beam connecting the wheels on the same axle. While it offers high durability and load capacity, it compromises comfort and handling—for example, leaf springs. On the other hand, independent suspension allows each wheel to move independently, providing better comfort and handling at the cost of reduced durability and load capacity, such as the double wishbone suspension.

A hybrid system known as semi-independent suspension allows some degree of movement between wheels on the same axle, such as the twist beam suspension. Lastly, active suspension utilizes sensors, actuators, and controllers to adjust suspension parameters for optimal comfort and dynamic handling. However, this system comes with higher costs and increased complexity.

2 LITERATURE REVIEW

Manufacturing is the process of transforming raw materials into finished products through the use of tools, labour, machining, and chemical processing [1]. Every manufacturing process begins with design, which is carried out using advanced CAD software to create 2D or 3D models of the product intended for production.

Material selection is a critical step in manufacturing, directly impacting the final product's strength, stiffness, and weight [2]. Choosing an unsuitable material can lead to product failure. For this reason, steel is commonly used in large-scale manufacturing due to its desirable mechanical properties.

Cutting involves shaping a workpiece such as metal by moving it about a cutting tool [3]. Techniques such as shaving, drilling, and milling are used to achieve the desired shape. Cutting also includes separating or dividing materials into smaller parts for further processing.

Metal joining is a controlled process used to fuse metals, either temporarily or permanently, with or without applying heat or pressure [4]. Various joining techniques include welding, brazing, soldering, bolting, and riveting. This process is essential because many products cannot be fabricated as a single piece; individual components are manufactured separately and later assembled. The strength and durability of the final product depend on the joining method used.

After joining, the finishing process is applied to remove imperfections and achieve precise dimensional accuracy. Finishing also enhances the product's appearance and extends its lifespan by adding corrosion resistance. Standard finishing techniques include powder coating, plating, and painting, which create a protective layer on the product's surface.

3 METHODOLOGY

A flowchart is a crucial tool in the improvement process, providing a clear and structured representation of workflow and decision-making steps. Figure 3.1 presents the flowchart for FYP 1 to FYP 2 in a graphical format, outlining the key stages of the project. This flowchart serves as a guide to help identify critical steps and maintain focus during the fabrication process, ensuring a systematic and efficient approach.

The fabrication process involves several steps, each requiring specific tools and equipment to ensure accuracy and quality. It begins with measuring and marking, where a measuring tape is used to determine and mark the desired length of the metal beams before cutting. Once marked, the beams are cut using a cut-off machine to achieve the required dimensions.

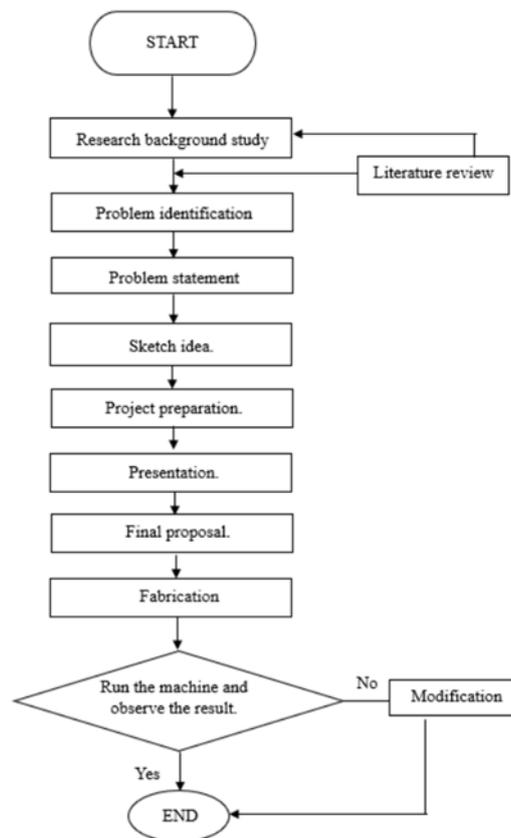


Fig. 2: Flow chart

After cutting, grinding is performed with a stone grinder to smooth out any sharp edges, ensuring safety and precision. Next, the drilling process is carried out using a bench drill, which creates holes in the metal beams to serve as mounting points for nuts and bolts.



Fig. 3: Fabrication process

The joining stage follows, where a MIG welding machine is used to securely weld the metal beams together, ensuring a strong and stable structure. Finally, the finishing process is applied using a hand grinder to refine the surface, allowing the spray paint to adhere effectively. This step enhances the final product's appearance while providing a protective layer to prevent corrosion. This structured approach ensures that the fabricated components are precise, durable, and visually appealing.

4 RESULTS AND DISCUSSION

As shown in Figure 3.14, the complete go-kart prototype is designed with front suspensions securely attached to the frame using welded brackets. This reinforcement enhances the connection's strength, ensuring the control arm remains stable and does not fail under load. In Figure 3.15, the demonstration showcases the functionality of the prototype. Initially, the front suspension remains static in its original state. However, when weight is applied, the system moves upward to absorb and dampen the force. This demonstration confirms that the prototype is fully operational and performs as intended.



Fig. 4: Final prototype

The front suspension prototype consists of several key components, each playing a crucial role in ensuring stability and performance. The upper and lower control arms manage the wheel's lateral movement, allowing controlled side-to-side motion. These arms are connected to the frame through control arm bushings, which enable vertical movement and absorb road impacts and vibrations. Shock absorbers regulate the spring action, preventing excessive bouncing when driving on uneven surfaces. Additionally, coil springs help maintain the proper ride height and control suspension travel during various driving manoeuvres. Before testing the prototype, users should read the user manual to understand the system's functionality and learn how to replace broken parts if necessary.

The front suspension operates by absorbing and damping road vibrations. When the wheel encounters an obstacle, the spring compresses to absorb the impact energy. The shock absorber dampens this motion, preventing excessive vibrations and ensuring a smooth ride. This suspension system also contributes to distributing weight evenly, maintaining balance, and enhancing overall handling. During cornering, the suspension adjusts dynamically to keep the go-kart stable and responsive, providing better control for the driver.

5 CONCLUSIONS

In this project, the front suspension of a go-kart was successfully designed by first developing three design concepts. After careful evaluation, the final design was selected and modelled using SolidWorks. Once the design phase was completed, necessary calculations and analyses were conducted to ensure structural integrity and performance. The front suspension was fabricated according to the finalized design specifications. The fabrication and testing process took approximately 10 weeks to complete. The prototype demonstrated excellent reliability in absorbing shocks and maintaining stability under load. During intense testing, which included applying a 50 kg weight by stepping on the suspension, the system effectively dampened the force, proving its durability and functionality.

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