Design and Developing of EcoDesk Applying Sustainable Machining

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***Abstract*— This study aims to develop a customized study desk for children with special needs, specifically targeting primary school students from the B40 economic category in Durian Tunggal, Malaysia. The primary users, children under the age of twelve, require enhanced support and space to facilitate effective learning. The desk design will focus on improving accessibility, comfort, and practicality to accommodate diverse learning requirements, promoting inclusion and an optimal learning environment. The initiative, organized by UTeM, seeks to support financially disadvantaged families by providing affordable, tailored workstations. Additionally, the desk will be portable, ensuring ease of assembly, disassembly, and storage, thereby reducing academic burdens and fostering better student interaction.**

Keywords*— *disadvantage family, portable workstation, school table, sustainable industry

I. INTRODUCTION

The current design of wooden tables often requires a significant amount of wood to ensure stability and strength, contributing to resource depletion and environmental concerns. There is a need to develop a more sustainable approach to table design that reduces the amount of wood used while maintaining a solid structure [1].

The current design of wooden tables lacks flexibility in requiring tables at different heights for various activities or ergonomic preferences. This limitation restricts the usability and adaptability of wooden tables particularly in environments where users have diverse needs and preferences. As a result, users may experience discomfort or inconvenience while using standard fixed-height wooden tables hindering their productivity and satisfaction [2].

Many users experience discomfort and ergonomic issues while using traditional tables with sharp edges and rough finishes. These issues can lead to discomfort, fatigue, and even injuries during prolonged use. The lack of consideration for ergonomics and user comfort in table design hinders productivity and contributes to user dissatisfaction [3].

The objective is to give a customized study desk designed exclusively for children with special needs, with a focus on primary school kids in the B40 economic category in Durian Tunggal, Malaysia. Children under the age of twelve will be the major users of this desk design as they require greater support and room to enable effective learning. This desk will have aspects designed to improve accessibility, comfort, and practicality for students with a variety of learning requirements ensuring inclusion and encouraging an ideal learning environment for all individuals. Furthermore, it will be targeted to the needs of the B40 community in Durian Tunggal, being reserved for use during study hours, thus reducing the academic burden while motivating students to interact more successfully. The program organized by UTeM, aims to assist those with little financial ability to develop workstations that are exactly customized to their needs, therefore increasing in cutting expenses. Furthermore, the desk will be designed to be portable making it easy to assemble and disassemble for movement and storage.

II. METHODS

We ensure accurate and high-quality project outcomes with a defined methodology with many key components. Each stage builds on the previous one to ensure orderly concept-to-manufacturing progression [4].

The initial phase of the project involves the development of sketches and prototypes, which are subsequently followed by the creation of two-dimensional drawings and comprehensive three-dimensional designs. To ensure the accuracy of the information, this is subsequently followed by the production of 3D drawings that depict each part individually. Subsequently, the components are manufactured using the machining process, with strict adherence to established machining processes to get the intended outcome [4]

A. Sketching and Prototyping

Initially, with hand-drawn sketches, design ideas are generated. These sketches show the planned product's appearance and functionality. Prototypes are developed to improve design ideas after sketching [2].

B. 2D Drawing

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After prototypes, we develop detailed 2D designs. Diagrams show each component's dimensions and properties. Two-dimensional drawings show all pieces appropriately for design and manufacture. Maintaining consistency and precision requires a detailed development plan [5].

C. 3D Design

Improve 2D sketches using modern CAD tools to produce 3D models. These 3D designs show how each item fits and works together by providing a realistic view of the total. By offering virtual assembly and functionality testing, 3D models help us find design issues. This process ensures the finished product meets design standards and works as planned.

D. Machining Process To Fabricate

The full fabrication process involves initially setting up a laser cut machine to precisely cut plywood according to a 2D drawing. Following this, the surface of the wood is polished using sandpaper to eliminate any rough edges, ensuring a smooth finish. The next step involves applying oil paint to enhance the table's appearance, making it visually appealing. During the assembly phase, part 4 is first attached to the bottom of part 2, followed by attaching part 3 to the middle of part 2, and finally, part 1 is applied to the top of all parts, completing the assembly. Any excess glue that remains on unimportant parts is carefully removed during the touch-up process. The final step is to ensure the product is in good condition and safe to use, completing the fabrication process [4].

E. Machining Procedure

By following these steps, the material is properly prepared and secured for the cutting process, ensuring precision and accuracy in the final product. This preparation is vital for achieving high-quality results and minimizing errors during fabrication.

- Prepare a Design File: First, prepare a design file using appropriate computer-aided design (CAD) software. This design will serve as the blueprint for the cutting process [4].
- Set Up the Materials: Next, place the wood material on the cutting bed. It is essential to ensure that the material is flat and securely positioned to prevent any movement during the cutting process. This step is crucial for achieving precise cuts and maintaining the integrity of the design [8].
- Secure the Material: Use clamps to secure the edges of the material. This prevents any movement of the wood during the cutting process, which is vital for maintaining accuracy. Additionally, ensure that the material is properly aligned on the project table. Use rulers or alignment guides to position the material accurately. Proper alignment is critical to ensure that the cuts are made according to the design specifications.
- Start Cutting: Pressing the " Start" button on the laser cutter control panel or software interface.
- Check Cut Quality: After cutting. Examine the edge of the material to ensure clean and precise.

III. Result And Discussion

The static analysis indicates that the table is solid in the middle due to its support mechanism, which prevents bending. The table is also very sturdy because it uses two layers of wood on the legs. With this design, the table's stiffness allows it to cope with weights of 2 kilograms or more per load. See the design in Fig. 1.

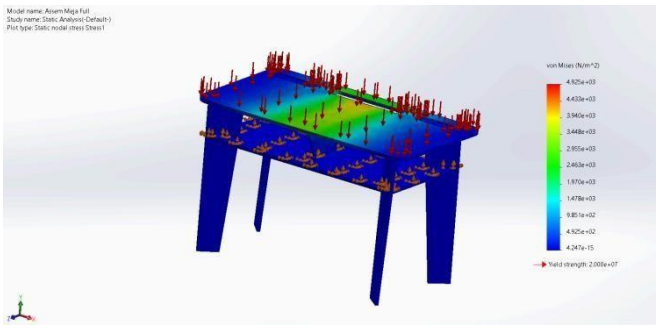


Fig. 1. Static analysis

Discovered that the table has a problem with its support because there is no designated place to install a support part. Additionally, when using the cutting laser, we found that the machine could not engrave the slot part. See Fig. 2 for the engraved slot.

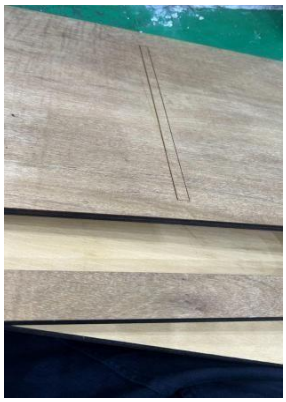


Fig. 2. Engrave Slot

It is crucial to thoroughly research materials before initiating any cutting process, as demonstrated in this project. High-quality plywood was selected for its ease of use with laser cutting equipment, ensuring a smooth manufacturing process. The table project was completed, resulting in a durable and sturdy product. Throughout the process, valuable lessons were learned about the laser cutting equipment, its functionality, and the overall manufacturing steps. Mistakes made along the way provided key insights into improving techniques, making the experience educational and beneficial for future projects involving similar materials and technology.

The development of a customized study desk for children with special needs in Malaysia aligns with the growing emphasis on sustainable and inclusive design in manufacturing. Research has highlighted the importance of implementing sustainable manufacturing practices to overcome economic and environmental challenges, as seen in Malaysia's efforts to balance drivers and barriers in this domain [9]. Eco-design principles, which focus on

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minimizing environmental impacts while ensuring product functionality, are critical to sustainable product development [10]. Additionally, integrating eco-friendly machining techniques, such as the use of sustainable lubricants [11], and alternative cutting fluids [12], enhances the efficiency and environmental impact of manufacturing processes. Sustainable machining technologies not only improve machinability but also contribute to long-term economic and environmental benefits [13]. In the context of Industry 4.0, sustainable manufacturing is increasingly relevant, driving innovation and improving resource efficiency in product development [14]. This research, therefore, aims to contribute to these global efforts by delivering a cost-effective, portable, and sustainable solution for children in the B40 economic group, addressing both their educational and financial needs.

IV. Conclusion

The project's lesson was that it is best to research the materials to be utilized before beginning any cutting. However, utilize high-quality plywood that is simple to cut with laser cutting equipment. The table project was successfully finished and is in wonderful sturdy shape. Through working on this project, learned about the laser cutting equipment as well as the manufacturing process and the mistakes that have been made. Appreciation is extended to Mr. Gazalan for teaching and being willing to work with the group. Prof. Hadzley and Dr. Norfariza are also remembered for their help along the way to ensure the success of this initiative.

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