

Research Article

Multipurpose Orbital Shaker

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Abstract: This project addresses the limited accessibility and high cost of conventional laboratory mixing equipment by developing a compact, low-cost Multipurpose Orbital Shaker suitable for educational, research, and small-scale applications. The methodology involves designing the shaker using SolidWorks and fabricating a prototype with an aluminium profile frame, stainless steel platform, worm-gear DC motor, and an electronically controlled system with PWM speed regulation and IoT-based remote operation. The results demonstrate that the shaker can deliver stable orbital motion with adjustable speed, supporting loads of up to 15 kg while maintaining consistent performance. The project concludes that the proposed Multipurpose Orbital Shaker offers a practical, affordable alternative to commercial units, enhances hands-on laboratory learning, and provides a flexible solution for mixing, stirring, and sieving tasks within constrained budgets and spaces.



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1. INTRODUCTION

Many students, educators, and small-scale researchers rely on laboratory mixing, stirring, and sieving processes for experiments and practical work. However, these tasks are often carried out using manual methods or limited shared equipment, which require considerable time, physical effort, and

repeated handling. This makes the process tiring and inefficient, particularly when experiments must be repeated or conducted for long durations. Manual operation can also lead to inconsistent mixing quality, uneven sample distribution, and unreliable experimental results.

Currently, most educational laboratories depend on conventional orbital shakers that are bulky, expensive, and limited in availability. As a result, students frequently need to wait their turn to use equipment or resort to improvise manual techniques. Although manual methods are simple, they are highly dependent on user skill and endurance. Prolonged manual mixing can reduce productivity, increase fatigue, and limit the number of experiments that can be completed within a given time frame, thereby affecting learning outcomes and research efficiency.

To address these issues, a compact and low-cost Multipurpose Orbital Shaker is proposed to assist laboratory mixing, stirring, and sieving activities. This device reduces manual effort while improving consistency, efficiency, and operational speed. Designed using SolidWorks, the shaker emphasizes functionality, practicality, and affordability, making it suitable for educational institutions and small laboratories. The project aims to enhance hands-on learning, improve experimental reliability, and expand access to essential laboratory equipment within limited budgets.

2. LITERATURE REVIEW

Efficient laboratory agitation and mixing systems play a crucial role in improving experimental consistency while reducing manual handling and operator fatigue. Precise control of motion parameters such as rotational speed, orbital radius, and load balance is essential to ensure uniform mixing, stirring, and sieving outcomes across repeated experimental cycles. Previous studies and patented shaker mechanisms emphasize the use of automated or semi-automated motion control systems to enhance operational efficiency, repeatability, and user safety in laboratory environments.

Several patents and prior designs also highlight the importance of mechanical simplicity, balanced structures, and controlled motion transmission to minimize vibration, reduce component wear, and extend equipment service life. These design principles are directly applicable to the development of a Multipurpose Orbital Shaker, as they enable stable orbital motion while maintaining affordability and ease of fabrication. By integrating proven mechanical concepts with modern electronic control, such systems can support reliable laboratory operation and remain suitable for educational institutions and small-scale laboratory applications with limited resources..

3. METHODOLOGY

The process design of design and fabrication of the product were done according to the process flow shown in Figure 1. The design and analysis were conducted using SolidWorks.

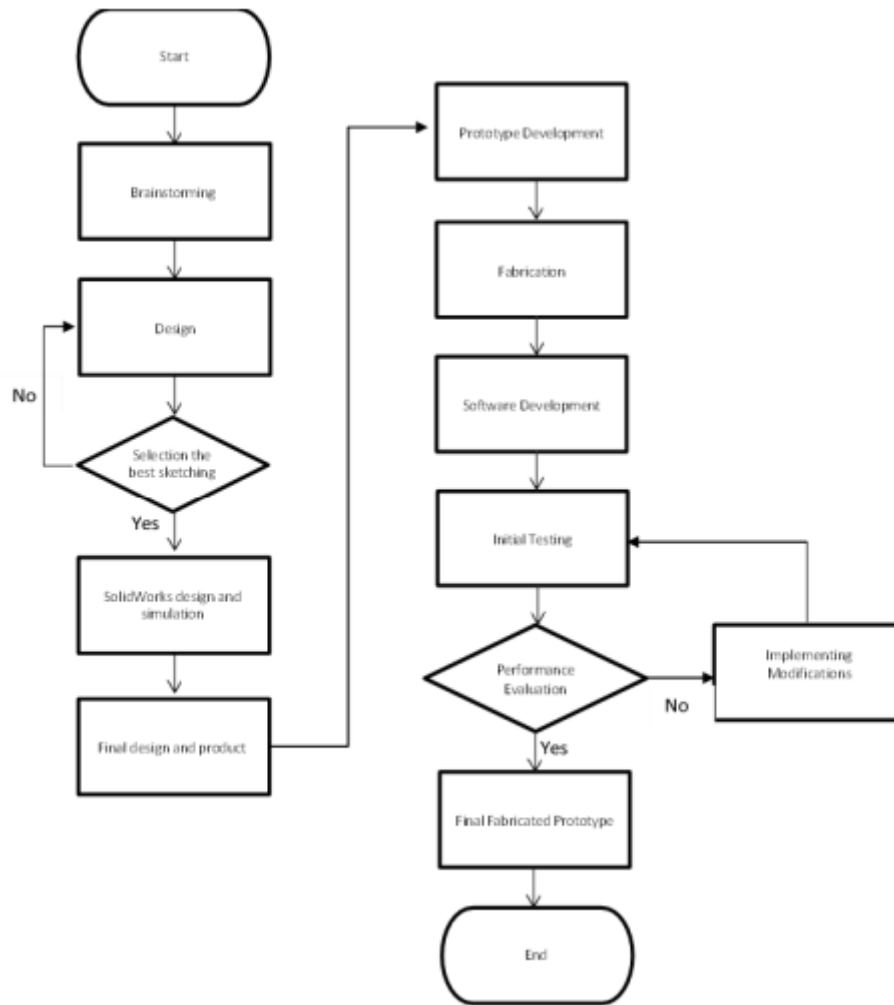


Figure 1. Process flow of the design and fabrication

The fabrication process of the Multipurpose Orbital Shaker begins with detailed product design and the selection of suitable raw materials to meet structural, functional, and cost requirements. Materials such as aluminium profiles and stainless steel plates are selected for their strength, durability, and ease of fabrication. These materials are then processed using basic manufacturing techniques including cutting, drilling, grinding, and welding to achieve the required dimensions and component shapes.

After the individual parts are prepared, they are assembled using bolts, nuts, and modular connectors to form the complete shaker structure. This approach allows accurate alignment and simplifies future maintenance or component replacement. Throughout the fabrication process, standard workshop safety procedures are strictly followed. Personal protective equipment such as safety jackets and safety boots are worn to minimize the risk of injury and ensure a safe working environment. The use of basic fabrication methods makes the machine practical to build within an educational workshop setting while maintaining reliability and functionality.

4. FINDINGS

4.1 Design of the Multipurpose Orbital Shaker

SolidWorks is a widely used computer-aided design tool in the early stages of product development (Miguel et al., 2013). In this project, SolidWorks was used to design the Multipurpose Orbital Shaker. The design process started with several hand sketches to develop different concepts. After comparison, the most suitable design was selected based on functionality and practicality, then redrawn and refined using SolidWorks. Exploded and assembly views were produced to show individual components and the complete structure. These drawings were used as references during fabrication to ensure accurate dimensions, proper fit, and correct assembly of the prototype.

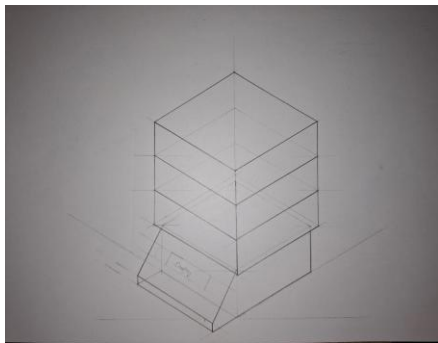


Figure 2. Design 1

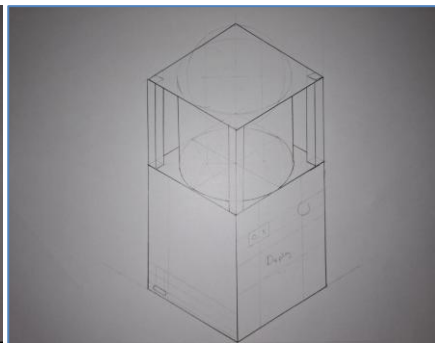


Figure 3. Design 2

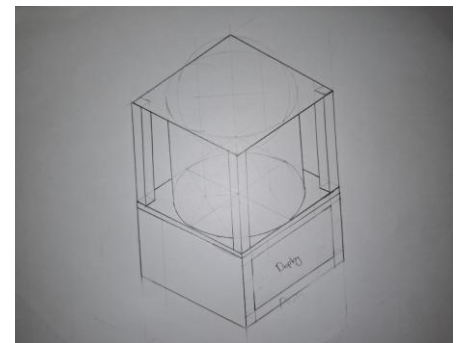


Figure 4. Design 3

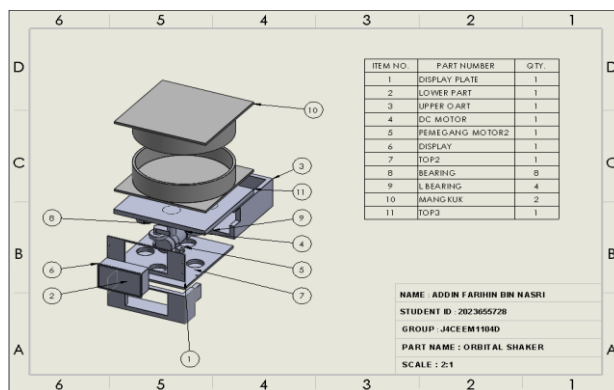


Figure 5. Exploded View Multipurpose Orbital Shaker

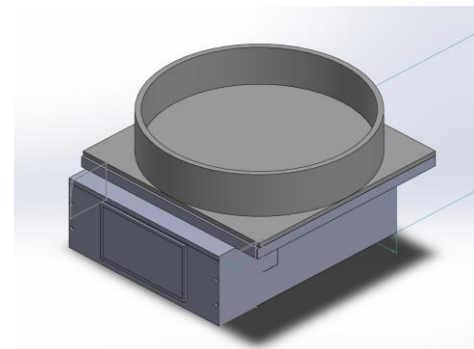


Figure 6. Assembly Drawing for Orbital Shaker

4.1.2 Final Fabricated Prototype

The final prototype was successfully fabricated as shown in Figure 7. The prototype was constructed based on the SolidWorks design, with all dimensions maintained within a tolerance of 1–1.5 mm. The machine frame is made of stainless steel due to its high strength, corrosion resistance, and suitability for hygienic applications. These material properties improve the durability of the machine and ensure safe operation for long-term use (Zaffora et al., 2021).

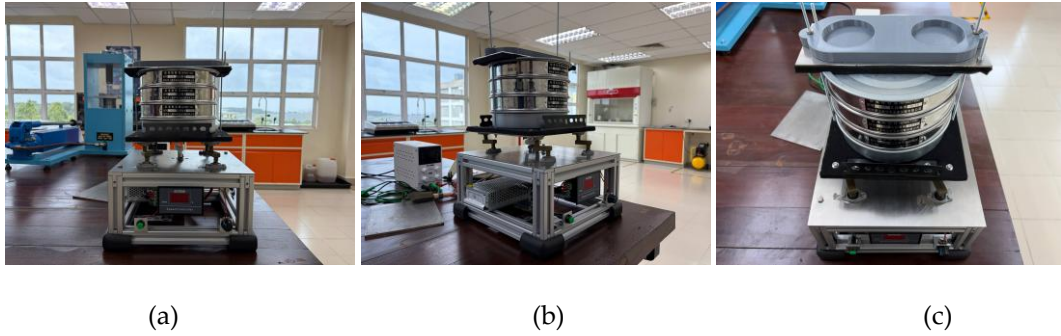


Figure 7. (a) Top view, (b) front view and (c) side view of the completed prototype

4.1.3 Product Testing

The prototype was tested to ensure proper operation and to identify any functional issues. A DC motor was used to generate the required motion for the shaker mechanism. When the system is switched on, the motor drives the linkage to produce continuous orbital movement of the platform. The motion was observed to be smooth and stable during operation, and the platform returned to its stationary position once the power was switched off. This testing confirmed that the mechanical and electrical systems functioned as intended.



Figure 8. Product testing

5. DISCUSSION

Table 1 presents the final specifications of the Multipurpose Orbital Shaker, including details on materials, dimensions, power system, and operating capability. These specifications reflect the design objectives of durability, functionality, and suitability for educational and small-scale laboratory use.

Table 1. Final Product Specification

Types	Specification
Material	Aluminium profile frame & stainless-steel platform
Dimension	200 mm × 400 mm (compact footprint)
Power Source	DC motor with PWM speed controller
Input Voltage	12 V DC

Maximum Load	Up to 15 kg
Operating Speed	Adjustable up to ~260 RPM
Product Capability	Mixing, stirring, and sieving

6. CONCLUSION

In conclusion, the objectives of designing and fabricating a Multipurpose Orbital Shaker were successfully achieved. The issues related to limited equipment access, manual handling, and inconsistent laboratory mixing were addressed through the development of this compact and low-cost device. The prototype demonstrates stable orbital motion, adjustable speed control, and sufficient load capacity, while reducing operator effort and improving experimental consistency. Overall, the shaker provides a practical and affordable solution for educational institutions and small laboratories, supporting effective hands-on learning and experimental work.

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